

# SMART CITIES INDIA READINESS GUIDE

The planning manual for building tomorrow's cities today

Smart**Cities**Council **India**  
Livability | Workability | Sustainability





# Smart Cities India Readiness Guide®

The planning manual for building tomorrow's cities today

## Acknowledgments

The India Readiness Guide is, first and foremost, a collaborative effort. We are grateful for the expertise, the energy and the meticulous diligence of dozens of enthusiastic smart city advocates – subject matter experts from around the world, municipal government leaders and their staffs, technology advocates and business leaders.

We extend our sincere thanks and congratulations to the Lead and Associate Partners of the Smart Cities Council India for their involvement and passion for this project: Tyco, Essel Infra, Orange Smart City, Thomson Reuters, 3M, Fluentgrid, Votarytech, Excelize, TE, Corning; and Lead and Associate Partners of Smart Cities Council for their involvement and passion for this project: Allied Telesis, Alstom Grid, Bechtel, Cisco, Cubic Transportation Systems, Daimler, Enel, GE, IBM, Itron, Inc., MasterCard, Microsoft, Ooredoo, Qualcomm, S&C Electric Co., Schneider Electric, Verizon, ABB Ltd. Alphinat, Apex CoVantage, Badger Meter, Bit Stew Systems, Black & Veatch, CH2M, Civic Resource Group International, Clevest, Elster, Enevo, Entrigna, Imex Systems Inc., Intel, K2 Geospatial, Neptune Technology Group, Organic Energy Corp., OSIsoft, Saudi Telecom, Siemens, Silver Spring Networks, Space-Time Insight, Spire Metering Technology, SunGard Public Sector, TROVE, Urban Integrated, Veolia and West Monroe Partners. Learn more about all of these industry-leading companies beginning on page 331.

The India Readiness Guide would also not have been possible without the help of the Council's Advisory Board, a collection of the world's foremost smart city thinkers, doers and visionaries. Our 60-plus Advisors are listed on page 364 of this Guide's Appendix.

Authors and Key Contributors:

This Guide was written and edited by Smart Cities Council Founder and Director Pratap Padode, Editorial Director Falguni Padode, Editor and Smart Cities Expert Darshana Mali, and research assistants Supriya Gawde and Surekha Yadav.

E-mail: [Pratap.Padode@india.smartcitiescouncil.com](mailto:Pratap.Padode@india.smartcitiescouncil.com)

# TABLE OF CONTENTS

- 1. Introduction to smart cities**
  - 2. How To Use The India Readiness Guide**
  - 3. Universal**
  - 4. Smart People**
  - 5. Built Environment**
  - 6. Energy**
  - 7. Telecommunications**
  - 8. Transportation**
  - 9. Water And Wastewater**
  - 10. Waste Management**
  - 11. Health And Human Services**
  - 12. Public Safety**
  - 13. Finance And Payments**
  - 14. Ideas To Action**
- Appendix**



**Welcome to the Smart Cities India Readiness Guide. This document was assembled with input from many of the world’s leading smart city practitioners — the members and advisors of the Smart Cities Council India and Smart Cities Council. It will help you create a vision for the future of your own city. Equally important, it will help you build an action plan to get to that better future.**

# 1 Introduction To Smart Cities

**T**hrough the India Readiness Guide, the first and foremost goal is to give you a 'vision' of a smart city, to help you understand how technology will transform the cities of tomorrow and how people will contribute in enhancing and realising the transformation.

The second goal is to help you construct your own roadmap to that future. It suggests the goals to which you should aspire, the features and functions you should specify, the best practices that will gain you the maximum benefits for the minimum cost, at reduced risk, and the collaborative environment you should create to envisage and assimilate all aspects of smart cities together.

The India Readiness Guide is intended for mayors, city managers, city planners and their staffs. It helps cities help themselves by providing objective, vendor-neutral information to make confident, educated choices about the technologies that can transform a city.

Cities around the world are already making tremendous progress in achieving economic, environmental and social sustainability, in the creation of 21st century jobs. All of these are excellent ways to improve city living standards and economies. The concept of smart cities doesn't compete with these efforts. Instead, smart city technologies can support and enhance work already underway.

This introductory section defines smart cities and then explores the current environment and drivers of smart cities in India. Then it looks at the various supporting government missions. And, then it discusses some of the barriers cities may face and benefits it will bring.

## Taking a holistic view of 'city'

Before we define the 'smart' piece, however, we should first deal with the word 'city'. Real-world smart city examples are rarely a city in the strictest term. Many are more than a single city, such as a metropolitan region, a cluster of cities, counties and groups of counties, a collection of nearby towns or a regional coalition. Other examples are less than a full-scale city, such as districts, neighbourhoods, townships, villages, campuses and military bases. Indeed, many municipalities are taking a neighbourhood-by-neighbourhood approach to modernisation. This Guide is designed to address all of these human ecosystems.

Because it is in common use, we will continue to use 'city' throughout this Guide. But we use it to mean all relevant examples big and small. Regardless of size, we are taking a comprehensive, holistic view that includes the entirety of human activity in an area,

including city governments, schools, hospitals, infrastructure, resources, businesses and people. As you'll read, smart technologies have matured to the point that cities of all sizes can afford and benefit from their implementation. For example, new cloud computing offerings allow even the smallest city to affordably tap into enormous computing power. So the lessons of this Guide apply regardless of size and you'll see real-world examples in the case studies featured throughout.

The transition to smart cities will be a long and gradual one. Ten years from now, the transition will have been made in the minds of citizens and decision-makers. We will have many smart city pilots providing new insights for future projects and developments.

## The definition of a smart city

The advancement in technologies and open, collaborative partnerships will drive the speed and magnitude of changes. Collaborative innovation and integration is the key to transformation of smart cities, today and in the future.

A smart city uses information and communications technology (ICT) to enhance its livability, workability and sustainability. In simplest terms, there are three parts to that job: collecting, communicating and ‘crunching’. First, a smart city collects information about itself through sensors, other devices and existing systems. Next, it communicates that data using wired or wireless networks. Third, it ‘crunches’ (analyses) that data to understand what’s happening now and what’s likely to happen next.

**Collecting data.** Smart devices are logically located throughout the city to measure and monitor conditions. For instance, smart meters can measure electricity, gas and water usage with great accuracy. Smart traffic sensors can report on road conditions and congestion. Smart GPS gear can pinpoint the exact locations of the city’s buses or the whereabouts of emergency crews. Automated weather stations can report conditions. And the mobile devices carried by many city dwellers are also sensors that can — when specifically authorised by their users to do so — collect their position, speed, where they cluster at different times of the day and the environmental conditions around them. Smart phones also gauge an always-local, perpetually renewable but inherently limited natural resource — radiofrequency spectrum — that smart cities depend on and will ultimately need to manage.

A smart city, then, is one that knows about itself and makes itself more known to its populace. No longer do we have to wonder if a street is congested — the street reports its condition. No longer do we have to wonder if we’re losing water to leaks — the smart water network detects and reports leaks as soon as they occur. No longer do we have to guess the progress of the city’s garbage trucks — the trucks report where they’ve been already and where they are headed next.

**Communicating data.** Once you’ve collected the data, you need to send it along. smart cities typically mix and match a variety of wired and wireless communications pathways, from fibre-optic to cellular to cable. The ultimate goal is to have connectivity everywhere, to every person and every device. Interoperability is a key requirement.

## THE THREE CORE FUNCTIONS OF A SMART CITY

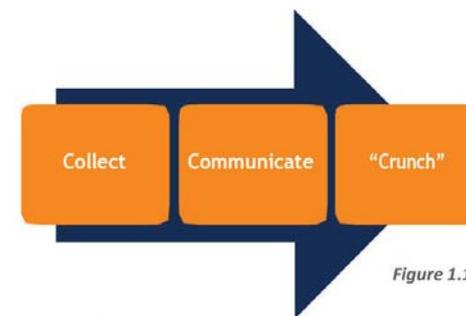


Figure 1.1

- 1 Collect**  
*information about current conditions across all responsibility areas (power, water, traffic, weather, buildings, etc.).*
- 2 Communicate**  
*information, sometimes to other devices, sometimes to a control center and sometimes to servers running powerful software.*
- 3 Crunch**  
*data, analyzing it to present information, to perfect (optimize) operations and to predict what might happen next.*



### Smart cities collect, communicate and crunch data:

*The city of Rio de Janeiro collects information from 30 different city departments about transportation, water, energy, weather, and other conditions. Then it communicates those conditions to powerful computers, which crunch the data and present it in a unified control center the city developed with IBM. Not only does the city gain full situational awareness, it can even predict some conditions in advance, such as where floods will occur during severe storms.*

**Crunching data.** After collecting and communicating the data, you analyse it for one of these three purposes: 1) presenting, 2) perfecting or 3) predicting. If you've read about "analytics" or "Big Data," then you may already know about the astonishing things that become possible by analysing large amounts of data. Importantly, analysing data turns information into intelligence that helps people and machines to act and make better decisions. This begins a virtual cycle wherein data is made useful, people make use of that data to improve decisions and behaviour, which in turn means more and better data is collected, and thereby further improving decisions and behaviour.

- 1. Presenting** information tells us what's going on right now. In the aerospace and defence industries, they call this "situational awareness." Software monitors the huge flow of incoming data, then summarises and visualises it in a way that makes it easy for human operators to understand. For instance, a smart operations centre can monitor all aspects of an emergency situation, including the actions and locations of police, fire, ambulances, traffic, downed power lines, closed streets and much more.
- 2. Perfecting** operations uses the power of computers to optimise complex systems. For instance, balancing the supply and demand on an electricity network, or synchronising traffic signals to minimise congestion, or selecting the ideal routes for a delivery fleet to minimise time and fuel costs, or optimising the energy usage of an entire high-rise to achieve maximum comfort, or to balance the grid with the optimal mix of renewable and traditional power sources at any given point of time.
- 3. Predicting** what's next is perhaps the most exciting part of analytics. Singapore uses data to predict traffic jams while there is still time to minimise their effects. Rio de Janeiro predicts just where flooding will occur from a particular storm, so emergency crews know just where to go.



**Livability, workability and sustainability are the goals:**

## **OTHER SMART CITY DEFINITIONS**

**T**he Council defines a smart city as one that “uses information and communications technology (ICT) to enhance its livability, workability and sustainability.” Other organizations have their own definitions. For instance, Forrester Research emphasizes the use of computing to monitor infrastructure and improve services: “The use of smart computing technologies to make the critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation and utilities – more intelligent, interconnected and efficient.”

The U.S. Office of Scientific and Technical Information also stresses infrastructure, explaining that “a city that monitors and integrates conditions of all of its critical infrastructures -including roads, bridges, tunnels, rails,

subways, airports, seaports, communications, water, power, even major buildings – can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens.”

Meanwhile, in 2010 IBM’s Journal of Research and Development paid particular attention to the wide range of smart devices that collect information, calling it “an instrumented, interconnected and intelligent city.”

These and other definitions are valid and helpful understandings of what smart cities are. The Council stands behind its comprehensive definition. But we mention these others so that cities that have planned and invested under these and other models will understand that we share complementary, not competitive, views of the smart city.



**Livability, workability and sustainability are the goals:**

*Smart cities use information and communications technologies to achieve them. Seoul, South Korea – pictured here – is often cited as one of the world’s most vibrant, sustainable cities.*



As we'll see in more detail, a smart city is a system of systems — water, power, transportation, emergency response, built environment, etc., — with each one affecting all the others. In the last few years, we've refined our ability to merge multiple data streams and mine them for amazing insights. It is those insights — presenting, perfecting and predicting — deployed in a creative way that enhance the livability, workability and sustainability of a smart city.

## The drivers of smart cities

Powerful forces are converging to make smart cities a growing trend all around the world. It is valuable for city leaders to understand what's behind this momentum and how it will play out in their region. Chances are some of the pain points described below will hit close to home.

**Growing urbanisation.** Cities deliver many benefits — greater employment opportunities, greater access to healthcare and education, and greater access to entertainment, culture and the arts. As a result, people are moving to cities at an unprecedented rate.



### Growing urbanisation:

*Cities provide lucrative employment opportunities, greater access to healthcare and education, and greater access to entertainment, culture and the arts. As a result, people are moving to cities at an unprecedented rate. By 2031, cities will account for nearly 70% of India's GDP and about 600 million people are expected to live in India's cities, according to the World Bank.*

Cities can derive benefit by collecting, communicating and analysing information from a single department. But the greatest benefits come when data is connected with multiple departments and third parties. Many cities combine historic traffic data with information about population growth and business expansion to know when and where to add or subtract bus and train routes. Other cities correlate multiple data sources to predict crime the way we predict weather.

Although India is on the path to have a great number of people in cities in less than a decade, the proportion of Indian citizens living in cities is still low — 31% urbanisation rate compared to a rate of 54% (758 million) in China, 53% (134 million) in Indonesia and a whopping 85% (173 million) in Brazil. By 2031, cities will account for nearly 70% of India's GDP and about 600 million people are expected to live in India's cities, according to the World Bank.

Moreover, India's urban growth is largely concentrated in large cities with a population of 100,000 or more. Three of India's cities are among the top most populous in the world – Delhi (25 million) ranking in the top five, followed by Mumbai and Kolkata. As a result, the number of cities with a population exceeding 1 million has increased from 35 in 2001 to 53 in 2011, and is expected to be 87 by 2030. Conversely, population growth in smaller towns and cities (of below 100,000 people) has tended to stagnate and even decline — with the share of the population in towns decreasing from 31% in 2001 to 28%.

**Growing stress.** Such high concentration of people in Indian cities pose many challenges to municipalities and local authorities, among them mass migration, environmental and regulatory requirements, declining tax bases and budgets and increased costs — at the same time many cities are experiencing

difficult growing pains ranging from increasing pollution, traffic congestion, poor healthcare, insufficient water and sanitation systems, crowding and sprawl to inadequate housing, high unemployment, and rising crime rates and security issues.

**Inadequate infrastructure.** Urbanisation is putting significant strain on city infrastructures that were, in most cases, built for populations a fraction of their current size. Much of the developed world has infrastructure that is near or past its design life, requiring massive upgrades. For instance, in 2013 the American Society of Civil Engineers gave the United States an overall grade of D+ for its infrastructure. Meanwhile, much of the developing world has missing or inadequate infrastructure, requiring massive build-outs. The 2012 blackout in India that left more than 600 million people without electricity is a prime example; the country has inadequate power generation to meet ever-increasing demand. The bottom line? McKinsey & Company estimates that cities will need to double their capital investment by 2025, to \$20 trillion from today's \$10 trillion per year.

**Growing economic competition.** India is facing a dual problem; in search of better employment opportunities and quality of life, there are two growing trends — mass migration to large Indian cities as well as the best talent leaving the country. This

leads to severe competition between cities to secure investments, jobs, businesses and talent for economic success. Increasingly, both businesses and individuals evaluate a city's 'technology quotient' in deciding where to locate. A real challenge for cities with economies based on heavy industry is creating job opportunities that appeal to recent university graduates so that they will stay and help build the kind of high-quality workforce that new industries, for instance those in technology, demand.

**Growing expectations.** Citizens are increasingly getting instant, anywhere, anytime, personalised access to information and services via mobile devices and computers. And they increasingly expect the same kind of access to city services. In fact, a May 2013 United Nations survey of over 560,000 citizens from 194 countries revealed that their top priorities are a good education, better healthcare and an honest and responsive government. We also know that people want to live in cities that can provide efficient transportation, high-bandwidth communications and healthy job markets.



### **Rapidly improving technology capabilities:**

*The reduced costs of solar energy and renewables systems (distributed generation) are increasing adoption rapidly in homes and businesses. By balancing these new resources with the grid, cities can increase their energy sustainability.*

Hundreds of millions of smart meters and smart sensors are now in place, producing data of value to a smart city.

- With the arrival of smart thermostats and building management systems, there are now millions of buildings with some of the pieces needed to be smart, on the cusp of being able to 'talk' and 'listen.'
- The reduced costs of solar energy and renewables systems (distributed generation) are increasing adoption rapidly in homes and businesses. By balancing these new resources with the grid, cities can increase their energy sustainability.
- On the health and human services front, we're seeing better access to healthcare with in-home consultations via computers. Meanwhile, most agencies are switching to electronic records and many are using analytics to improve results.
- An increasing number of cities are starting to benefit from a large network of Near-field Communication (NFC) equipped point of sales with the rollout of contactless cards.

**Growing environmental challenges.** Cities house half of the world's population but use two-thirds of the world's energy and generate three-fourths of the world's CO2 emissions. If we are going to mitigate climate change, it will have to happen in cities. Many regions and cities have aggressive climate and environmental goals — goals that cannot be reached without the help of smart technologies. Smart cities are better able to address resiliency and adaptation to climate change.

**Rapidly improving technology capabilities.** Many of the smart city drivers listed above are negatives — problems that demand solutions. There are positive drivers as well, especially the rapid progress in technology. The costs of collecting, communicating and crunching data have plunged. What's more, much of the needed technology is already in place:

- Over the last decade, many regions have begun to modernise their electric power grids and their water and gas networks.

- Our highways and byways are becoming smarter thanks to intelligent transportation management software, roadway sensors and smart parking apps. Navigation apps and equipment display real-time traffic so users can find — and even be automatically pointed to — less congested alternatives. And we are seeing more electric vehicles on our roads which help reduce pollution and our dependence on oil.
- Over the last two decades, we have deployed high-bandwidth networks worldwide that connect one billion computers and four billion cell phones. These networks are already in place in almost all major cities and can be leveraged for smart city applications.

Let's consider that final example in more detail. It's important to realise that today's ubiquitous smartphones are becoming both a 'delivery platform' and a 'sensor network' for smart city applications. The delivery platform is obvious – a smartphone is a great place for a resident to receive alerts and access city services. But today's smartphones can also be leveraged to collect information when the user agrees to share data. For instance, one smartphone launched in 2013 has the following sensors: a GPS locator, a microphone, a gyroscope, a light sensor, a camera, an accelerometer, a barometer, a thermometer, a magnetometer and a hygrometer. Once in

place, that technology provides the basis for a wide range of innovative smart city applications and services.

**Rapidly declining technology costs.** Even as capabilities are climbing, technology costs are plummeting. Hardware costs are declining at a steady pace. But it is software costs that have plunged the most, thanks to four trends.

The first trend is the advent of inexpensive mobile apps and information services viewable by mobile phones. Those phones are so popular that millions of developers have turned their attention to building applications, many of which cost only a few dollars. Mobile technology has allowed citizens of developing countries to essentially leapfrog into 21st century expectations — and cities have to find ways to address them.

The second trend is the arrival of social media. Applications such as Facebook and Twitter act as free 'platforms' to deliver alerts, updates or even small-scale apps. They also act as 'listening posts' that help cities monitor citizen needs and preferences. In fact, companies such as IBM and Microsoft now have the capability to use machine intelligence to monitor social media and derive trends.

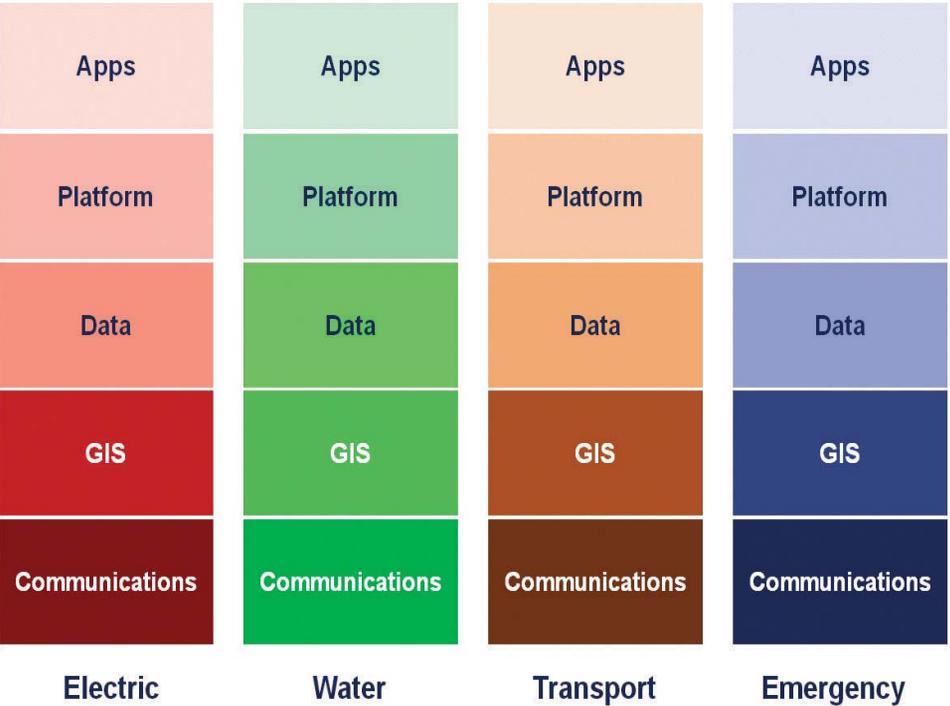
The third trend is the maturation of cloud computing. Cloud computing delivers powerful solutions via the Internet. Suppliers save

money because they can build one solution and sell it to many different users, gaining tremendous economies of scale. Users save money because they don't have to buy and maintain giant data centres or hire and train large IT staffs. Only a few years ago, advanced applications were available only to the very biggest agencies and corporations. Today — thanks to cloud computing — they are not out of reach for even the smallest township. And they are available without a giant upfront investment, simply by paying a monthly fee.

The fourth trend is about the data. From an analytics perspective, we can now cost-effectively handle the high volume, velocity and variety of data – e.g., Big Data.

**And there's much more to come.** The smart city is part of an even larger trend — the "Internet of Things". Technology provider Cisco estimates there were 200 million devices connected to the Internet in the year 2000. By 2012, that number had increased to 10 billion. A 2015 report from Cisco and DHL predicts there will be 50 billion devices connected to the Internet by 2020.

No surprise the world's biggest corporations and brightest entrepreneurs are racing to bring their best ideas to this market. And the fierce competition is raising capabilities, increasing choice and lowering costs at a rapid pace, making Smart cities more viable every day.



**Expensive redundancies:**

*Despite the fact that modern IT architectures make it possible to connect city departments and solutions today, far too many cities still use a "siloeed" approach to smart city applications.*

Building a smart city requires a system-wide view and an integrated, cross-departmental approach. The bad news: holistic thinking and collaborative work are hard. The good news: done right, they can save time and enable new services that were not possible in an isolated, siloed model. For instance, a city department can drastically cut the development time for a new application by re-using data and software modules already created by other departments. A municipal water utility can drastically cut the cost of a communications network by using one already built out for an electric utility. And a city can sometimes reduce overall information and communications technology (ICT) costs by as much as 25% just by implementing a master ICT architecture and technology roadmap.

## The barriers to smart cities

Despite the powerful drivers directing this movement, the path to smart cities has significant obstacles along the way. Smart cities are not a quick, one-time win. Given the long investment cycles, they require a continuous and prolonged effort in order to be successful. Members of the smart cities Council have worked on thousands of smart city projects all over the world. As they've collaborated with local governments, certain consistent barriers have emerged.

**Siloed, piecemeal implementations.** Cities often tackle challenges in a piecemeal fashion, due to short-term financial constraints and long-term traditions that divide city functions into separate, 'siloeed' departments with little interaction. As a result, many projects are built to solve a single problem in a single department, creating 'islands of automation' that duplicate expenses while making it difficult to share systems or data.

This is not to suggest that cities must finance and implement dozens of investments at one time. In fact, it is entirely fine to begin with just one or two projects. What is critical is that these projects all fall into a larger, integrated plan so that city investments are not redundant. Silo avoidance depends on the use of widely adopted open international standards.

Most experts agree that technology will not be the gating factor for the smart city transformation. Instead, we will be limited by our human ability to coordinate and collaborate between departmental and technology silos.

**Lack of financing.** Tax revenues are shrinking in many cities, making infrastructure projects increasingly difficult to finance. In fact, some cities have been forced to implement austerity measures — such as furloughing employees one day a month or cutting back on travel and discretionary expenses. Yet if those cities remain old-fashioned while others modernise, they will suffer even more, since cities must now compete globally. Fortunately, new financial models are emerging. And payment innovations like e-procurement or electronic benefits can help cities reduce costs and free up money to invest in infrastructure and other improvements. Some of them require little or no upfront capital from the city. Instead, the city “rents” its solution as it goes. And performance contracts and shared revenue models between the city and solution vendors provide cities with attractive financing solutions. What’s more, many smart city solutions have a rapid payback so that they save money over the long run. In many cases, the technology can actually improve the city’s economic return.

**Lack of ICT knowhow.** Although industry has developed highly sophisticated ICT skills, few city governments have had the budget or the vision to push state-of-the-art solutions. In India, technologies have been adapted at a brisk pace over the last couple of years especially with growth in smartphones and social media. However, going into the future,



due to lack of interfaces and tools developed, citizens are not yet fully acquainted with the power that they have to manage their resources. Since smart cities are essentially the injection of ICT into every phase of operations, this lack of ICT skills puts cities at a disadvantage.

Fortunately, more and more applications are being offered as a service. That is, they are hosted in the cloud (out on the Internet) where they have access to tremendous computing power virtually unlimited storage and innovative software.



### **The barriers to smart cities:**

*Despite the powerful drivers in favor, the path to smart cities has obstacles along the way. Sometimes it comes down to lack of a smart city visionary.*

Another plus is that the smart city sector has developed a large cadre of experienced global, regional and local consultants and service providers who are partnering with cities to deploy ICT solutions.



water usage, their taxes and fees, their social services programs and more. And ideas like Open Data not only improve transparency, they enforce a citizen-first perspective that is critical in smart cities.

**Lack of citizen engagement.** The smart cities movement is often held back by a lack of clarity about what a smart city is and what it can do for citizens. As a result, many stakeholders are unaware of the smart city options that have found success already. Cities need to recognise when they need citizen and business awareness versus complete 'buy-in.'

Remedying the citizen engagement challenge will require visionary leadership that paints a picture of the benefits technology can bring. In the US in the late 2000s, several electric power utilities learned this lesson the hard way. They rolled out smart meters without explaining how customers would benefit. They suffered consumer backlash and resistance as a result.

**Lack of a smart city visionary.** Every parade needs a leader. Sometimes that leadership comes from an elected official — a mayor or council person who acts as the smart city champion. smart city leadership can also come from elsewhere in the administration — a city manager or a planning director, for instance. Or it can come with involvement from business leaders, civic organisations or public-private partnerships.



### The barriers to smart cities:

*Despite the powerful drivers in favor, the path to smart cities has obstacles along the way. Sometimes it comes down to lack of a smart city visionary. Cities need a smart city champion – a mayor, a city manager, a planning director.*

**Lack of integrated services.** The extent of ICT applied by the cities in the past was to their internal, siloed operations. The result has been a grab-bag of aging applications that only city employees can use. Although this was an acceptable practice in the last century, today we can and must allow citizen access and self-service. There is no reason that citizens who want, for instance, to open a restaurant should have to make multiple applications to multiple city departments. In a smart city, a single portal can gather all the data and parcel it out to the appropriate departments. Likewise, residents should have instant access to up-to-the-minute information about their energy and



# JOIN LEARN A SKILL, EARN FAME AND REWARD TOO.

Achieve inclusivity:

## DRIVING FINANCIAL INCLUSION THROUGH SKILL DEVELOPMENT

The National Skill Development Corporation (NSDC), a Public Private Partnership initiative of the Government of India aims to promote skill development by funding 'for profit' vocational training institutions that provide skills-based training to the youth making them employable. NSDC has set an ambitious target of skilling 150 million youths by 2022.

Under its National Skills Certification and Monetary Rewards Scheme, NSDC encourages skill development in youth by providing monetary rewards for successful completion of approved training programs. The scheme strives to achieve standardisation in certification process and creation of a registry of skills. Under this scheme, successful candidates receive Rs. 10,000 on an average for courses that run for nearly 4-6 weeks. At an estimated total cost of Rs. 10,000 million, about 1 million youth were targeted to benefit from this.

NSDC collaborated with Council member MasterCard to devise a model to facilitate electronic disbursement of this benefit. MasterCard brought in a bank partner with a trusted name to participate in the program. The bank opens current accounts for training institutions as well as zero-balance savings accounts for trainees.

As a part of the account opening kit, the bank issues MasterCard Debit Cards to the trainees. Keeping the program construct in mind, trainees' accounts are created with a hold that is equal to the course fee and a provision of one-time auto debit.

Upon successful completion of the course NSDC transfers scholarships to trainees' bank account. Due to the hold, the fee amount then gets auto-debited from the accounts and credited to the training institutions' current account.



Achieve inclusivity:

*The program has been a big success with about two-thirds of the candidates getting employed after passing out. The program achieves financial inclusion by opening bank accounts for underprivileged youth trainees and succeeds in building a lasting relationship between the bank and these beneficiaries.*

The hold on the trainees' accounts is automatically released thereafter. There after the accounts get classified as Payroll accounts for receiving salary/payment credits.

NSDC supports the economics of this business model by making a limited period fixed deposit with the bank. Other sources of income for the bank include balances in current accounts opened for training institutions and continuing credit balances in trainees' accounts.

The innovative program construct has enabled efficient disbursement of benefits thereby reducing leakage.

The program has been a big success with about two-thirds of the candidates getting employed after passing out. The program achieves financial inclusion by opening bank accounts for underprivileged youth trainees and succeeds in building a lasting relationship between the bank and these beneficiaries.

## The benefits of smart cities

Running today's cities is becoming increasingly complex and challenging. But the integration of innovation and ICT interconnecting the various systems in the cities is opening up new opportunities. Let's look at why it is so worthwhile to overcome those barriers and take advantage of the technology advances described earlier that allow you to re-imagine your city.

With the right vision, planning and investment, government leaders can make our cities more liveable, more workable and more sustainable. Let's examine those overall goals, which are the very purpose of becoming smart.

**Enhanced livability** means a better quality of life for city residents on a day-to-day basis and during major events or crises. In the smart city, people have access to a comfortable, clean, engaged, interconnected, healthy and safe lifestyle. Some of the most highly valued aspects include inexpensive energy, convenient mass transit, good schools, faster emergency responses, clean water and air, low crime and access to quality green spaces, entertainment and cultural options. Smart cities improve lives of people today and in the future.

**Enhanced workability** means accelerated economic development. Put another way, it means more jobs and better jobs and increased local GDP. In the smart city, people have access to the foundations of prosperity

— the fundamental infrastructure services that let them compete in the world economy. Those services include clean, reliable, inexpensive energy; broadband connectivity; educational opportunities; affordable housing and commercial space; and efficient transportation.

**Enhanced sustainability** means giving people access to the resources they need without compromising the ability of future generations to meet their own needs. Merriam-Webster defines sustainability as a method of using a resource so that it is not depleted or permanently damaged. When the Council uses the term, it refers not only to the environment, but also to economic realities.



Enhancing livability, workability and sustainability:

## REVITALISING D.C.'S RIVER WATERFRONT AND URBAN NEIGHBOURHOODS

In a partnership among 19 federal and District of Columbia government agencies, the Anacostia Waterfront Initiative (AWI) is bringing communities together and residents to the doors of new businesses.

AWI is a trailblazing endeavor that is removing physical barriers and opening a gateway to the future by transforming a once disconnected and deficient urban environment.

Council member CH2M is working alongside the District Department of Transportation on this visionary urban revitalization, helping to transform neighborhoods in the nation's capital and create lasting legacies by amplifying their unique strengths.

The 30-year, \$10 billion project is restoring the long-neglected Anacostia Waterfront, reconnecting neighborhoods and showcasing their historic and cultural identity.

Aimed to leverage private investment in the economy and provide a cleaner river environment, AWI offers residents and businesses blocks of revitalized urban areas through multi-modal transportation, waterfront parks and recreation areas. Serving as the spine of the economic revitalization, the transportation infrastructure is connecting new mixed-use development areas along key corridors. The conversion of highways to urban boulevards, improved connectivity between neighborhoods and the elimination of regional travelers from local streets is improving development opportunities, commuter traffic flow and quality of life for local residents.



Enhancing livability, workability and sustainability:

*The anacostia projects in Washington D.C. is transforming a once disconnected and deficient urban environment.  
Image: Topos magazine*



### Three key aspects of smart cities:

*Sustainability is achieved at local level through context-specific initiatives, by integrating social, environmental, and economic performance.*

*Image: CH2M HILL*

smart cities enable the efficient use of natural, human and capital assets, and promote resources and cost saving in times of austerity, and they are careful stewards of taxpayer dollars. Though sustainability is a broader concept, in practice the sustainability is achieved primarily through local vision and initiatives focusing on three key aspects — social, environmental, and economic.

It isn't about investing huge sums of money into new infrastructure, it's about optimising the infrastructure, making it do more and last longer for less. In the smart city, the sustainability encompasses a broader concept, achieved through context-specific local level initiatives, enhanced by integrating social, environmental, and economic sustainability.

Life is better in a smart city — better for people and better for businesses. In the chapters to come, we will discuss dozens of specific benefits that accrue to cities that embrace the smart city vision.

## India's move towards formulating smart cities

In India, there are multiple missions and yojanas are in motion, which are a step in the direction of achieving smart and sustainable growth.

Funds are available to the city administration from Digital India, Swachh Bharat Mission, Smart Cities Mission, AMRUT, HRIDAY as part of different programs. These programs come with guidelines as under:

**Land Pooling.** Inclusiveness, financially wise solution, expedites project execution

**Transparency.** Concrete well incubated plans for long term attract firm investments, faith in execution and delivery enhances value of investment

**Financial sustainability.** Projects which can sustain by user charges, capital costs which are structured in a gradual gradient, analysis of accounts and mapping alongwith need assessment of cities/state

**Capacity building.** Training for conceptualising projects, monitoring, maintenance and replacement

**E-Governance.** Winning the confidence of citizens by an efficient grievance redressal system, accountability on government services to respond within time frames for raising objections, use of information technology (a'la Income Tax etc)

**Technology.** Universal open protocol systems, open data, security, privacy, ability to measure and allocate resources

**Resilience.** Disaster management strategy, emergency citizen protection protocol, rebuilding, reconnecting

**Inclusiveness.** Planning projects to meet the provision of benchmarks for healthcare, education, job opportunities

**Retrofitting.** Policies to measure the effectiveness of using current legacy systems integrated with new systems and ascertainment of the point of replacement

**Social Cost.** All projects to be planned and executed bearing in mind social cost which may include inconvenience to citizens, users, investors versus the cost of lack of facility being installed.

It is a first that such a competition is taking place between cities vying for funds for development with time lines. Further the city administrations are working with empaneled consultants to draw up plans for competing in the challenge. While the larger metro cities have had exposure to such plans and projects, it is the smaller cities that are seeing a revolution in introspection. The Government has introduced the 'Smart City Challenge', handing over the onus of planned urbanisation to the states. In the approach to the Smart Cities Mission, the objective is to promote cities that provide core infrastructure and offer quality of life to citizens, a clean and sustainable environment and application of 'smart' solutions.

Most of the challenge in building smart cities lies in the 'mindset' of the municipal cadre, which has not known better than to complete 'tasks' without timelines and has had absolutely no concept of 'qualitative benchmarking' and 'citizen satisfaction'. The challenge has done well on this yardstick to mandate the involvement of citizens in the city development plans, so submitted. This has yielded the breaking of the first silo which holds back consultative approach in building cities. 'Siloism' is the bane of city development. The chain of road diggers right from the telecom department to the electricity department to the water department, often consecutively, is the most legendary example

of the 'silo' effect. Financing cities is the third big obstacle in city development. The only couple of times that a municipal bond issue has been able to raise some funds was once in 1995 in Gujarat and then another in Tamil Nadu with very mixed results. The municipal finances have suffered due to frequent changes in commissioners and senior officers, political interference, lack of accountability and so on. With a weak balance sheet and a weak recourse for the lenders, money has not moved in this direction. But to sustain cities this is a bridge that we will have to cross. Here are some other challenges which the Smart Cities Mission has to face:

- 1. Retrofitting existing legacy city infrastructure to make it smart.** There are a number of latent issues to consider when reviewing a smart city strategy. The most important is to determine the existing city's weak areas that need utmost consideration, e.g. 100-per-cent distribution of water supply and sanitation. The integration of formerly isolated legacy systems to achieve citywide efficiencies can be a significant challenge.
- 2. Financing smart cities:** The High Power Expert Committee (HPEC) on Investment Estimates in Urban Infrastructure has assessed a per-capita investment cost (PCIC) of Rs 43,386 for a 20-year period. Using an average figure of 1 million people

in each of the 100 smart cities, the total estimate of investment requirements for the smart city comes to Rs 7 lakh crore over 20 years (with an annual escalation of 10 per cent from 2009-20 to 2014-15). This translates into an annual requirement of Rs 35,000 crore. One needs to see how these projects will be financed as the majority of project need would move through complete private investment or through PPPs (public-private partnership).

- 3. Generating resources by cutting down wastage.** Buildings consume nearly 40% of the city energy requirements. Yet the guidelines on their ability to contain wastage of electricity by use of good quality insulation or standards in use of HVAC are left to the choice of the developers who have no interest in curbing the wastage inbuilt in their faulty construction as they are waiting to dispose the asset. Green ratings too fall short in their audit mechanism and do not pull up buildings which fail to adhere to the guidelines once year on year. Similarly water wastage through leaking pipelines causes a strain in supply of drinking water. Rain water harvesting is finally now made mandatory in some states. Higher level of compliance should be mandated through guidelines with penalties to curb wastage as huge resources can be generated from within.

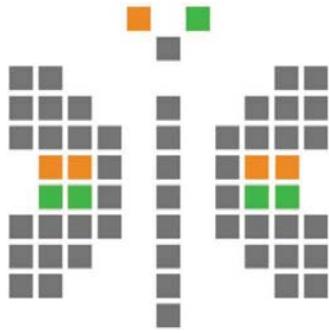
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- 4. Financial sustainability of ULBs.** Most ULBs are not financially self-sustainable and tariff levels fixed by the ULBs for providing services often do not mirror the cost of supplying the same. Even if additional investments are recovered in a phased manner, inadequate cost recovery will lead to continued financial losses.
- 5. Technical constraints of ULBs.** Most ULBs have limited technical capacity to ensure timely and cost-effective implementation

and subsequent operations and maintenance owing to limited recruitment over a number of years along with inability of the ULBs to attract best of talent at market competitive compensation rates.

- 6. Three-tier governance.** Successful implementation of smart city solutions needs effective horizontal and vertical coordination between various institutions providing various municipal amenities as well as effective coordination between central government (MoUD), state government and local government agencies on various issues related to financing and sharing of best practices and service delivery processes.
- 7. Providing clearances in a timely manner.** For timely completion of the project, all clearances should use online processes and be cleared in a time-bound manner. A regulatory body should be set up for all utility services so that a level playing field is made available to the private sector and tariffs are set in a manner that balances financial sustainability with quality.
- 8. Dealing with a multivendor environment.** Another major challenge in the Indian smart city space is that software infrastructure in cities contains components supplied by different vendors.

Hence, 'interoperability', the ability to handle complex combinations of smart city solutions developed by multiple technology vendors becomes very significant.

- 9. Capacity building programme.** Building capacity for 100 smart cities is not an easy task and most ambitious projects are delayed owing to lack of quality manpower, both at the centre and state levels. In terms of funds, only around 5 per cent of the central allocation may be allocated for capacity building programs that focus on training, contextual research, knowledge exchange and a rich database. Investments in capacity building programs have a multiplier effect as they help in time-bound completion of projects and in designing programs, developing faculty, building databases as well as designing tool kits, decision support systems, and time lag right at the beginning.
- 10. Reliability of utility services.** For any smart city in the world, the focus is on reliability of utility services, whether it is electricity, water, telephone or broadband services. Smart cities should have universal access to electricity 24x7; this is not possible with the existing supply and distribution system. Cities need to shift towards renewable sources and focus on green buildings and green transport to reduce the need for electricity.



# Smart City

MISSION TRANSFORM-NATION

## SMART CITIES MISSION

The smart cities Mission is an innovative and new initiative by the Government of India to drive economic growth and improve the quality of life of people by enabling local development and harnessing technology as a means to create smart outcomes for citizens.

### Purpose

The objective of the smart cities Mission, is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions. The focus is on sustainable and inclusive development and

the idea is to look at compact areas, create a replicable model which will act like a light house to other aspiring cities. The smart cities Mission is meant to set examples that can be replicated both within and outside the smart city, catalysing the creation of similar smart cities in various regions and parts of the country.

### Scope & Strategy

Under this scheme, 100 selected cities will get funds amounting to Rs.100 crore per year for the next five years. The cities will be selected through a 'city challenge competition' that will be conducted in each state. States will then shortlist a smart city based on specified norms. Special emphasis will be given to participation of citizens in prioritizing and planning urban interventions.

The strategic components of Area-based development in the smart cities Mission are city improvement (retrofitting), city renewal (redevelopment) and city extension (green field development) plus a Pan-city initiative in which Smart Solutions are applied covering larger parts of the city.

### Thrust

Focus of this mission will be on core infrastructure services such as clean water supply, power supply, robust IT connectivity,

governance, e-governance and citizen participation, safety and security of citizens, health, education and sustainable urban environment. The objective of building 100 smart cities is to promote adoption of smarter solutions for efficient use of available resources, assets and infrastructure. This is to enhance the quality of urban life and promote a clean and sustainable environment.

The smart city action plans will be implemented by Special Purpose Vehicles (SPV) that will be set up for every city and state government to mobilize resources accordingly.

### Financing of smart cities

The smart city Mission will be operated as a Centrally Sponsored Scheme (CSS) and the Central Government proposes to give financial support to the Mission to the extent of Rs. 48,000 crores over five years i.e. on an average Rs. 100 crore per city per year. An equal amount, on a matching basis, will have to be contributed by the State/ULB; therefore, nearly Rupees one lakh crore of Government/ULB funds will be available for smart cities development.



## DIGITAL INDIA

The Digital India programme is a flagship programme of the Government of India with a vision to transform India into a digitally empowered society and knowledge economy.

It was launched on 1 July 2015 by Prime Minister Narendra Modi. The initiative includes plans to connect rural areas with high-speed internet networks. Digital India has three core components: the creation of digital infrastructure, delivering services digitally and digital literacy.

### Vision of Digital India

The vision of Digital India programme is to transform India into a digitally empowered society and knowledge economy.

### Need

E-governance initiatives in India took a broader dimension in the mid 1990s for wider sectoral applications with emphasis on citizen-centric

services. The major ICT initiatives of the Government included, inter alia, some major projects such as railway computerization, land record computerization, etc. which focused mainly on the development of information systems.

Though these e-governance projects were citizen-centric, they could make less than the desired impact due to their limited features. The isolated and less interactive systems revealed major gaps that were thwarting the successful adoption of e-governance along the entire spectrum of governance. They clearly pointed towards the need for a more comprehensive planning and implementation for the infrastructure, interoperability issues to be addressed, etc. to establish a more connected government.

### Scope

A two-way platform will be created where the service providers and the consumers will benefit. The scheme will be monitored and administered by the Digital India Advisory group which will be chaired by the Ministry of Communications and IT. It will be an inter-Ministerial initiative where all ministries and departments will offer their own services to the public: Healthcare, Education, Judicial, etc. The Public-private partnership model will be adopted selectively. Also, there are plans to restructure the National Informatics Centre.

### Approach

Approach and Methodology for Digital India Programme are:

- Ministries / Departments / States would fully leverage the Common and Support ICT Infrastructure established by GoI. DeitY would also evolve/ lay down standards and policy guidelines, provide technical and handholding support, undertake capacity building, R&D, etc.
- The existing/ongoing e-Governance initiatives would be suitably revamped to align them with the principles of Digital India. Scope enhancement, Process Reengineering, use of integrated & interoperable systems and deployment of emerging technologies like cloud & mobile would be undertaken to enhance the delivery of government services to citizens.
- States would be given flexibility to identify for inclusion additional state-specific projects, which are relevant for their socio-economic needs.
- e-Governance would be promoted through a centralised initiative to the extent necessary, to ensure citizen-centric service orientation, interoperability of various e-Governance applications and optimal utilisation of ICT infrastructure/ resources.



## ATAL MISSION FOR REJUVENATION AND URBAN TRANSFORMATION

The AMRUT is conceptualized to replace Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and has been allotted Rs.50,000crore.

The scheme was launched by Prime Minister NarendraModi in June 2015 with the focus to ensure basic infrastructure services relating to water supply, sewerage, management, storm water drains, transport and development of green spaces and parks with special provision for meeting the needs of children.

### Purpose

The purpose of Atal Mission for Rejuvenation and Urban Transformation (AMRUT) is to (i) ensure that every household has access to a tap with assured supply of water and a sewerage connection; (ii) increase the amenity value of cities by developing greenery and well maintained open spaces (e.g. parks); and (iii) reduce pollution by switching to public transport or constructing facilities for non-motorized transport (e.g. walking and cycling). All these outcomes are valued by citizens, particularly women, and indicators and standards have been prescribed by the Ministry of Urban Development (MoUD) in the form of Service Level Benchmarks (SLBs).

### Target

Under this scheme the government is targeting 500 cities, these 500 cities are selected on the basis of population i.e. one lakh and above, while the other criteria of selection will apply for certain locations like tourist popularity, cities located at the stems of main rivers, certain popular hill towns and some select islands.

### Thrust

AMRUT implementation would expect urban reforms, such as 'e-governance, constitution

of professional municipal cadre, devolving funds and functions to urban local bodies, review of building bye-laws, improvement in assessment and collection of municipal taxes, credit rating of urban local bodies, energy and water audit and citizen-centric urban planning.' All this would improve the quality of urban governance, leading to better citizen satisfaction.

Under the mission, the states will get substantial operational flexibility in designing schemes based on the needs of identified cities and also in the execution and monitoring of the schemes. States are expected to submit the State Annual Action Plans to the Centre for broad concurrence based on which funds will be released. This is a departure from JNNURM wherein, the Union government appraised individual projects.

### Funds Allocation

The Cabinet has approved Rs 50,000 crore for this mission which is to be spent over the next five years. Central assistance will be to the extent of 50 percent of project cost for cities and towns with a population of up to 10 lakh and one-third of the project cost for those with a population of above 10 lakh. This assistance will be released in three instalments, in the ratio of 20:40:40, based on the achievement of milestones indicated in State Annual Action Plans.

# HOUSING FOR ALL

Housing for All scheme in India is a vision of Prime Minister Narendra Modi of India where all facilities will provide in a place. The government has identified 305 cities and towns have been identified in 9 states for beginning construction of houses for urban poor.

## Objectives

The Project is aimed for urban areas with following components/options to States/Union Territories and cities:-

1. Slum rehabilitation of Slum Dwellers with participation of private developers using land as a resource;
2. Promotion of affordable housing for weaker section through credit linked subsidy;
3. Affordable housing in partnership with Public & Private sectors and
4. Subsidy for beneficiary-led individual house construction or enhancement.

## Finance

Central grant of Rs. one lakh per house, on an average, will be available under the slum rehabilitation programme. A State Government would have flexibility in deploying this slum

rehabilitation grant to any slum rehabilitation project taken for development using land as a resource for providing houses to slum dwellers. Under the Credit Linked Interest Subsidy component, interest subsidy of 6.5 percent on housing loans availed upto a tenure of 15 years will be provided to EWS/LIG categories, wherein the subsidy pay-out on NPV basis would be about Rs.2.3 lakh per house for both the categories. Central assistance at the rate of Rs.1.5 lakh per house for EWS category will be provided under the Affordable Housing in Partnership and Beneficiary-led individual house construction or enhancement. State Government or their para statals like Housing Boards can take up project of affordable housing to avail the Central Government grant.

## Implementation

The scheme will be implemented as a Centrally Sponsored Scheme except the credit linked subsidy component, which will be implemented as a Central Sector Scheme. The Mission also prescribes certain mandatory reforms for easing up the urban land market for housing, to make adequate urban land available for affordable housing. Houses constructed under the mission would be allotted in the name of the female head of the households or in the joint name of the male head of the household and his wife.

## Scope

The scheme will cover the entire urban area consisting of 4041 statutory towns with initial focus on 500 Class I cities and it will be implemented in three phases as follows, viz. Phase-I (April 2015 - March 2017) to cover 100 Cities to be selected from States/UTs as per their willingness; Phase - II (April 2017 - March 2019) to cover additional 200 Cities and Phase-III (April 2019 - March 2022) to cover all other remaining Cities. However, there will be flexibility in covering number of cities in various phases and inclusion of additional cities may be considered by the Ministry of Housing & Urban Poverty Alleviation in case there is demand from States and cities and have capacity to include them in earlier phases. Credit linked subsidy component of the scheme would be implemented across the country in all statutory towns from the very beginning.

## Technology Sub-mission

A Technology Sub-mission under the Mission would be set up to facilitate adoption of modern, innovative and green technologies and building material for faster and quality construction of houses. The Technology Sub-Mission will also facilitate preparation and adoption of layout designs and building plans suitable for various geo-climatic zones. Also assist Cities in deploying disaster resistant and environment friendly technologies.

# HRIDAY

Rejuvenating the Soul of Urban India

## HERITAGE CITY DEVELOPMENT AND AUGMENTATION YOJANA

National Heritage City Development and Augmentation Yojana (HRIDAY) was launched on 21 January 2015 with the aim of bringing together urban planning, economic growth and heritage conservation in an inclusive manner to preserve the characters of each Heritage City.

### Purpose

All these years, redevelopment of heritage structures was taken up as isolated cases. But a need was felt to link the heritage development within a city to the overall planned development of the locality, which not only makes the region more tourist friendly but also improves quality of life of locals. Installation of CCTV cameras and provision of Wi-Fi access areas will also be a focus area.

### Scope

The Scheme supports development of core heritage infrastructure projects which shall

include revitalization of urban infrastructure for areas around heritage assets identified/ approved by the Ministry of Culture, Government of India and State Governments. These initiatives shall include development of water supply, sanitation, drainage, waste management, approach roads, footpaths, street lights, tourist conveniences, electricity wiring, landscaping and such citizen services.

### Duration

With a duration of 27 months (completing in 2017) and a total outlay of INR 500 Crores, the Scheme is being implemented in 12 identified Cities namely, Ajmer, Amaravati, Amritsar, Badami, Dwarka, Gaya, Kanchipuram, Mathura, Puri, Varanasi, Velankanni and Warangal.

### Objectives

- To bring urban planning, economic growth and heritage conservation together for heritage cities.
- Beautification in an inclusive and integrated manner with focus on cleanliness, livelihoods, skills, safety, security, accessibility and faster service delivery of heritage cities.
- To guide their conservation, restoration, future use and development.
- Create improved connectivity platform and access to tourists

- Improve last-mile connectivity heritage sites by documentation, conservation of areas, more facilities for women, senior citizens and differently abled citizens.

### Institutional arrangements

HRIDAY will be planned, developed, and implemented under the aegis of the MoUD with the National Institute of Urban Affairs (NIUA). A robust and interactive mechanism for coordination with ministries like culture, tourism, water resource, housing and urban poverty alleviation, and with state governments, urban local bodies would ensure convergence of activities such that the development is properly planned. For this purpose HRIDAY a National Empowered Committee (HNEC) will be constituted at the central level. The HNEC will have representation from all line departments and agencies and will involve the expertise of technical, research, academic institutions and organizations at various levels.

### Budget

With Rs 500 crore of government funds for HRIDAY aims to bring together urban planning, economic growth and heritage conservation besides beautification in an inclusive and integrated manner with focus on cleanliness, livelihoods, skills, safety, security, accessibility and faster service delivery.

## AT A GLANCE: TRADITIONAL CITIES VS SMART CITIES

	The Problem	Targets
<b>Planning</b>	<ul style="list-style-type: none"> <li>• Ad hoc and decentralized</li> <li>• Cost savings aren't realized</li> <li>• Limited potential for scalability of investment</li> </ul>	<ul style="list-style-type: none"> <li>• Coordinated and holistic</li> <li>• Resources are shared</li> <li>• Cost savings are fully realized</li> <li>• Investments are scalable</li> <li>• Improved city planning and forecasting</li> </ul>
<b>Infrastructure</b>	<ul style="list-style-type: none"> <li>• Runs inefficiently</li> <li>• Costs more money and resources to run</li> </ul>	<ul style="list-style-type: none"> <li>• Optimized with cutting-edge technology</li> <li>• Saves money and resources</li> <li>• Improved service-level agreements</li> <li>• Built on open standards</li> </ul>
<b>System operators</b>	<ul style="list-style-type: none"> <li>• Guess at infrastructure conditions</li> <li>• React to problems</li> <li>• Can't deploy resources efficiently to address problems</li> </ul>	<ul style="list-style-type: none"> <li>• Enjoy real-time reporting on infrastructure conditions</li> <li>• Predict and prevent problems</li> <li>• Deploy resources more efficiently</li> <li>• Automate maintenance</li> <li>• Save money</li> </ul>
<b>ICT investments</b>	<ul style="list-style-type: none"> <li>• Piecemeal and siloed</li> <li>• Deliver suboptimal benefit</li> <li>• Don't realize economies of scale</li> </ul>	<ul style="list-style-type: none"> <li>• Centrally planned</li> <li>• Deployed across city departments and projects</li> <li>• Deliver optimal benefit</li> <li>• Provide maximum value and savings</li> </ul>
<b>Citizen engagement</b>	<ul style="list-style-type: none"> <li>• Limited, scattered online connection to citizens</li> <li>• Citizens can't make optimal use of city services (or easily find them)</li> </ul>	<ul style="list-style-type: none"> <li>• Complete and singular online presence</li> <li>• Citizens can easily find and use services</li> <li>• Citizens can participate in smart city initiatives</li> <li>• Two-way communications between government and people</li> <li>• Specialized services focused on the individual citizen</li> <li>• Citizens can both contribute to and access real-time intelligent city data and offer apps that use the data</li> </ul>
<b>Sharing data</b>	<ul style="list-style-type: none"> <li>• Departments and functions are siloed</li> <li>• Departments rarely share data and collaborate on initiatives</li> </ul>	<ul style="list-style-type: none"> <li>• Departments and functions are integrated and/or shared</li> <li>• Data is shared between departments and better correlated with other data services through open standards</li> <li>• Results are improved</li> <li>• Costs are cut</li> </ul>

# 2

## How To Use The India Readiness Guide



**The role of the India Readiness Guide is to help you transition to a smart city, at your own pace and on your own terms. This chapter explains the smart cities frameworks that supports that mission. We think you will find it a useful mechanism to understand the totality of a smart city and how the pieces work together.**

**This chapter gives you what you need to construct a “target list” or “wish list” for your city. When you are ready to turn that list into an actual plan, you’ll find guidance in Chapter 14, “Ideas to Action.”**

Our introduction defined a smart city as one that uses information and communications technology (ICT) with effective citizen participation to enhance livability, workability and sustainability. The smart cities framework captures this relationship between a city’s responsibilities (what it needs to accomplish for citizens) and its enablers (the smart technologies that can make those tasks easier and smart citizen engagement that can make those implementations more inclusive).

**Aligning responsibilities and enablers:**

*The vertical responsibilities denote essential services that cities require. The horizontal enablers are technology capabilities that improve those responsibilities.*

		CITY RESPONSIBILITIES											
		Universal Aspects	Built Environment	Energy	Telecommunications	Transportation	Water and Wastewater	Health and Human Services	Public Safety	Payment and Finance	waste Management		
ENABLERS	Inclusivity												
	Collaborativity												
	Governance												
	Instrumentation and Control												
	Connectivity												
	Interoperability												
	Security and Privacy												
	Data Management												
	Security and Privacy												
	Computing Resources												
	Analytics												

# Smart city responsibilities

Cities have essential functions and services that must be available every day. Homes must have water, businesses must have power, waste must be collected, children must be educated, and so on. In the India Readiness Guide, we refer to these vertical city functions as responsibilities. Although not all of them fall under a city’s direct control, all of them are essential to everyday life and commerce. The nine city responsibilities are:

- 1. Built environment.** In the India Readiness Guide, built environment refers to all of a city’s buildings, parks and public spaces. Certain components of the built environment — including streets and utility infrastructure — are not emphasised here because they are treated in other responsibilities.
- 2. Energy.** The infrastructure to produce and deliver energy, primarily electricity and gas for powering virtually all services and needs, processes and comfort.
- 3. Telecommunications.** This term can have several different meanings. The India Readiness Guide uses the telecommunications responsibility to refer to communications for people and businesses. We use connectivity to

refer to communications for devices.

- 4. Transportation.** A city’s road infrastructure, streets, bike paths, vehicles, railways, monorails, light rails, buses, bicycles, streetcars, ferries, air and maritime ports — any and every system that relates to citizen mobility.
- 5. Health and human services.** The essential human services for the provision of health care, education and social services.
- 6. Water and wastewater.** The infrastructure responsible for water — from collection, distribution, use, and finally reuse and recycling. Pipes, distribution centres, catchment areas, treatment facilities, pump stations, plants and even the water meters at private homes are all essential components of this responsibility.
- 7. Waste management.** The infrastructure responsible for the collection, distribution, reuse, recycling, and recovering of the waste materials.
- 8. Public safety.** The infrastructure, agencies and personnel to keep citizens safe. Examples include police and fire departments, emergency and disaster prevention and management agencies, courts and corrections facilities.

## SMART CITY



- 9. Payments and finance.** Payments link a payer and a payee and refer to all the key contributors involved: government services, merchants, consumers, businesses, banks, payment instruments providers and payment schemes. Payments sit at the heart of the economic activity in cities and form the core component of every economic flow.

## Smart city enablers

Smart cities can radically improve all of the responsibilities through the power of ICT (information and communications technology). ICT can make buildings more efficient, energy more affordable, transportation quicker and neighbourhoods safer. In the India Readiness Guide, we refer to these transformative capabilities as technology enablers.

Moreover, engaging citizens is especially important for formulating Indian smart cities. Citizen participation and multilateral collaboration play a crucial role in truly creating resilient, inclusive and sustainable smart cities. In the India Readiness Guide, we refer to these human and institutional enablers.

These enablers — technology, human, and institutional that put the “smart” in smart cities — are listed below:

- 1. Inclusivity** is the framework used to include and engage the citizens into the transformation process. Involving “all” in the process, the city is able to better plan the it’s infrastructure and services to meet their needs. Greater involvement of citizens in the planning, design and implantation process helps local government establish two-way communication and create inclusive smart cities.
- 2. Collaborativity** creates a collaborative platform devising innovative and creative approaches — to develop frameworks that can better connect various departments within local government as well as with private industry, and cultivate partnerships and cooperation. Cross-pollination of ideas, collaborative innovation, and creative ways of collective actions foster innovation — required to realise the smart cities vision.
- 3. Governance** is the policies, practices, and processes that create high levels of organisation effectiveness in relation to policy-formulation and -implementation. Accountable, transparent, and equitable governance enables to plan and implement responsive and resilient planning and implementation.
- 4. Instrumentation** and control is how a smart city monitors and controls conditions. Instrumentation provides the eyes and ears of a smart city. Examples include smart meters for electricity, water and gas; air quality sensors; closed circuit TV and video monitors and roadway sensors. Control systems provide remote management capabilities. Examples include switches, breakers and other devices that let operators measure, monitor and control from afar.
- 5. Connectivity** is how the smart city’s devices communicate with each other and with the control centre. Connectivity ensures that data gets from where it is collected to where it is analysed and used. Examples include citywide Wi-Fi networks, RF mesh networks and cellular networks. (Note: When a cellular network communicates with devices, the India Readiness Guide refers to it as connectivity. When it lets people communicate, the Guide uses the term telecommunications. These are arbitrary distinctions used only in the Guide to make it easier to distinguish between the two sides of communications — devices and people).
- 6. Interoperability** ensures that products and services from disparate providers can exchange information and work together seamlessly. Interoperability has many benefits. For one, it prevents the city from being “locked in” to just one proprietary supplier. For another, it gives the city more choice, since it can buy from any company that supports the city’s chosen standards. For another, it lets the city build projects over time in phases, with confidence that all the pieces will work together in the end. Open standards are the key to interoperability.



Providing more and faster access to smarter education:

## 'THE LOOP' TACKLES DIGITAL DIVIDE IN NELSON

When the New Zealand government prioritised high speed, high bandwidth school networks to meet the projected digital demand such as graphic intensive learning and video conferencing, small and remote schools in the Nelson region struggled — they either had poor quality network infrastructures or none at all. In 2005, for the first time in New Zealand, Council partner Allied Telesis, Network Tasman, TorqueIP, the Ministry of Education, and leading Nelson educational institutions collaborated and launched a unique educational community network — The Nelson Loop.

The Loop needed to offer a non-proprietary, competitive alternative to commercial models by providing significantly cheaper, faster, more responsive, and more educationally valid digital services. With plans to connect with schools outside of the Nelson and offer services to community-based initiatives, the network had to be scalable, secure, and technologically advanced to meet future demands.

The Nelson Loop is a unique and inspirational story of committed enthusiasts who pursued a dream to connect their educational community with an open-access fibre network, for increased access to educational opportunities — to tackle the 'Digital Divide' and improve equity.

Allied Telesis multilayer switches provided superior Quality of Service to ensure maximum availability of premium voice, video, and data services serving over 20,000 concurrent users. The 10 gigabit solution guaranteed the performance, reliability, and stability of applications on the network. In addition to increased network performance and reliability, the Loop added significant value to productivity and learning within schools and the community.

GigaNelson, New Zealand's first giga town in 2014, is keen to share its digital transformation with the entire nation. Award-winning Nelson loop — one of the best networks in the country continues to power GigaNelson schools and pre-schools in adapting to e-learning.



Providing more and faster access to smarter education:

*Award-winning Nelson loop — one of the best networks in the country continues to power GigaNelson schools and pre-schools in adapting to e-learning.*



**7. Security and privacy** are technologies, policies and practices that safeguard data, privacy and physical assets. Examples include the publishing of clear privacy rules and the implementation of a cyber-security system. Security and privacy play a critical role in enabling smart cities because they build trust with people. Without trust, a city may have difficulty adopting new technologies and practices.

**8. Data management** is the process of storing, protecting and processing data while guaranteeing its accuracy, accessibility, reliability and timeliness. Data is king in a smart city. Proper management is essential to maintain data integrity and value. A citywide data management, transparency and sharing policy — including proper policies around access, authentication and authorisation — is one step toward proper data management, as explained below.

**9. Computing resources** include 1) billions of computer “brains” of all sizes, from wrist watch components to server farms, 2) in those computers, a similar range of simple to very complex software, and 3) data, which has little value until it is communicated. Open standard software interfaces and data encodings enable digital communication. Most city data refers to things and phenomena where locations are important, so spatial standards are among the essential open standards that enable smart cities.

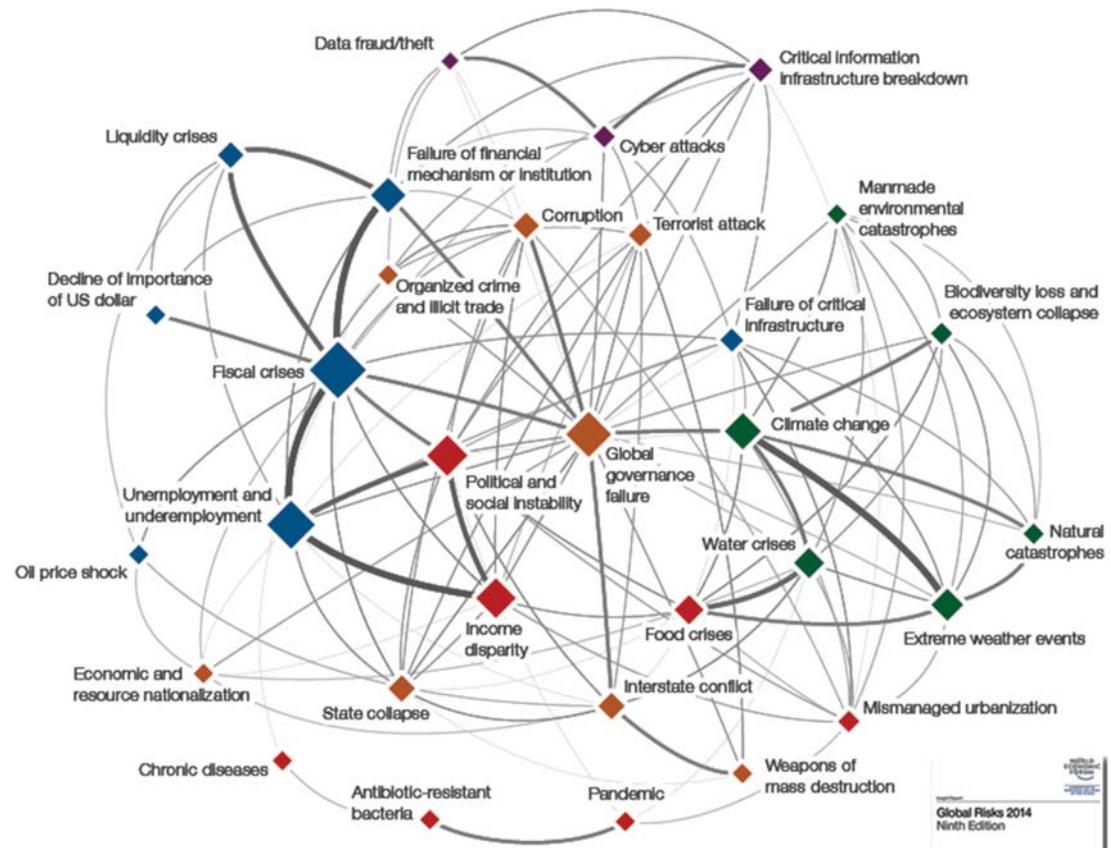
**10. Analytics** create value from the data that instrumentation provides. Examples include: forecasting crime the way we already forecast weather; analysing electric power usage to know when and where to expand or adjust to accommodate demand; analysing conditions to predict which equipment needs repair; automatically plotting the best route for a mass transit user, and creating personalised portals for every citizen by analysing what they value most. And analytics that utilise data from across departments have tremendous potential to identify new insights and unique solutions to delivering services, thereby improving outcomes.

# Assessment of interconnectedness

In the previous chapter we explored the pitfalls of siloed cities. Cities that don't coordinate their various departments at the strategic and technology planning level often end up with redundant investments in technologies, infrastructure, training and even personnel.

The understanding of interconnectedness among the smart city responsibilities is even more crucial. Rapidly advancing communication technology and wider access to information and faster physical mobility has significantly overlapped various functions within the responsibilities. Since so many city systems, services and infrastructures are connected in one way or another, becoming smart in one area is often dependent on progress being made in another.

Hence, incorporating an interconnectedness lens into city planning can meaningfully contribute to enhance resilience and sustainability of the smart city. As cities develop long-term goals and plans, it is important to consider how desired improvements to the performance of a single responsibility may require improvements in a responsibility on which there is a dependency. For example, cities cannot expect to foster a healthy population if water systems cannot



ensure water quality. Yet water systems rely heavily on energy systems to pump and move water through city infrastructure. On the other hand, traditional energy production consumes lot of finite source of water available. Hence, this is not a linear process, but rather a circular one. So, as you plan projects to improve water infrastructure, be sure to examine any requirements that need to be addressed by electrical systems and the distribution grid. Think holistically to avoid having to make major system changes or unanticipated course corrections in your smart city planning.



## Understanding of interconnectedness:

*Incorporating an interconnectedness lens into city planning can meaningfully contribute to enhance resilience and sustainability of the smart city. Image: Global Risks Report, 2015 by World Economic Forum*



Council member Cisco is one of the high-tech companies partnering with the government of Portugal to invent and build a state-of-the-art smart city from the ground up. Located in the town of Paredes about two hours north of Lisbon, Portugal, the project is spearheaded by Portuguese company Living PlanIT. Spread over an area more than 4,000 acres, the community will take at least four years to complete at an estimated cost of \$10 billion. It will eventually house around 225,000 people, many of whom will work for Living PlanIT's technology partners at new research and commercialisation centres.

The city is designed as a living laboratory for new technologies. Data collection sensors will be added

to virtually everything, from refrigerators to trash containers to traffic lights.

Those sensors will monitor every aspect of urban life, including traffic flow, energy consumption, water use, waste processing and even the temperature of individual rooms. All these sensors will be connected to Living PlanIT's Urban OS (UOS), a middleware platform that is embedded in the fabric of buildings and infrastructure.



**A consortium led by the Living PlanIT company is creating a smart city from the ground up in northern Portugal:**

*Data collection sensors will be added to virtually everything, from refrigerators to trash containers to traffic lights.*



Developing an intelligent city platform:

## LIVING PLAN IT BUILT SMART FROM THE GROUND UP

UOS will integrate with Council member Microsoft’s Devices & Services Platform to enable city governments to deliver a comprehensive set of services. Cisco is acting as the master planner for information technology and communications design and architecture. Cisco is also building a cutting-edge data centre at an estimated cost of \$38 million.

The city’s digital control system will accommodate an expanding list of applications, from managing electricity demand to routing traffic to finding a parking spot, to name just a few. In the event of a fire, for instance, sensors can pinpoint the location, alert people nearby, notify the fire station and manage the traffic lights, so that fire engines can reach as quickly as possible.

The control system might also notice that the interior of a building is getting too hot. With its knowledge of the outside temperature plus the building’s equipment and orientation, it could relay a command to darken the smart glass on the building’s sunward side to reduce the sun’s warming effect.

The consortium hopes to ultimately create a platform to enable a new generation of intelligent cities. “Software has transformed industries — medicine, education, science, finance and manufacturing,” explains Steve Lewis, Living PlanIT’s co-founder and CEO. “And software will transform our cities to achieve their economic, social and environmental potential.”

### Developing an intelligent city platform:

*The city’s digital control system will accommodate an expanding list of applications, from managing electricity demand to routing traffic to finding a parking spot, to name just a few.*



## The India Readiness Guide structure

As you move through the chapters in this Guide, we will assess this interconnectedness that merit consideration. You'll come to realise that understanding interconnectedness is another reason to bring cross-departmental teams together early in your smart city planning process.

The India Readiness Guide is made up of multiple chapters. One chapter examines "universal" principles — enablers common to all responsibilities. The chapter that follows focuses on citizens, the smart people who live and work in the city. The following chapters detail how individual city responsibilities — energy, transportation, public safety, payments, etc.— should use the technology as well as human and institutional enablers. The final chapters cover how to translate the Guide's theories into a roadmap.

Each chapter has four sections. The first section envisions what each responsibility could look like by the year 2030 and the key drivers. The second section presents key smart solutions that illustrate how integration of innovative tools and ICT achieve smarter 'responsibility'. The third section examines the strategies and benefits that arise from each target. Targets are goals — end points or outcomes a city should work toward. And the fourth section provides a checklist of the relevant targets for that responsibility. You can use these checklists (and the summary checklist in the final chapter) to create a "wish list" that can inform and improve your smart city roadmap.

Scattered throughout are brief examples to show how cities are applying these theories in real life.

**What this guide does NOT do.** We've talked about what the Guide wants to do, but it's also important to acknowledge the things that are outside its scope.

**The Guide does NOT suggest what your city's overall goals should be.** Smart city technologies are a means to an end. Every city should decide for itself what ends it hopes to achieve. But whatever you're after, the targets described in this guide represent the best technical foundation for pursuing those goals.

**The Guide does NOT propose which responsibilities should be prioritised.** Every city has its own unique strengths and weaknesses, its own unique history and resources, its own unique preferences and aspirations. Some cities may choose to tackle transportation first, for instance, while others may feel that energy is more urgent.

**The Guide does NOT pretend that its targets are set in stone.** Change is continuous, and technology advances are famously unpredictable. The targets shown here are the best recommendations we can make today, as informed by a large contingent of the world's top experts. They will put cities on the right path, but cities will still need to make periodic evaluations and course corrections as technology evolves.



The world's first smart island:

## MALTA: WHY NOT A SMART ISLAND?

Located in the heart of the Mediterranean and known for its stable economy and pro-business government, Malta is a group of small islands 50 miles to the south of Sicily. Home to roughly 400,000 people, it has the highest population density in Europe, putting a genuine strain on power, gas, waste management, and other essential services.

In 2008, the national energy and water providers partnered with Council members IBM, Itron and other suppliers to gradually roll out smart meters for all electric and water customers. The utilities are saving money by not employing meter readers. What's more, the metering data is integrated into new back-office applications for billing. It is also used for analytics that locate problems and determine when and whether to expand the grid.

So far, results have been very successful. For instance, the new smart water grid has increased theft detection, while also introducing new pricing options for customers that reward conservation.

With those smart grids in place, Malta has the foundational elements for a smart island. And the government is taking things even further in one aspect. It is transforming an industrial park into a state-of-the-art information technology and media city. The goal of smartcity Malta is to put everything a high-tech company needs to succeed in one place, including state-of-the-art ICT infrastructure along with a host of IT, media and production services. Melita, one of Europe's oldest cable operators, is providing a seamless broadband service for Malta with Council member Cisco's Universal Wi-Fi.

### The world's first smart island:

*Thanks to its smart water and electricity networks, Malta is the world's first smart island. It is also the home of smartcity Malta (shown here), a cutting edge development designed to attract high-tech industry.*

## Conclusion

As you review the chapters that follow, you can use the checklists at the end of each one to note where your city is currently weak or strong. Once you've completed those assessments, you can transfer them to the summary checklist in the final chapter, 'Ideas to Action'. With that summary in place, you'll be ready to build your smart city roadmap, using the tips and techniques provided in that last chapter.

The mission of the smart cities Council India Readiness Guide is to set you on the path to becoming a city of the future — a smart city with enhanced livability, workability and sustainability. It will take patience to march through each chapter to compile your own "wish list" of essential features. And it will take leadership to build those features into a comprehensive smart city plan that has the support of the public.

But significant advantages await those cities that make the effort. Their citizens will have a healthier, happier place to live along with better, higher-paying jobs. And all of that in a sustainable fashion that doesn't rob from the next generation.





# 3 Universal Aspects Of A Smart City

Some of today's greatest cities benefitted from visionaries who, centuries ago, saw possibilities for civic betterment and made it happen. A compelling example comes from leaders back in the 1800s. Way before the phrase "urban sprawl" had entered our psyche, they committed to preserving vast amounts of open spaces for public use. Think of Hyde Park in London, Central Park jutting through Manhattan, Ueno Park in Tokyo or Sanjay Gandhi National Park in Mumbai. They are all testaments to leaders "thinking outside the box" a very long time ago.



### City visionaries:

*Thanks to the visionary planners, Sanjay Gandhi National Park remains a popular gathering spot in Mumbai.*

**F**ast-forward a couple of centuries. It's your turn to make that same kind of lasting impact on your city. This chapter will help get you started. In many ways, it is the most important chapter in the Guide because it lays out the universal principles that should underlie every city responsibility, from water to energy to public safety and the others. Get these right and you've set up your city for decades of success.

This chapter includes 23 goals — we call them “targets” — that will propel you down the smart city path. We refer to these 23 as “universal targets” because each of them applies to every city responsibility.

Here's an example: One of the targets is to use analytics to achieve full situational awareness. That means giving system operators a real-time, big-picture view of what's going on so they can spot problems early and act quickly to mitigate them. An example might be an accident that has a major thoroughfare blocked. Knowing about the accident in real time gives transit operators a chance to reroute buses.

But that situational awareness also has great value to public safety, to water, to energy, to virtually every city responsibility, hence their inclusion in this Universal chapter. (In later chapters, you'll read about targets that apply

only to specific responsibilities — energy or transportation, for instance).

Before we drill down on the 23 universal targets, a quick refresher on key terms:

- **ICT** — information and communications technologies. The blanket term for the devices, software, standards and communications that make cities smart.
- **Instrumentation** — the devices used to collect data about city conditions. Examples include smart meters, occupancy sensors, temperature sensors, light detectors, pressure sensors and many more.
- **Responsibilities** — the everyday essential functions and services a city provides such as water, public safety, transportation, etc.
- **Enablers** — to enable is “to give power, means, competence or ability.” By that token, enablers are the individual ICT components that allow city responsibilities to get smart. Examples include computing resources, data analytics and similar functionalities.
- **Targets** — goals for smart city efforts. A series of objectives that, taken together, form the foundation of an ICT-enabled smart city.

## Benefits of realising the universal targets

We've talked about the hurdles cities face on their smart city journey and how realising targets will require commitment, planning and execution. Now let's talk about the rewards!

Because the 23 universal targets described here apply to every responsibility, the benefits highlighted below are also citywide in their application. We've organised the benefits by our three core smart city objectives — enhanced livability, workability and sustainability.



### Livability

Livability will mean different things to different people because we all define quality of life in different ways. Yet the smart city benefits highlighted below have the potential to help everyone:

**Improving comfort and health.** By rethinking the various city responsibilities from a holistic integrated perspective, and adding and optimising various city services, the city can improve and maintain health, level of comfort, and quality of life.

### Improving city service by sharing data.

Many of the most exciting city applications come from sharing data between departments. Or, in a similar fashion, by sharing data with outside developers who can innovate and produce new applications. For instance, cities including Amsterdam, London, Philadelphia and San Francisco have instituted "Open Data" programs. They have resulted in hundreds of innovative applications, including trip planners, parking spot finders, bus locators, crime reporting and alerts, and business planning tools, to name just a few.

### Improving city service by sharing data:

*Most exciting city applications come from sharing data between departments. "Open Data" programs have resulted in numerous innovative applications, including trip planners, parking spot finders, bus locators, crime reporting and alerts, and business planning tools, to name a few.*

**Revolutionising people's relationship with their government.** By providing instant, electronic access to the information people need, the services they require, and the interaction they want with officials, cities build citizens' trust and satisfaction.

**Enabling real-time alerts and real-time monitoring.** Health and public safety are improved when citizens are alerted to fires, floods, air-quality issues, public disturbances, pipeline leaks, downed electricity lines, chemical spills, Metro lines, bus locations, etc.

**Creating citywide situational awareness.** When you are able to fully visualise your city's traffic, energy, gas and water networks, you can best ensure reliability and resiliency of those essential services.

**Protecting personal privacy.** People have a right to and great desire for privacy and that issue will certainly crop up when you start marching down the smart city path. The Guide's universal principles include recommendations on privacy.

## Workability

Workability means accelerated economic development.

**Creating a "recruiting tool" for attracting talent and jobs.** Increasingly, mobile businesses and professionals are attracted to cities that have a strong, compelling vision for a better future.

**Creating world-class infrastructure.** Businesses weigh the efficiency and reliability of city infrastructures when they make their investments. They have many options. Why locate in city A, when nearby city B has a more efficient transportation network, a more reliable and cost-effective energy grid, or a more advanced law enforcement program? Cities that have optimised their infrastructures are more attractive investment locations.

**Protecting business from cybercrime.** Hacking and theft are serious risks to businesses. A 2012 study reported that incidents of cybercrime doubled over the last three years, while their financial impact rose by 40%. Enforcing cyber-security as described in this Guide will help city governments achieve safety and resiliency, and create trust for companies contemplating a move to your city.

**Unleashing innovation.** Cities that free up their data via Open Data or similar programs

will unleash the power of people on their data sets and benefit from new ideas. Data is a valuable and profitable resource that can fuel innovation and invention, thereby creating new businesses, revenue streams and jobs.

**Supporting skills development.** With rapidly changing technology, more and more job opportunities are created that need skilled talent, and businesses, and in turn, investors are looking for skilled-based talent pool. Hence, city-supported skill development can be an enormous draw to businesses looking for specialised talent.

## Sustainability

Sustainability is how Smart cities provide necessary and desirable services in a way that doesn't deplete resources — natural, financial, or social.

**Reducing resource use through optimisation.** The optimisation gains from analytics and improved planning mean that cities, their businesses and their residents consume fewer resources. By harnessing the power of ICT, smart cities can curb the theft of resources and deliver a better future for generations to come.



Reducing resource use through optimisation:

## BUILDING A SUSTAINABLE AND RESILIENT CAMPUS

Cities represent three quarters of energy consumption and 80% of CO2 emissions worldwide. Smart cities have the goal of reducing energy consumption, reduce GHG emission and aim to achieve zero waste in the city. Council member SAS initiated key energy and emissions initiatives including calculating and reporting global carbon footprint, building and maintaining facilities to LEED guidelines, investing in renewable energy, and pursuing new energy-efficient technologies for operating buildings and data centres.

The entire SAS campus of 11 LEED certified buildings are powered by 3 PV Roof Top Systems of 312 KW capacity and 3 Solar Thermal Systems of 104 KW. SAS has 2 solar farms of 2.2 MW generating 4 million kilowatt-hours each year from directional arrays that track the sun and connected to the electricity grid.

SAS advanced analytics platform improves collecting, understanding, and managing energy and emissions requirements, increases the ability to report and proactively influences consumption trends.

SAS reduced energy consumption by 3% for the past four years, despite staff growth of 10%, facilities growth of 9%, and rapidly expanding data centre operations to satisfy growing customer demand for computing and storage solutions. 2.2 megawatt solar farm facility, transferring excess electricity to electricity grid, is reducing carbon footprint over the conventional sources by more than 2,000 tonnes annually.

High energy efficient data centres operations regularly achieve average power usage effectiveness of 1.35 or better.



Reducing resource use through optimisation:

*SAS reduced energy consumption by 3% for the past four years, despite staff growth of 10% and rapidly expanding data centre operations. 2.2 megawatt solar farm facility is reducing carbon footprint over the conventional sources by more than 2,000 tonnes annually.*

**Enabling a broad selection of technology choices.** Cities that pursue interoperability in their smart technology investments will save money, by being able to pick from the widest variety of solutions possible.

**Reducing duplication of effort.** When smart city efforts are confined to departmental silos, functions are needlessly repeated. This unnecessary duplication may range from market research to community outreach to technical design to security planning to staff training to procurement processes to designing user interfaces and much more. Agreeing in advance on universal principles takes care of these things once, for use in all departments.

**Reducing costs through infrastructure sharing.** Some early smart city efforts have overlooked the potential to share costs. Here are just a few of the elements that can often be purchased or designed just once and reused many times: geographical information systems (GIS); communications networks; cyber-security designs and implementations; database management systems; enterprise service buses; workforce and field crew management architecture, and operations centres. Additionally, in some cases, costs can be reduced by partnering with private sector providers (operators) who have already deployed networks and services.

**Reducing costs by re-using software modules.** By realising the targets in this Guide, cities can construct their applications in a way that creates a collaborative and secure environment, making it easy to share code modules between different applications, minimising expensive programming.

**Increasing economies of scale.** By agreeing on universal standards and specifications, cities can often lower their purchasing costs while increasing interoperability. Otherwise, each city department makes its own small, slightly different order with diminished bargaining power.

**Embedding best practices.** By way of example, consider something as crucial as cyber security. Now suppose that every department is responsible on its own for researching, planning and implementing that security. It's not hard to recognise that some departments will not have the skills and resources to do the best possible job. By contrast, if the city adopts a universal security framework, it can be assured that the individual departmental implementations will be state-of-the-art.

**Enabling better financial forecasting.** Financial forecasting is an important discipline and it can be greatly enhanced with the help of the data flowing from smart cities. Combining and correlating growth projections,



depreciation and historic operating patterns can improve cities' 5-, 10- and 20-year plans. And by monitoring key performance indicators, cities can measure their progress and their return on investment.

**Squeezing the maximum value from city assets.** Electronically monitoring the actual condition of assets at every moment helps predict when they will need maintenance in time to prevent breakdowns. With device management and asset optimisation, cities will save money while still ensuring the reliability of their technology deployments.

**Using computer simulations to plan with great precision.** Thanks to computer modelling and simulations, cities can test assumptions, try different scenarios and make mistakes in the simulations instead of costly mistakes in real life. Many experts predict that smart city technologies will change the very nature of planning — from a once-in-a-decade activity based on estimates to an ongoing process based upon real-time data.

## How to use this chapter (and the ones that follow)

The goal of the Readiness Guide is to help you make two key decisions: 1) where you want to end up and 2) where you should start.

This chapter and those that follow will help you with the first issue. They suggest the targets at which you should aim. Your only job is to review those targets and determine a) whether they apply to your city and b) how far along you are already.

When it comes to which ones apply, we are biased — we think every target in this Guide is essential to the long-term success of a smart city. Not to be overly dramatic, but you ignore these targets — especially the universal targets — at your own peril.

The universal targets are highlighted on the checklist you'll see on the next page (and again at the end of the chapter). Each target is explained in detail on the pages that follow. When it comes to how far along you are, you can use the column at the far right of the checklist to record your estimate. You'll use that estimate of progress in the final chapter, Ideas to Action, where you will set your priorities. Knowing where you are strong and weak will help you choose where to point your smart city efforts first.

You don't have to over-think the process. Nor do you have to become an expert in every target. When you have gone through all the chapters and completed the consolidated target list in the final chapter, you will be handing it to specialists to build detailed project plans. You can count on their expertise for the details.

A few large cities will hand their target list to in-house staff. But most cities will use outside experts. Either way, your job is to hand those experts your "wish list" — your prioritised target list. That list will tell them, in general terms, where you want to start and where you want to end up.

So don't feel overwhelmed as you read through the targets. Your job is not to solve all of these issues. That's where the experts come in. Your job is to know which issues need a solution and to decide which issues to tackle first.

If you have further questions about targets and checklists, reach out to the smart cities Council via the website or the contact information in the appendix.

And now, on to the universal targets. As you read through each one, jump to a checklist to record your assessment of your city's progress. After completing this chapter and the ones that follow, use the summary checklist in the final chapter to combine your results into one document.



### Universal targets:

*Knowing where you are strong and weak will help you choose where to point your smart city efforts first.*

# UNIVERSAL TARGETS

	Enabler	<b>Universal Targets</b> How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress			
			None	Partial	Over 50%	Complete
Human	<b>Inclusivity</b> Achieve accessibility optimisation Formulate citizen reporting framework for outcome thinking Achieve citizen engagement		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	<b>Collaborativity</b> Create institutional framework Pursue multilateral collaboration		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Governance</b> Achieve existing infrastructure optimisation Formulate new supporting policy frameworks and regulatory mandates		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# UNIVERSAL TARGETS

Technology	Enabler	Universal Targets How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress			
			None	Partial	Over 50%	Complete
	<b>Instrumentation and Control</b>	Implement optimal instrumentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Connectivity</b>	Connect devices with citywide, multi-service communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Interoperability</b>	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Security and Privacy</b>	Publish privacy rules Create a security framework Implement cyber security	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Data Management</b>	Create a citywide data management, transparency and sharing policy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Computing Resources</b>	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Analytics</b>	Achieve full situational awareness Achieve operational optimisation Achieve asset optimization Pursue predictive analytics	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			

# Inclusivity

The foundation of smart cities formulation is based on the idea of a holistic vision to include all citizens. Smart cities value the citizens and look at them as both engine and catalyst for sustainable urban transformation. The focus is not about smart city itself, it is about people and the community integrated within. And the success of smart cities is vastly dependent on the praxis of inclusivity in diversity — shaping smart cities' vision considering all classes, irrespective of their physical, cultural, gender and financial merits.

Active participation of various groups of citizens – such as policy makers and planners, youth and students associations, welfare associations, tax-payers associations, senior citizens, special interest groups, slum dwellers, and others – helps in effectively identifying local priority issues and co-creating solutions.

India is a country of unity in vast diversity, the multiplicity of heritage, culture, economic class, race, etc., is reflected and coexists in every city. National unity and integrity have been maintained even through acute economic and social inequalities. Though each city has a unique combination of socioeconomic strata, estimated acceleration of mass migration to cities in the future will likely change the equation. While developing the concept

of inclusiveness in the smart city vision and solutions, the city must look into how citizens can interact with the government, how businesses can be integrated into the communities, and how city resources and services can be optimised to benefit all citizens.

Smart communities actively apply technologies in the city operations and inspire its citizens to participate and engage in the efforts to encourage community economy and social development. ICT technologies make governments and city administrations more transparent, responsive, and accountable, allow for greater involvement of common citizens in the planning, formulation and implementation of city services, and encourage continuous dialogue among citizens, businesses and the cities to achieve transformative economic, social, and environmental benefits.

**Achieve accessibility optimisation, both physical and Web accessibility.** Accessibility for all is not just an aspect relating to 'built environment'; it is a horizontal dimension that must span across all smart city responsibilities. Design for all is an essential aspect and the first step for inclusive smart city formulation. Accessibility for all means offering equal opportunities — it's going beyond the usual idea of offering accessibility to the people who need physical assistance, and offering physical and Web accessibility to all — to seamlessly connect and share services.

Accessibility rules have to be embedded into every aspect of the life — from planning mobility that encourages public transit commute to designing streets with slope for reduced mobility people to web accessibility for the elderly and blind to online services or documents in electronic format. Innovative vision, creative ideas and ICT technologies together help span the digital divide, such as in education. Having transparent and easily accessible reports and tools that give the citizen information about the city planning and implementation activities in real time is another important aspect of accessibility.

**Formulate citizen reporting framework for outcome thinking.** An effective two-way dialogue between the citizen and the city is critical and an important tool for creating smart, participatory, inclusive and sustainable cities.

The citizen reporting frameworks not only enhance the citizens role in decision-making for city formulations, it also empower the citizens to make more informed decisions about their daily practices and help shaping the vision that affect their lives. Smart cities develop collaborative, value added tools using visualization, user-interface and social media. Many cities in India created online portals where a citizen can post suggestions/ ideas pertaining to infrastructure services and financing and the revenue models.

Participation of citizens and stakeholders in systematic and open decision-making reporting and implementation assists ineffectively identifying local priority issues and create contextual solutions. Digitizing citizen interface further enables the citizens to more effectively communicate as well as collaborate with the local government.

City can create interactive online portal with GIS layering to flag and comment local urban issues – from potholes and broken streetlights to changing timelines and cost escalation in public work projects. 'LoveCleanLondon' is a free online portal that helps people in London to upload photographs of community problems that require actions by the local authorities. An interactive map using Council member Microsoft browser plug-in shows reports in real time while free application programming interface allows developers to create own applications.

The results showed 30% reduction in graffiti in two years with clean-up time reduced dramatically, while citizen satisfaction and authority responsiveness has increased. "This use of technology can deliver real savings while encouraging people to take an active pride in their environment" Boris Johnson, Mayor of London.

**Achieve citizen engagement.** Smart cities understand the importance of enabling, engaging, encouraging and empowering citizens to achieve sustainable transformation. The citizen participation and engagement are empowering citizens, making smarter and greener decisions in daily life. ICT provides tools to citizens to take actions in a smarter and more responsible and sustainable manner. The smart cities instigate ubiquitous and visual approaches to the use of IT within citizen participation and engagement at multiple levels in the city using different means.

The smart cities continuously and systematically present the balanced and objective data in most effective, user-friendly way – to ensure that their concerns and aspirations are consistently understood and considered – which allows the citizens to better engaged, involved and responsive resolving the complex, interconnected urban challenges.

One such example, Seoul's Eco-Mileage System – a citizen participation project that rewards households and businesses with refunds based on the reductions they make in greenhouse gas emissions. This voluntary initiative already has over 1.88 million members, and counting. It is even more remarkable that it has been introduced into every elementary school in the city, which drives behavioural change from an early age and deepens a cultural mind-set around environmental adaptation.



Smart cities also develop preferential studies making use of the potential for virtual environments to involve much large number of participants and to create interaction among them.



## Collaborativity

Formulating smart cities' visions and solutions requires combining collaboration and creativity, especially in a country like India, which still lacks a lot of basic services in many cities. However, India is growing rapidly and adapting technology at a much faster pace. Leveraging all available assets — people, resources, technology — the creativity of citizens, the proficiency of experts, the knowhow of business, the resources and services of the city, emerging technologies to create innovative and unique solutions for each city's needs is paramount. Smart cities take advantage of new frameworks, tools and partners to sustain resources and improve wellbeing of the residents, and ultimately enhancing the quality of life for its citizens.

Achieving inclusive smart city vision is a daunting task. However, a systematic,

collaborative and innovative approach is the best way for India to achieve its goal to create ambitious, smart, inclusive cities.

### Create institutional frameworks

To realise the inclusive vision, there is a need to create and encourage new institutional frameworks and city service authorises to break the siloed structure and adapt an open, collaborative approach.

**Device new institutional frameworks to create a holistic solution.** To create an inclusive and sustainable smart cities vision and initiatives, the city needs to collaborate internally as well as externally. The various city responsibilities need to cooperate with each other and share data in a more open and collaborative environment to create a long-term holistic vision and together plan implementation strategies that reduce duplication of resources.

**Create new opportunities for collaboration.** Developing potential for interdisciplinary collaboration through capacity building, skills development and cross-discipline interactions generates a holistic perspective to create smart solutions. Innovations in smart cities will be aligned with the organizational and financial cooperation structures and models.

### Pursue multilateral collaboration

Multilateral collaboration among the various industry players is paramount to resolve global crises; however, it is has become equally critical in city-wise solutions to create tools for the citizens, experts, businesses, and the city to collaborate together. Going beyond the internal collaboration, municipalities need to partner with other stakeholders such as businesses, non-profit organisations and think-tanks to devise solutions.

**Public-Private-People partnerships models.** In the smart cities, public-private-people partnerships will act as catalyst to drive innovations and new technologies integration. Such cooperation is crucial, where the governments – the public – create a solid platform, where the businesses – the private sector – plug in innovative and commercial solutions and non-profits and citizens – the people – identify local, contextual issues and provide critical inputs as an end user. The special purpose vehicles (SPV) are extremely essential. However, the cities need to take a coherent and long-term approach in formulating public-private-people partnerships.



Consider cloud computing:

## BARCELONA REALISES VISION OF INNOVATIVE CITY GOVERNANCE WITH CLOUD AND APPS

**B**arcelona, Spain has a global reputation for innovation. Many of the technological solutions that the city has adopted in recent years are at the leading edge of city management.

Council member Microsoft is a close partner in this effort. It has helped the city drive new services for citizens and visitors and create and support new technology-based companies and entrepreneurs, while also enabling the city government to reduce costs through new cloud computing services and devices.

In 2011, Barcelona began to use Windows Azure cloudbased services to make information available to citizens, which could be easily accessed over the Internet. The main driver for adoption of a public cloud was better management of the public data that

is collected by the city's municipal operations and recordkeeping practices.

In addition to storing data in the cloud for others to analyse, the Barcelona City Council is harnessing the opportunities that city data presents through Big Data and analytics solutions. Having gained confidence in the scalability and security features of Windows Azure, the City Council embarked on an Open Data initiative intended to standardise digital formats and streamline data analysis.

The ultimate goal of the initiative is to promote economic growth by encouraging data sharing between city government and the private sector.



**Consider cloud computing:**

*Barcelona has utilised the power of the Microsoft Windows Azure cloud -based platform to help businesses be more productive and to draw more visitors to the city.*

'Love Clean Streets' is the leading public engagement platform for local governments and municipalities who want to provide efficient ways for citizens, their partners and their employees to report and deal with images and location based reports.

**Civic-cyber intelligence.** The cities can work with and state-agencies can collaborate with citizen champions, experts and researchers at local non-profits and think-tanks that work with community groups and neighbourhoods to identify and reprioritise the local needs. Local think tanks can become systematic bridges. One such example is 'Transparent Chennai', a non-profit action-research oriented group that focuses on interactive urban design, identifying local issues using community-mapping and GIS projects with local inputs and design feedback approaches. TC identified inadequacies in the city's pedestrian infrastructure and challenges for reduced mobility citizens, which helped in initiating other city-led mobility infrastructure projects.

Systematic and analytical local frameworks act as a laboratory for data collection tools and methodologies for citizen engagement, supporting the city to improve its ability to use data, mapping and participation to increase safety and establish a network of practitioners and advocates who share practical, context-specific, and effective strategies to create transparent and inclusive cities.

## Governance

### Achieve existing infrastructure optimisation

Most cities already have infrastructure, systems and processes in place to serve citizens. However, some of them are aging and decaying, while others are working but not efficiently. Cities need to develop systematic frameworks to identify such systems and optimise those using innovative approaches and ICT technologies. For example, instead of building new roads, highways and bridges, the existing infrastructure and systems can be optimised using citizen inputs and sensor data analytics by better managing traffic lights, toll systems and automating the public mobility to accommodate peaking demand with real-time information and citizen engagement.

Cities can even take more a sustainable and creative approach by devising and encouraging greener solutions. Rather than deploy newer infrastructure, cities need to reprioritise local needs. One such example is the Chennai Street Design Project, a collaborative effort by the city government of Chennai, the Institute for Transportation and Development Policy (ITDP) and community to address the safety challenges related to transport in the city. The solution focused on constructing and maintaining infrastructure for non-motorised

transit by allocating at least 60% of the city's transport budget. This resulted in expanded, walkable footpaths, safe pedestrian crossings, protected cycle tracks, properly scaled carriageways, conveniently placed bus stops, and clearly designated on-street parking, improving walkability and reducing accidents.

### Create new supporting policy frameworks

Transparency and efficiency are central to achieve smart inclusive solutions. It is thus extremely crucial to crafting public policy to retain the distinct socio-cultural identity of the marginalised and deprived groups by ensuring dignified living space along with sustained source of income.

**Stimulate extra capacity building and employment generation.** Smart cities aim to develop capacity to match skills and create talent pools. While digitising India, there should be a clear focus on improving livelihood of citizens.

- **Attract and retain top talent.** ICT-integrated cities even further demand high-skilled workforce. Although the service sector now accounts for the largest single share of GDP, most of the jobs in this sector are low-skilled and under-paid.

By creating potential collaboration platforms and “lighthouse” projects, cities not only generate skilled white-collar jobs, but also assist in retaining the talent pool.

- **Provide skill-matching solution.** India has a massive low-skilled workforce with limited prospects in formal industry or modern services. India’s construction industry is going to be the largest industry in the world by 2020. So, a smart strategy for city-building should factor in employment generation, incorporating and upgrading small-scale construction and the real estate sector. Public-private partnerships (PPP) are integral for bridging this gap. For example, the Ministry of Rural Development worked with Council member Microsoft to create a skill-matching payment solution, to create a formalised system to connect work-skills for the businesses and assist the workforce to find employment.
- **Integrate small-scale enterprises.** The largely informal small, medium and micro-enterprises that form the backbone of India’s urban economy, need to be accommodated and integrated into the formal system in order to bridge the gap between demand-supply of various city services such as energy generation-distribution and waste management. There is a need to creatively develop formal

frameworks for successfully integrating such mechanisms into the PPP model.

**Create new policies, guidelines and regulations.** With rapidly changing new technology and innovative approaches, cities should be equipped to adapt to the changing environment and quickly incorporate new regulations and policies. With an energy crisis looming, renewable energy is the way to go for smart cities. The Government of India has targeted to build 100 GW solar capacity by 2022. This not only encourages the businesses to pursue a new direction but also provides incentives to achieve it.

However, there are multiple areas that need immediate attention, especially at the city level. For example, current regulations don’t allow the use of treated recycled products from C&D waste to be used in public construction. Adapting such regulations will encourage businesses to produce or use such materials as well as support the recycling of waste, which otherwise would have got dumped in landfills, further straining the problem of waste management.

**Formulate stable policy framework for private investors.** Smart cities formulation is a continual process, and smart cities need have to be self-sustaining. However, developing smart cities heavily depends on the initial capital to implement smart initiatives,



and investors are important piece in the system. Improvement in the clarity of various regulations and policies and a strong investor value proposition on a project-by-project basis attracts and retains investors.

To manage financing risk, the government could consider alternative approaches to incentivising transactions, such as credit guarantees. For demand uncertainty, risk-mitigation options could include availability-based payments and risk sharing. Finally, market sounding with potential investors should be interactive and undertaken early to generate feedback on a project.



### Implement optimal instrumentation:

*Implementing optimal instrumentation creates the data critical to a smart city. It is also the first step in connecting city infrastructure to the "Internet of Things."*

## Instrumentation and control

Instrumentation is the bedrock of smart cities. It provides the key source of data that allows a city to make informed decisions on how to reduce costs and allocate funding. In energy, instrumentation may mean smart meters that measure energy flow. In transportation it may mean embedded devices in roads and highways that measure traffic.

Implement optimal instrumentation. The purpose of this target is two-fold. 1) We use instrumentation to gather information about city conditions. 2) We use control devices to take action remotely — for instance, to throw a switch or open a valve. Becoming smart is all about having the right data to work with to make better decisions. So the overarching goal is optimal instrumentation and control.

Optimal is the key word here. The ideal smart city will have exactly the devices it needs, exactly where needed. In many responsibility areas, optimal may mean a device at every end point. In water, for instance, it may mean a smart water meter at every customer's premises. In other cases, it may mean a sensor "every so often" — as frequently as needed to generate enough data to provide a full picture of what's going on.

Three issues are worth mentioning as they

apply to instrumentation; these three will be addressed in more detail later in the chapter:

**Privacy and security** — Given the amount of data generated, cities must be absolutely vigilant about respecting privacy and implementing security.

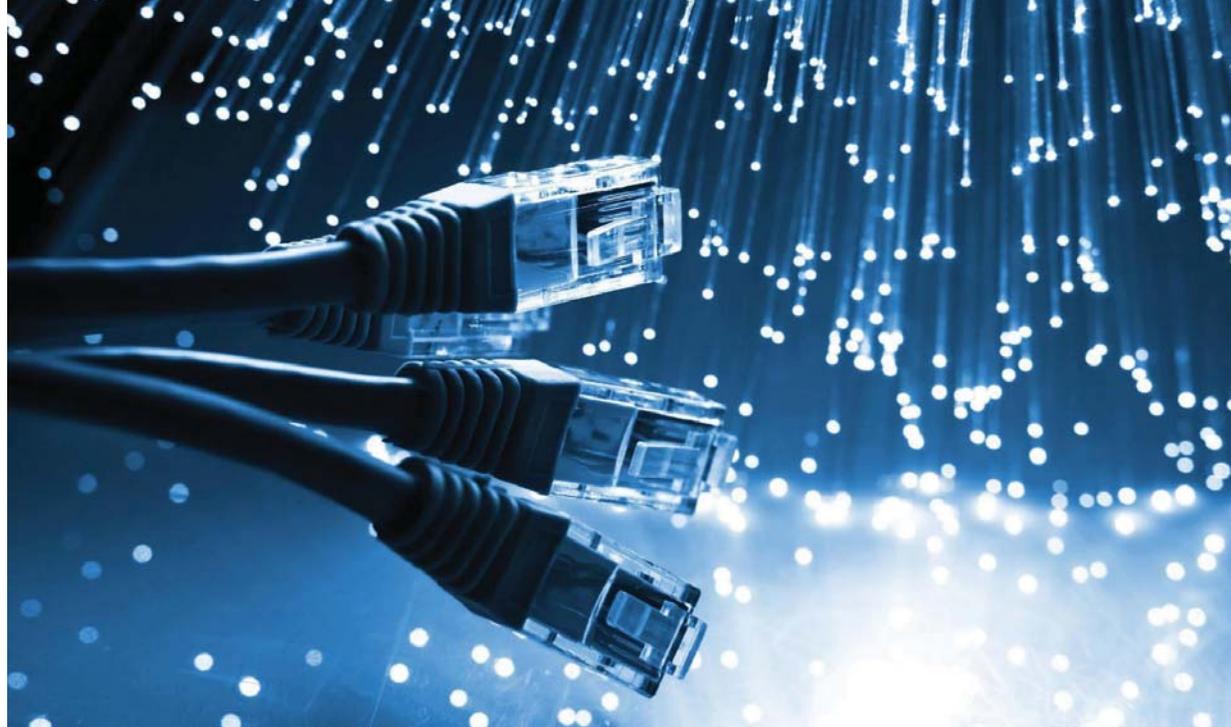
**Legacy devices** — Your city may already have lots of data available without the need for additional instrumentation immediately. For instance, anonymous cell phone GPS data can tell you where people are, or how fast they are moving on roadways. Key intersections may already have traffic sensors. Streetlights may already detect ambient light. Water; power or gas utilities may already have smart meters. You may decide to add additional sensors — especially now that prices are plummeting — but it's often possible to get started with the data you are getting already.

**Connectivity** — In smart cities, instrumentation needs to be connectible. Having sensors that need to be checked manually is not optimal — for instance, you wouldn't want to have to send a technician to every water pump in your city.

Implementing optimal instrumentation creates the data critical to a smart city. It is also the first step in connecting city infrastructure to the "Internet of Things," which is described next in the connectivity discussion.

# Connectivity

Take a moment to consider the incredible ways technology has changed our lives in the last four decades — microprocessors, ATMs, the World Wide Web, email, Google Maps, smartphones and iPads — to name a few. Clearly we've been on a connectivity roll for a while. And it's not going to stop. Today we are entering the Internet of Things (Iot) era where people talk to devices and devices talk to each other. This helps explain why connectivity is such a robust smart city enabler, and why machine-to-machine communications is all the buzz these days.



## Connect devices with citywide, multi-service communications:

Once those instruments are generating information, they need to be connected, so that they can communicate to provide data, as well as be able to receive orders.

The target, therefore, is to connect all devices to a citywide communications system. In rare cases, cities use a single communications network for all device connectivity. In most cases, cities use a variety of communication channels, including cellular, fibre, Wi-Fi, power-line and RF mesh.

But it's not enough to have just any communications system. It's critical to have systems that are reliable and secure, based on

open standards, have high data rates and are able to offer real-time communications to those devices that need it.

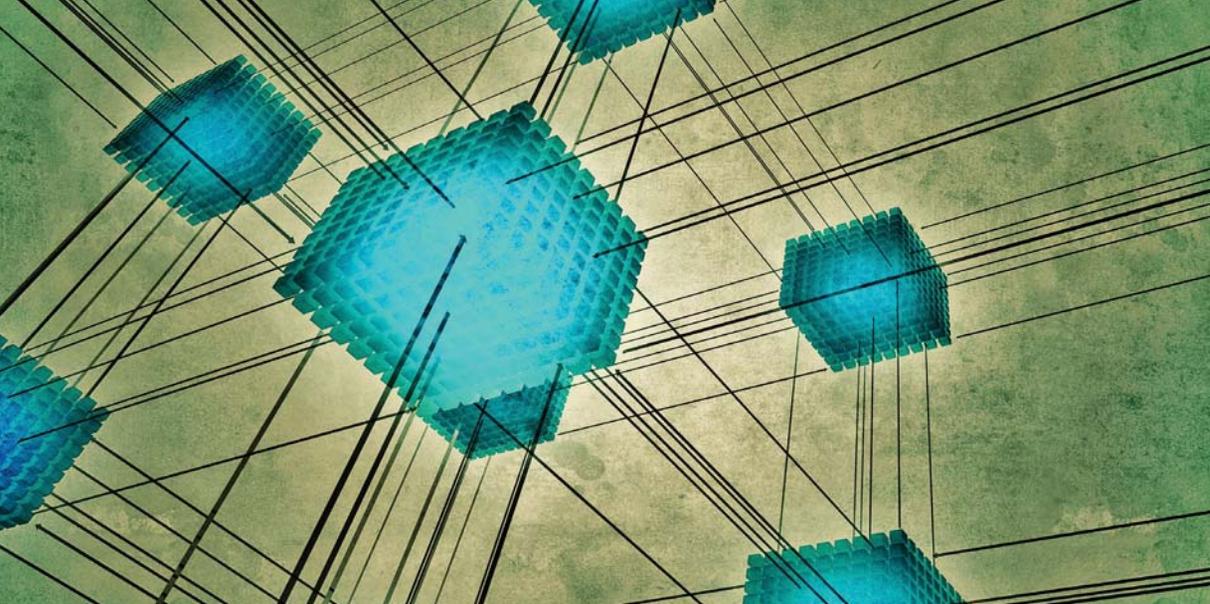
Most cities will have multiple communications systems, because no single network can realistically support every single application now and into the future. To save costs, cities ought to give strong consideration to the following approaches:

- **Prioritise technologies and tools that can manage “hybrid” networks.** Tools exist that can merge different communications technologies, even old analogue technologies such as radio.
- **Connecting instrumentation and control devices allows a city to feed data into analytical programs** that greatly improve outcomes, minimise resource use and save money, as we will cover in detail later.



## Connect devices:

*Multi-service communications system can carry messages for multiple applications from multiple sources.*



## Interoperability

Interoperability ensures the technologies you deploy work well together. There are three interoperability targets:

**Adhere to open standards.** If you hope to achieve your smart city goals, different technologies from different vendors must be able to work together. In particular, they must be able to exchange information. Adhering to standards helps to guarantee that the products you buy can use predefined mechanisms to talk to each other.

And you don't want just any standards, you want "open" standards — standards that

have been defined by an industry group and published for all to use. This contrasts with "proprietary" standards, which typically come from a single vendor who retains control over who can use them and when they will change.

Open standards help cities control both their expenses and their risk. They allow cities to mix and match products from different vendors without jeopardising the ability to exchange data. Put another way, open standards contribute to interoperability, choice and flexibility. They also make maintenance easier, because there are communities of specialists trained in published standards, such as those from Council advisors, the International Electrotechnical Commission (IEC), the Institute of Electrical and Electronics Engineers (IEEE), the International Telecommunication Union (ITU), the American National Standards Institute (ANSI) and many others including 3GPP for 3G/4G and the Wi-Fi Alliance. The Open Geospatial Consortium (OGC) — also a Council advisor — provides open standards for sharing spatial information, indoor and outdoor, and for communicating with sensors of all types.

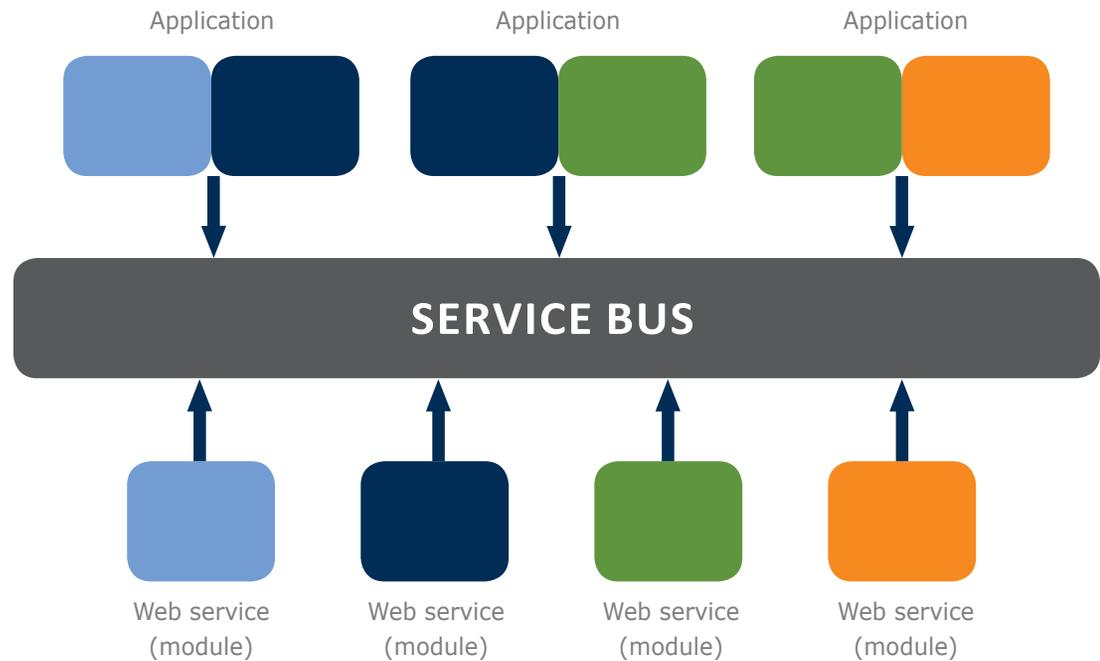
Although open standards are absolutely essential to the long-term success of a smart city, putting them into practice can be challenging. There are hundreds, if not thousands, of standards that apply to one aspect or another of urban life. The best advice is to leave the heavy lifting to the experts.

When you get to the project planning phase (as described in the final chapter), select suppliers with a public, proven commitment to open standards. Give them the task of selecting the best ones to use, subject to the oversight of your project manager or systems integrator.

When it comes to the smart grid portion, there is happily some good news. The IEC has undertaken the job of creating a free Smart Grid Standards Mapping Tool that makes it far easier to discover and choose between standards. Using either a diagram or a list, you can drill down to a specific aspect, then see a list of all the standards that relate. The IEC lists not just its own standards, but those from other organisations as well.

**Use open integration architectures and loosely coupled interfaces to facilitate sharing of data and reuse of code.** This gets a bit technical, but the important thing to understand is that you can build your applications in a way that makes it easy to reuse code “modules,” saving time and expense. Systems that are “loosely coupled” don’t have components that are dependent on each other, theoretically making it easier to swap them in and out. Open integration architectures are enhanced by methodologies such as service-oriented architecture (SOA) and enterprise service bus (ESB). Benefits include:

## OPEN INTEGRATION ARCHITECTURE SYSTEM



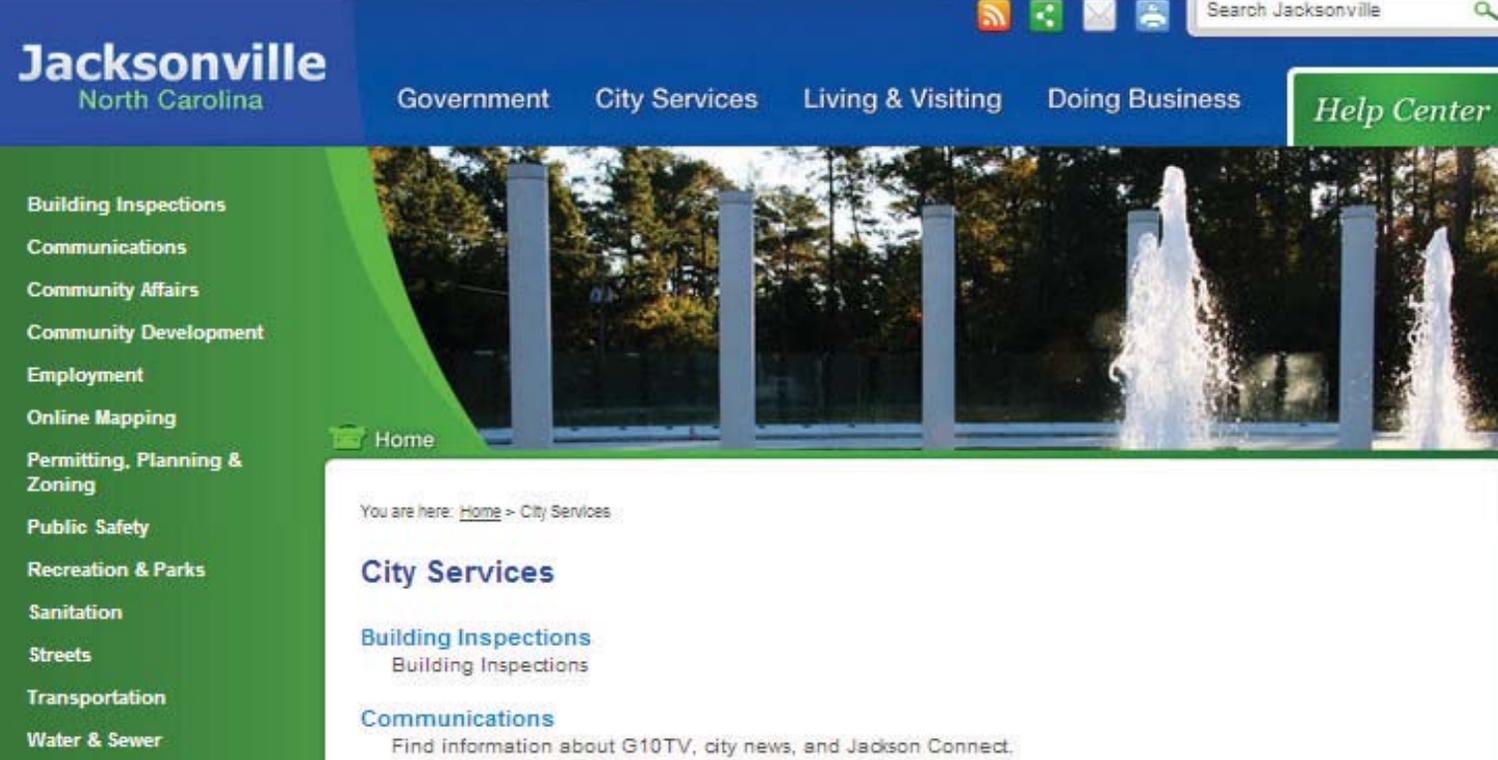
- **Faster software implementations** because they can be assembled in part from previously written modules
- **More robust implementations** because the city can have standardised tools and best practices
- **Greater scalability** because the loose coupling that is part of an open integration architecture allows for high availability, fault tolerance and load balancing — techniques that allow systems to deal with huge amounts of data
- **Easier changes** because you alter only the affected module(s), not the entire application, and because changing one module has minimal impact on the rest of the system



**Prioritise legacy investments.** No city can afford to rip out its current infrastructure and replace everything from scratch. Priority must go to making the most of existing investments. Typically, that means retrofitting existing assets — streets, buildings, equipment — with sensors and communications.

Fortunately, a wave of new, low-cost technologies makes it possible to connect legacy assets. In the area of emergency response, it is now possible to integrate old,

analogue radios with state-of-the-art IP-based communications, stitching them together into a seamless network. Likewise, a city government can often find ways to continue using old software by sending its data to new software modules that add value on top. Likewise, an electric power utility doesn't have to replace its old transformers, it can simply add transformer monitors to report on their conditions.



Create a citywide security policy:

## HOW JACKSONVILLE MADE ITS VIRTUAL ENVIRONMENT MORE SECURE

**Create a citywide security policy that continually assesses risks:**

*Upgrading its ICT infrastructure provided many benefits for Jacksonville, North Carolina, including better protection from the growing number of online threats.*

Jacksonville is the 14th largest city in North Carolina and home to more than 70,000 residents. Jacksonville’s Information Technology Services (ITS) department provides citywide support for all computer, phone, security and geographic information systems through its operations centre for over 500 end users.

As the city’s workers became more and more dependent on the ITS department, Jacksonville’s IT director Earl Bunting along with other city officials, decided it was time to refresh the department’s infrastructure to ensure it remained fully functional at all times. It also wanted to give employees access to needed materials, but in a secure fashion.

Jacksonville decided to upgrade to a Virtualisation Experience Infrastructure (VXI) from Council member Cisco, which supports Jacksonville’s operation centres. The approach goes beyond traditional virtual desktops to deliver next-generation virtual workspaces by unifying virtual desktops, voice and video.

While Jacksonville citizens and employees have seen a number of benefits from the upgrade, the solution has also helped Jacksonville’s virtual environment become more secure. “Our IT department no longer has to waste time monitoring for threats,” says Bunting. “VXI has made our environment increasingly secure and protected us from the growing number of online threats that comes with such a large number of users.”



## Security and privacy

One of the greatest challenges for smart city leaders is to reassure residents that their rights will be respected and their data protected. This section highlights three important targets that address those issues.

**Publish privacy rules.** Make it a priority to produce clear privacy policies that are easily accessible. The rules should balance residents' desire for privacy and control with the ability to gain access to data to provide better services. They should stipulate:

- **Which data sets** are owned by which stakeholders
- **What rights and protections** are afforded by ownership
- **Which data sets are private** (requiring authorisation prior to sharing)
- **Which data sets can be shared** with the city or authorised third parties
- **How data can be shared** if defined protocols for making information anonymous are followed

Publishing privacy rules can save time, money and headaches. It can also unleash innovation. Entrepreneurs are more comfortable building new products and services if they know the rules in advance and they know those rules will

apply equally to their competition.

It's one thing to have privacy rules. It's another to ensure that residents and businesses know about them — and yet another to actively enforce them in collaboration with national and state/province level authorities.

A 2013 column in the Boston Globe titled "The Too-smart city" garnered a lot of attention. It took a "big brother is watching" slant on the Smart cities movement: "A city tracking its citizens, even for helpful reasons, encroaches on the personal liberty we count on in public spaces."

Cities and cultures will have different priorities for privacy. There are several sources of guidance on privacy rules that cities may want to review. As you will see, you don't need to invent your privacy guidelines from scratch. There are several sources of helpful examples, including:

- European Union Privacy Directive
- Electronic Privacy Information Centre
- International Association of Privacy Professionals
- Criminal Justice Information Services
- Federal Information Processing Standard
- Office of the Information and Privacy Commissioner of Ontario, Canada



**Publish privacy rules:**

## **CALIFORNIA UTILITY TAKES LESSONS FOR PRIVACY FRAMEWORK FROM CANADA**

**T**he city of San Diego, California's municipal utility in 2012 launched a 'Privacy by Design' smart grid initiative in conjunction with Ontario, Canada Privacy Commissioner Ann Cavoukian, a recognized champion of consumer privacy safeguards.

"Our cross-border partnership with SDG&E follows similar successful alliances forged with other organisations globally, as well as in my jurisdiction of Ontario, Canada, to build in Privacy by Design," said Cavoukian. "Privacy is a fundamental right of every energy customer, and I am very pleased to be working with SDG&E to ensure that our innovative privacy framework is an integral part of the smart grid deployment."

Developed by Dr Cavoukian, Privacy by Design has been made an international standard, and is a practical solution for ensuring privacy that can be designed into the ever-growing and systemic efforts of ICT, and of large-scale networked data systems, as the default.



**Publish privacy rules:**

*Cities can turn to several established systems to get started. For instance, the Privacy by Design system, originally developed in Ontario, Canada, is based on seven fundamental principles.*

**Create a security plan that designs security into smart systems from the beginning, and continually assesses risks thereafter.**

A smart city's security policy and risk management framework must be comprehensive, encompassing cyber security as well as the physical security of all assets — from massive infrastructure to tiny mobile devices.

Data privacy depends upon the security of the systems that store data. Highly secure systems are operated by authorised people only, and produce reliable, predictable results. Systems that are "insecure" are unreliable, highly vulnerable to attack, and subject to major data breaches.

New smart city capabilities — with everything from energy infrastructure to employee cell phones connected on the Internet — add tremendous connectivity, generate a lot of data, and offer great promise. But they also create what security experts call "an expanded attack surface," which introduces significant new cyber vulnerabilities.

Cities need an expert, comprehensive security plan at the heart of all smart city systems development. Cyber security must be "baked-in" throughout the system, starting in the design phase, not merely added afterward around the perimeter.

This plan should encompass data, applications, devices and communications systems at minimum. It should have a strong identity access management component; cyber defence-in-depth security controls; "human factor" security awareness training; and a strong trustworthy computing foundation.

It's best not let each individual city departments to come up with its own security plan. Instead, leverage the best cyber-security resources available to your city (internal and external) to come up with one security standard that everyone must meet.

But even with the best experts and strongest security plan, no city is immune from cyber attack. Therefore it is also extremely important to monitor breaking cyber threats and new vulnerabilities, constantly, and to have detailed disaster response and system restoration plans in place.

An aggressive cyber-security plan, with security control requirements, which all participating smart city departments must meet, can greatly reduce the risk of attack, and mitigate adverse consequences, should one occur. And, perhaps more important, it can build the kind of trust and confidence in smart city systems (and their privacy controls) that can lead to wide adoption.

## Data management

The streams of data that smart cities collect create enormous opportunities, but also require special handling. Smart cities treat public data as a citywide asset. That data needs to be accessible to other systems and stakeholders, including where possible, the research community to help ensure that the analytic environment is always current. Citizens, of course, will expect full access to their own data. These requirements demand a citywide policy.

As we move forward, city data will be used by multiple applications from multiple departments. And it may be used by outside developers as the foundation for useful services to benefit residents. An error in master data can cause errors in all the applications that use it. In a similar fashion, an error in releasing data to those not authorised can cause a cascade of problems.

Many types of city-managed data become infrastructure on which companies and others can build wealth. A "spatial data infrastructure," for example, enables city players to freely use and add to street and landscape data as well as 3D building models, point-of-interest data and weather data.

**One more time for emphasis.** A smart city's most precious resource is the data it produces. Avoid squandering or endangering that valuable commodity by failing to carefully define a thorough data policy, as explained below.

**Create a citywide data management, transparency and sharing policy.** Ideally, cities should build a master plan and an information data model that spells out how data is governed, stored and made accessible. Best practices call for a clear governance directive that a) establishes the chain of authority and control over data assets and b) spells out who makes access decisions and who determines accountability. The citywide data management policy defines a city information model for all entities and assets that preserves relationships, attributes and behaviours.

This citywide policy should cover both private and public data and ensure that data from each department is made available to others. It must also align with the policies in the security and privacy targets discussed previously. It is important for data to be stored on secure, reliable and scalable systems long enough to enable the dependable pattern analysis and reliable forecasting explained in the analytics target later in this Guide.

A citywide data management plan will increase the city's agility (ability to quickly build new

applications as needed) and accuracy (by ensuring everyone is working with correct data). It can also lower costs by reducing errors and eliminating unnecessary duplication. A citywide plan also makes it much easier to enforce privacy, security and best practices.

## Computing resources

Keeping up with ever-advancing computing technologies in an era of budget constraints can put city leaders between the proverbial rock and hard place. But smart cities find a way — and sometimes find the more advanced solution is more budget-friendly too. Even so, there is a right way and a wrong way to pursue your computing objectives, as you'll discover in reading about the four targets in this section.

Consider a cloud computing framework. There are many ways to deploy computers, but most cities should consider cloud computing first. It is the computing framework best equipped to deliver efficiency and optimisation.

Cloud computing is the practice of using a network of remote servers to store, manage and process data. Typically those servers are accessed via the Internet. Please note that cloud computing can be delivered as a service

from a third party — sometimes called "hosted solutions" or "software-as-a-service" (SaaS). Or it can be built and operated by a city using the same architectural principles as third-party providers.

Cloud computing provides a common, shared foundation across departments and across different computer systems. Consider these attributes:

- **Identity services** for consistent and secure single sign-on
- **Virtualisation** for seamless application portability. Virtualisation is the creation of a virtual (rather than actual) version of something, such as an operating system. A single server can run as multiple "virtual" computers with different operating systems, for instance.
- **Management functions** for full visibility and control
- **Scalability** to support millions of data collection points
- **Industry-standard frameworks** and languages for writing applications

Applications and services reside in the cloud, where they are accessible from any device.

Additionally, those applications and services are typically built with an event-triggered enterprise service bus architecture that provides a structured method for combining loosely coupled software components. As we discussed earlier in the interoperability target, this approach makes it easy to share data and reuse software code between departments.

There are many benefits of cloud computing:  
**Growth** — It becomes easier to add computing power in small increments

**Power** — It's typically less costly and simpler to scale up computing services

**Reliability** — If one computer crashes, others can easily pick up the slack.

**Cost** — It becomes possible to mix and match hardware from different vendors, increasing choice and thus driving down expenditures. In addition, many third-party providers will "rent" software to cities for a monthly charge, with little or no upfront cost.

**Advanced features** — Smaller cities can gain the same functionality as their larger cousins by tapping into cloud offerings from third parties. The provider sells the service to many different customers, allowing it to enjoy economies of scale that make it possible to

create advanced features. Smaller cities would never be able to afford the large ICT staff and server farm required to host such applications on their own.

Cloud computing may not be an immediate option for every city. Cities that have already made large investments in other approaches may settle on a hybrid computing model. And cities in geographies with a cultural emphasis on centralisation may prefer a centralised computing model.

- **Establish an open innovation platform — Open Data.** Today's Open Data movement represents one of the most powerful opportunities cities have to connect with citizens in meaningful, life-impacting ways. The move to make public data freely accessible to anyone who wants to use it for legitimate purposes has been referred to as "the big bang" for all of the Big Data that cities are amassing today.

US President Barack Obama characterises Open Data as "the new default for government information." Keep in mind that Open Data doesn't work well unless it is discoverable, assessable and usable through open data encodings and open software interfaces.

However, by making raw public information easy to access, you allow city employees, utilities, citizens and third-party developers to create innovative applications and services for the benefit of the city and its residents.

Most of this information has been collected at taxpayer expense. And most of it is available to the public in theory. Until recently, however, it could not be accessed in a useful way. (You can't build a data-based application if you have to go city hall and pull it out of paper files.)

New York City has been one of several leaders in the Open Data movement. In September 2013, officials there announced that since the launch of its Open Data portal in 2011, the city has opened up more than 1,100 data sets from over 60 agencies. These data sets total more than 600 million rows and have received more than 2.8 million views. NYC also announced a city-wide plan to unlock all of its public data by 2018.

## OneCity proposal

**TRANSIT PLAN:** TTC chair Karen Stintz and vice-chair Glenn DeBaeremaker have come up with a plan that would build about 175 kilometres of transit lines — six subway lines, 10 LRTs and five bus and streetcar routes — across Toronto. The proposal costs \$30 billion and would be built over the next 30 years. It would be financed with a Toronto property tax increase and financial help from the provincial and federal governments. The plan goes before council next month.



NYC, of course, is not alone. Government agencies around the world are embracing Open Data, providing dozens hundreds of applications that take advantage of city data. These applications range from:

- **Transit planning apps** that show the best way to travel
- **Crime reporting apps** that show trouble spots
- **Street monitoring apps** that pinpoint potholes and problems
- **Mapping apps** for first responders
- **Location apps** that show where to find ATMs, hotspots, day care centres, urgent care centres, government offices, parks, meeting spaces, etc.

Clearly, Open Data and similar innovation platforms can improve public services in countless ways. It can also make government agencies more accountable, generate new revenue streams and help to stimulate economic growth.

But cities often confront stumbling blocks on the road to an Open Data environment. Here are two that may be most challenging:

1. **Governance and privacy issues.** Who owns the data, who controls it, what safeguards are in place to protect personal information when a city decides to open its data for public consumption? Open Data policies must be clarified in the broader data management, transparency and sharing policy discussed earlier.
2. **Non-standard data formats.** Rather than spending taxpayer dollars to reinvent the wheel in every city, one of the promises of Open Data is the ability to share apps between cities. But that requires cities

to use the same data schema, which is often not the case. However there is an initiative underway involving seven major US cities — Boston, Chicago, Los Angeles, New York City, Philadelphia, San Francisco and Seattle — to create a database of standardised Open Data applications.

Fortunately, help is at hand for cities that want to join the Open Data movement, as you'll read on the next page.

Filter Search Results

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246 results

category: Environment

#### EMISSIONS

category ENVIRONMENT

Last edit 2015-03-31

Europe - France - Emissions

Energy

Emissions

Environmental results



There's no single path to an Open Data initiative, but most cities will want to take these three steps:

#### Create a team of Open Data advocates.

You'll want a team that includes personnel from a number of departments, including but not limited to: IT, communications/ media and managers from departments with data sets with citizen appeal – for example, public safety, transit, public health. Perhaps most important is to have executive-level representation on the team – the city manager or mayor, for instance.

**Develop an Open Data policy.** First, develop an Open Data policy that is included in and consistent with the city's broader data management, transparency and sharing policy. Second, create an Open Data policy roadmap that outlines your goals, which data sets you will start with (this can be expanded once you've tried a few pilots), where and how you will make them available (a new web portal, on your existing

city website, etc.) and what needs to get done by when and by whom. Third, smart city planners should emphasize the importance of open software interfaces and open data encodings, preferably open interfaces and encodings that implement freely usable global interface and encoding standards. These enable technical interoperability between diverse systems, which enables Open Data policies to work.

**Choose your first project.** Typically the safest approach is to choose a relatively small, low-cost pilot project to get some experience, work out any problems and get a success under your belt. You may want to take the approach that other cities have found successful and reach out to your local developer community via contests and hackathons. They'll likely have ideas about which data sets would make useful apps. Another route is to analyze what kinds of information is most requested by members of the public.



#### Establish an open innovation platform:

*Italian utility giant Enel has championed the Open Data movement, opening its corporate data in the spirit of increasing transparency, favoring technological innovation and improving the market it operates in. Council member Enel is also at the helm of Flexiciency, a European initiative to use smart meter data to its fullest potential.*



Once a city opens up its data, citizens and businesses start to rely on it. They may even have their business and revenue streams depend on it. Cities should make sure their Open Data implementation offers a 24x7x365 availability in a secure manner. As such, a choice for Open Data becomes a core responsibility of the city, reflected in a strong information back bone.

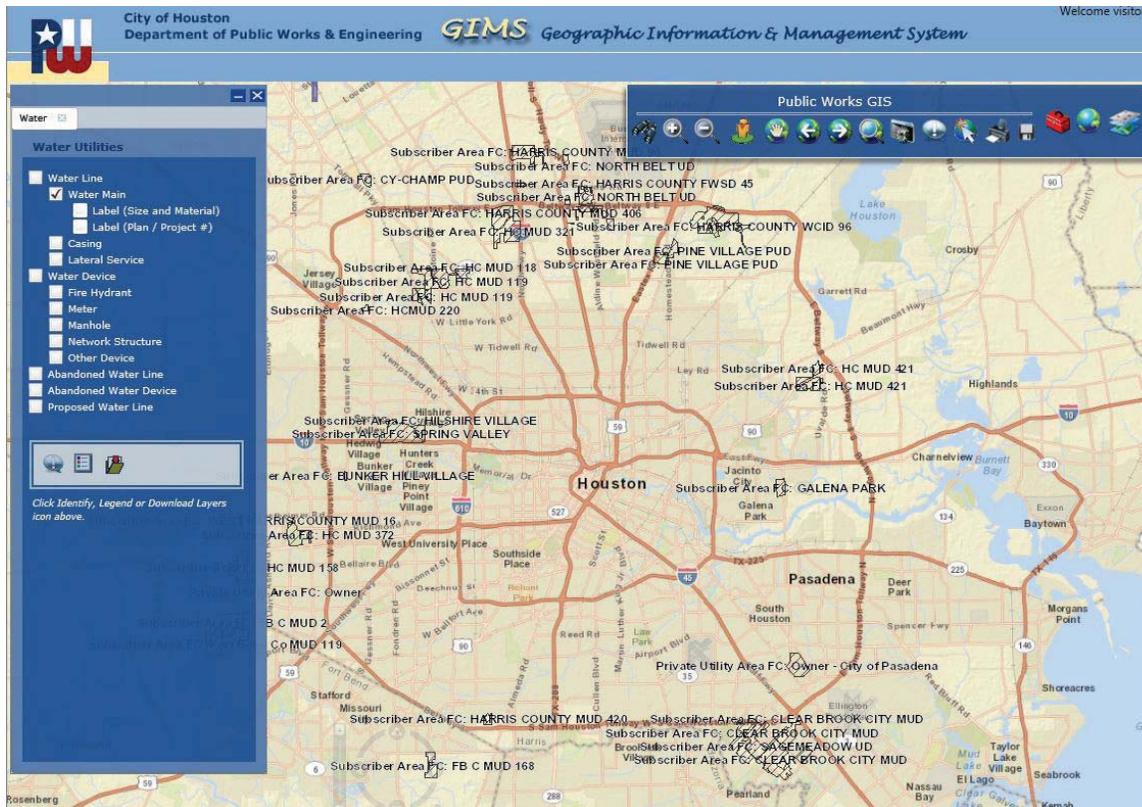
**Useful Open Data resources** There are many places to turn for ideas and inspiration on Open Data initiatives. The Council’s free smart cities Open Data Guide is a good place to start and our Apps Gallery showcases many examples of apps created by and for cities using Open Data.

Other useful resources include: City Forward is a free, web-based platform that enables users to view and interact with publicly available city data about cities and metropolitan areas around the world. On the site, which is a philanthropic donation of services and technology from Council member IBM, users can search for data

by city, subject or source. Code for America (CfA) runs a fellowship program designed to leverage technology and government data to make cities run better. Among the apps developed by CfA’s fellows are Boston’s adopt-a-hydrant app and Honolulu’s tsunami warning app. Data-smart city Solutions – an initiative by the Ash Center at Harvard Kennedy School and powered by Bloomberg Philanthropies – features news and trends in civic data. It’s a helpful resource if you want to see what other cities are doing with Open Data. Data.gov showcases examples of cities and developers working together to improve the lives of city residents. Open Data Platform formed in 2015 to open up the back end of open data projects. More than a dozen companies have joined the association at the outset, including Council members IBM, GE and Verizon. Association members will use the same basic platform for their open data solutions, providing a wide range of benefits for cities undertaking open data projects.

**Freeing London’s data:**

*The idea of London Datastore established in 2010 by the Greater London Authority is that information collected at public expense should be available to all, taking into account privacy or commercial confidentiality. The success of London’s experiment shows that it is also a way to garner a long list of useful applications for government, for business and for everyday citizens, usually at zero expense to the city.*



## Have access to a central GIS:

*The Houston, Texas public works department GIS is available online. The rendering above shows water main locations. Having a GIS that maps all of a city's assets and location information is a big contributor to what makes a smart city smart.*

**Have access to a central GIS.** A geographic information system (GIS) that maps all of the city's assets and location information is a big contributor to what makes a smart city smart. Most cities will want to implement a single, central GIS system so that data from one department (traffic alerts, for instance) can be shared with others (such as emergency responders). Some cities even share the cost of GIS services with outside organisations, such as utilities and phone companies.

What GIS enables users to do is combine many

layers of data — all linked by their geographic location (latitude and longitudinal coordinates) so that greater insights into issues can be discerned. For example, by layering one dataset on school facilities (building locations) with another dataset of the transfer routes for trucks carrying hazardous wastes through a city (street routes), you can reconfigure the travel routes to avoid such sensitive sites.

In another example, Council member DNV GL combined customer survey data on appliances, the propensity of electric consumers to

participate in a demand response program offered by their utility, and electric usage data by zip code with the physical locations of the utility service territory to identify the potential for reducing peak at specific geographic points around the system. Such data can also be used to target pilot programs or marketing campaigns for maximum effect. In short, GIS provides a way to get much more value out of data from different sources, and display results visually on a map for quick recognition of solutions.

GIS is tailor-made for smart cities. To name just a few of the great applications of this technology, cities can use GIS to:

- **Map crime data** to aid their public safety work
- **Locate pipes, pumps, cables** and other assets to help better monitor and analyse the efficacy of their water infrastructure
- **Maximise traffic flow** and share helpful traffic maps with the public
- **Conduct better environmental impact assessments** for their buildings and parks

There are also many benefits to cities with GIS:

- **Spatial decision-making** is greatly improved
- **Efficiency gains** accrue through more intelligent maintenance scheduling and delivery routes
- **Improved accuracy of essential records** such as property boundaries and locations of key assets
- **Resiliency** is boosted through improved situational awareness in times of stress.

Everything in a city has a location. In a smart city, location information is being used and produced for countless purposes by countless

different systems. Cities need to encourage use of open standards that provide seamless communication of geographic information between different systems. Open interface and encoding standards prevent vendor lock-in and enable systems of many kinds to share all types of geographic information. Most GISs implement open encoding and interface standards that enable them to “talk to” other GISs as well as diverse mobile devices, emergency response systems, smart grids, sensor webs, smart vehicles and more.

Application developers discover countless opportunities for innovation when cities provide access to 3D urban models, address data, elevation data, zoning, bus routes etc., via encodings and interfaces that implement open standards.

**Have access to comprehensive network and device management.** Eventually cities could have hundreds of thousands or even millions of small devices connected to their networks. That’s a lot of devices! Smart cities (or their suppliers) will need a robust device management platform that handles tasks such as device detection and registration, device configuration, device connection and disconnection, device security, device troubleshooting and device updates and upgrades. Such a platform is able to support virtually any kind of device, and it can span multiple communications networks.



Being able to manage devices remotely and with computer assistance offers significant benefits. Among them:

- **Cities can save time**, improve their infrastructure security and quickly and easily implement any necessary software upgrades
- **Cost savings accrue** to cities through the central management of their devices
- **It is easier to enforce consistency** and compliance with the city’s data management, security and privacy policies.

# Analytics

We don't want to diminish the importance of the other enablers. But truth be told, analytics is a super enabler. Analytics takes massive quantities of data and turns it into actionable intelligence that enhances liveability, workability and sustainability in very direct ways. In this section we'll cover three targets that let cities tap into the full power of analytics.

**Achieve full situational awareness.** Gain full knowledge of what is going on throughout the city. This situational awareness can be delivered in many ways. From dashboards to visualisations to command and control centres and to alerts delivered to computers or phones. The exact method of delivery depends on the unique circumstances of your city.

In most cities, this kind of awareness doesn't happen today. If you consider systems such as energy, water, traffic, policing and emergency response, you'll recognise that today's operators are often "flying blind." They may know general parameters, but they don't know precisely what is going on at every point throughout the system. One example is an electric utility that has not yet deployed smart meters or other sensing technologies across the electric grid.

If power is out in a neighbourhood, the utility may not know it until a customer calls in. Same story with transit operators, who may not get a heads-up that a bus has been disabled in an accident until the driver has a chance to make a call.

Giving operators full situational awareness has a long list of benefits. One is safety — for instance, we don't want police officers or firefighters sent into danger without a full picture of what they're getting into. A second is reliability and resiliency — for instance, utility workers can restore outages much more quickly if they aren't waiting for someone to call in and report them. And third is efficiency — a full picture of the entire system makes it much easier to make the correct choices and trade-offs. Additionally, operating budgets, staff and shift requirements can be reduced through mobile and remote monitoring and control technologies.

**Achieve operational optimisation.** Taking steps to arrive at the best decisions (including financial decisions) for the overall system. A simple definition is "the process of making something as good as possible." It implies balancing trade-offs to achieve the best results.

Today, infrastructure and system optimisation — if it occurs at all — happens without the ability to truly see the big picture. But in the smart city of tomorrow, optimisation will have data from many sensors and subsystems plus the computer power to analyse all of that input to find the best path forward.

As you can see, infrastructure and system operational optimisation offers many benefits. For instance, in energy and water scenarios it:

- Provides for the efficient generation, distribution, consumption and reporting of resources, both in the aggregate and at the individual business/citizen level
- Strikes an optimal balance between asset and citizen needs and health
- Enables the application of learning in the continuous maintenance, tuning and commissioning of assets

Bottom line, operational optimisation delivers cost saving, resource saving and better outcomes to cities and people.



Achieve full situational awareness:

## ICT HELPS TRANSFORM DMIC WITH SMARTER AND SUSTAINABLE CITIES

The Delhi-Mumbai Industrial Corridor (DMIC), a public-private partnership aimed at creating a new transportation and urbanisation corridor between India's capital city, New Delhi, and its business capital, Mumbai. The vision of the Delhi-Mumbai Industrial Corridor Development Corporation Ltd (DMICDC), is to create a strong economic base within a globally competitive environment, and state-of-the-art infrastructure to activate local commerce, enhance foreign investments and attain sustainable development along the corridor.

With the aim of providing seamless digital connectivity among townships and better living conditions, DMICDC partnered with Council member IBM to develop one of the biggest industrial development projects of the government of India — smarter and sustainable greenfield cities spanning across six states in India.

The Integrated Communication Technology (ICT) Master Plan for Dighi Port Industrial Area developed by IBM provides a futuristic roadmap for the area including the use of technology to deliver services to business and citizens such as monitoring energy consumption, traffic visualisation, improved water management, and enhanced public safety, education, and healthcare, allowing the essential key services of the city to be managed more effectively using smart devices, sensors and intelligent communications.

Using IBM's Smarter Cities software, the Intelligent Operations Centre, a command centre, will be established to integrate, interconnect and analyse large amount of Big Data from various city operations that enables quick and coordinated response, improving safety, preventing problems, and enhancing the quality of life with efficient citizen-centric services.



Achieve full situational awareness:

*The Intelligent Operations Centre will integrate, interconnect and analyse large amount of Big Data from various city operations that enables quick and coordinated response, improving safety, preventing problems, and enhancing the quality of life with efficient citizen-centric services.*



### **Pursue predictive analytics:**

*Cities can get more from the data they collect through predictive analytics, which predict what is likely to happen next.*

**Achieve asset optimisation.** Smart cities gain the maximum lifetime value from all of their assets by applying advanced analytics to the data gathered from their instrumentation. In other words, city assets — roads, power poles, transformers, pumps and so on — are equipped with sensors and instrumentation that report their condition. Then asset management systems can analyse that data to optimise asset performance and maximise their lifetime value.

Even a medium-sized city can save tens of millions of dollars over time through asset optimisation. For instance, a city can service its buses based on their actual condition, and not on a guess or an average or fixed schedule — sometimes referred to as “condition-based” or “predictive” maintenance.

Likewise, a city can replace or upgrade only the equipment that actually needs it, whether water pumps or bridges. Doing that extends the useful life of assets that may be past their design life on paper but are still performing well in real life.

Good asset management systems can also determine the “criticality” of an asset, so the city can accurately prioritise which assets need attention first because of the impact their failure would have on the system as a whole.

**Pursue predictive analytics.** As we’ve said, smart cities can pull data pieces together to analyse what is happening in real time and make operational decisions. But the value of that data doesn’t end there. Through predictive analytics cities can get a glimpse of what’s going to happen next — from where crime is most likely to occur to where streetlights are going to fail to where traffic congestion will stall the morning commute.

With predictive analytics, you can uncover patterns and associations you might not discover as quickly otherwise. Schools, for instance, might use analytics to identify patterns in dropout rates and then which students are at risk and which retention strategies might prove effective.

Here’s another example: Data scientists at the US Department of Energy’s Pacific Northwest National Laboratory, a Council member, have created a social media analysis tool capable of analysing billions of tweets and other social media messages in just seconds. The idea is to discover patterns and make sense of the data and ultimately retrieve useful information that can enhance public safety and health. An increasing number of messages on social media about social unrest could provide an early warning that can help authorities protect citizens from riots or other disturbances.

# UNIVERSAL TARGETS

	Enabler	<b>Universal Targets</b> How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress			
			None	Partial	Over 50%	Complete
Human	<b>Inclusivity</b> Achieve accessibility optimisation Formulate citizen reporting framework for outcome thinking Achieve citizen engagement		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	<b>Collaborativity</b> Create institutional framework Pursue multilateral collaboration		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Governance</b> Achieve existing infrastructure optimisation Formulate new supporting policy frameworks and regulatory mandates		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# UNIVERSAL TARGETS

Technology	Enabler	Universal Targets How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress			
			None	Partial	Over 50%	Complete
	<b>Instrumentation and Control</b>	Implement optimal instrumentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Connectivity</b>	Connect devices with citywide, multi-service communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Interoperability</b>	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritise use of legacy investments	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Security and Privacy</b>	Publish privacy rules Create a security framework Implement cyber security	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Data Management</b>	Create a citywide data management, transparency and sharing policy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Computing Resources</b>	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Analytics</b>	Achieve full situational awareness Achieve operational optimisation Achieve asset optimisation Pursue predictive analytics	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			

# 4

## Smart People



**A city isn't smart because it uses technology. A city is smart because it uses technology to make its citizens' lives better. This chapter focuses on the 'secret sauce' that turns the idea of a smart city into reality – the people who live in the city, who work in the city and the people who have hopes and dreams for the kind of city they will leave for future generations.**



## Use innovative approaches to encourage broad participation in city decisions:

*Smart cities encourage all city stakeholders to develop a vision for the city they want to live in.*

*Image: Huffington post*

This chapter will focus on how to bring all city stakeholders together to develop a vision for the city they want to live in — and the one they want their children and grandchildren to live in. It's about listening; about reaching out; about education and oftentimes it's about a new mindset that is more open, more transparent and more focused on inclusion.

For example, does your idea of listening to citizens consist of giving people a few minutes to speak during public meetings? And are they invited to speak only after you've nearly finalised your plans? If this is how your city "listens," you probably aren't hearing what is really important to your constituents — nor are you hearing from a truly broad cross-section of your city's population. And your projects may well suffer as a result.

In this chapter, we'll discuss a new mindset and showcase some of the exciting and innovative ways smart cities are building two-way communications with their citizens and creating stronger initiatives as a result.

Smart cities do not target the use of technology as an end in itself, rather use it as a tool to formulate citizen-centric, inclusive and sustainable cities. Becoming a smart city is a continuous process to improve quality of life in a way that is resource efficient and environmental friendly. Very often smart technologies are portrayed as a means to streamline, optimise, integrate, digitalise, systematise, consolidate and otherwise improve infrastructure. And that's certainly a part of what smart cities are about.

As more and more people move to urban centres and strain often inadequate or aging infrastructure, optimising, integrating and the like become essential if cities are going to provide their citizens with basic needs — energy, water and shelter.

However, the citizen focus is not underscored often or loudly enough by well-meaning city leaders struggling to find affordable solutions to pressing urban problems.

## The human side of technology

Technology for technology's sake rarely serves a useful purpose. The magic in technology is how it can transform lives. Consider these examples:

- **Making cities more accessible for all.** Accessible Way is an app developed by Council member IBM to enable citizens to report on mobility issues they spot as they go about their daily lives — roads and sidewalks, crosswalks, curbs, traffic and streetlights in need of repair. Or when there aren't enough handicapped parking spaces or when road signs are confusing. With just a few taps, people can report the exact location and type of the problem, giving cities detailed information to improve mobility.

To battle the high volumes of complaints anticipated in Indian cities, the data collected from the app could be prioritised with the use of analytics.

- **Helping the blind navigate the city** The smart stick is an idea that came from a conversation an engineering student had with her blind uncle about the challenges he faced getting around a city. Connecting to the Internet of Things, the smart stick

guides the blind safely by accessing information from traffic lights, cross walks, buses, construction and weather reports. Sensors at stores let them know if the store is open, what it sells, where the entrance is, etc. The project, backed by Council member Cisco, was developed by a team from the University of Lorraine.

- **Improving the health of people at-risk.** Myanmar, which has very high rate of infant mortality, is providing pregnant women with a free app from Council member Ooredoo that provides health alerts with care information and medical services. In China, where the textile workforce is predominately uneducated young women, a mobile program from Council member Qualcomm provides access to health services and information. Both projects are improving lives for populations that have disproportionately suffered with poor healthcare.
- **Helping children learn to read, write and tell stories.** In Australia, children who couldn't sit still for even a few minutes dramatically improved their language abilities when the lessons were presented in video game form. A project from Council member Microsoft made it easy for teachers to tailor the game technology to teach specific skills and to encourage the youngsters to practice.



### The human side of technology:

*The smart stick enables the blind to navigate cities more easily.*

**Using open data to improve lives.** Smart cities can get more mileage out of their ICT investments when they use analytics to sift the data provided via sensors and other smart devices to surface useful information that can help citizens improve their lives and livelihoods. We'll talk in more detail later about the open data movement. You can also download the Council's smart cities Open Data Guide for help getting your city started down the open data path. In this section we'll focus more on the benefits to citizens that can come from open data policies.

Opening or releasing data sets provides an opportunity for cities internally and the developer community externally to use the data to build Web-based and smartphone applications. As the open data movement has snowballed, so too has the depth and breadth of apps available today.

Consider just a few examples of common apps you can find in cities around the globe today:

- **Interactive crime maps** that help citizens see where crimes are occurring so they can take steps to be safer or be more vigilant and report suspicious behaviour.
- **Traffic flow apps** help commuters find the fastest route to their destination and by doing so, helping relieve road congestion.

- **Air pollution alerts** inform people when air quality reaches a worrisome level, allowing them to take steps to stay safe.
- **Restaurant inspection apps** help citizens choose dining establishments that take food safety seriously and stay away from those that don't. By extension they provide an incentive for restaurants that have been lax with safety to do a better job.

Now let's look at a few city-specific apps. As you'll see, cities of all sizes are participating in the open data movement with apps that help residents and visitors alike in countless ways.

**Toronto Cycling.** This app has a dual purpose of enabling cyclists to track their rides with GPS and help the city of Toronto improve current cycling infrastructure and plan for future cycling investment.

**Simon.** Developed by Belfast, Northern Ireland housing charity Simon, this app provides quick and easy access, at a local level, to services if someone is homeless or is at risk of becoming homeless and also gives community members a way to help individuals in need.

**Scenic Puget Sound.** With this app, commuters won't rush to a ferry terminal only to learn their boat left 15 minutes earlier. Users can view ferry schedules, cameras and vessel

positions and save favourite routes for quick access.

**App for Cornwall.** Boosting tourism in Cornwall, England is the intent of this smartphone app that provides information on attractions, activities, places to eat, pubs, clubs, shopping, accommodation and much more.

**DengueLah.** Singapore reported 22,318 dengue fever cases in 2013, making it the worst epidemic of the mosquito-borne viral disease since 2005, according to news reports. This app pinpoints dengue outbreaks in greater Singapore, based on data from the National Environment Agency.

**Calgary Pets.** People who want to adopt a pet or find one that they've lost can use this app to connect to the Animal Services Centre in Calgary, Alberta.

## Smart cities Apps Gallery

Browse through the Council's Apps Gallery for many more examples of smartphone apps developed by and for cities.



A day in your new urban life:

## HOW SMART CITIES LEAD TO HAPPIER CITIZENS

It's Monday morning, a rare day off for Josie. But when the alarm on her smart wrist-phone chirps, she doesn't reach for the snooze button. "Too much to do today," she reminds herself. Peeking around her bedroom's solar curtain, she's pleased to see the sun shining brightly.

"Perfect," she decides. "I can bike over to the mall, drop off the bike and pick up a car when I'm done."

Josie doesn't actually own a bike or a car; living in a city with abundant share programs means she doesn't have to. And since the café she runs is only 10 blocks from her condo, she typically walks to work — or if the weather is really lousy, hops on a bus. She's proud that her city has a smart transportation system that uses advanced technologies to streamline traffic flow — and that it works.

Wandering into the kitchen, Josie pours herself a cup of coffee that started brewing when her alarm went off. Between her smart wrist-phone and her smart

thermostat, pretty much every creature comfort in her condo is automated. She told the system her preferences, of course, but from then on it took care of the details. If it notices her overriding the original settings, it quickly adapts to her new wishes. Her shower is programmed to run at the same temperature every day and her refrigerator sends an alert to her phone when she's running low on items she typically has on hand. She just brings up the list when she's at the grocery store.

She knows she'll miss her condo when she and Miguel move into the loft they found. But the condo is on the small side for two people. Though the loft is small too, it has transformable spaces thanks to "robot walls" that can be moved to create different spaces for different needs. Josie is especially happy with the new TeleWall. The high-definition big screen will let Miguel telecommute much of the time and she plans to use it for the online courses she's taking.

### Sensors and digitisation will change lives:

*Day-to-day living will become much more convenient in tomorrow's smart cities, thanks to the digitisation of just about everything.*

After a quick trip to the roof to check on the garden she shares with the building's other tenants, she grabs her backpack and looks at a phone app to see the closest available bike-share. Turns out, there is one just around the corner. But if Josie had been running late or faced with rainy weather, she had only to enter her destination into her city transit app to get a route plan optimised for her preferences.

Jumping on her bike, she picks her destination from her favourites list and transfers her phone display to an overlay in her glasses. She instantly sees an alert from the city's traffic system warning of a downtown parade that threatens to jam her usual route. She picks an alternate route calculated by the system and follows the directions as they appear in her glasses.

The purpose of her trip to the mall is to find something to wear to a party. But as she walks past the virtual city hall that occupies a small storefront near the mall entrance, she realises she can take care of another item on her to-do list.

"This is pretty sweet," she says as she sits down in a private "closet" equipped with high-definition video equipment that allows her to interact with a remote city agent. She tells him she needs a permit for a street fair her cafe is going to participate in, but doesn't know what it's called. The agent quickly finds the form she needs, transmits it to the touchscreen in front of her and Josie is able to fill it out and send it back within minutes. Before she leaves the agent mentions a new waste management system the city is testing at restaurants. It's "pay as you throw" — meaning the less they throw away and the more they recycle, the lower their monthly bill. Josie likes the sound of that and signs up on the spot. She asks for daily updates. Since her trash and recycling bins are monitored by smart sensors, the city knows moment by moment how much trash Josie's cafe has accumulated. It can warn her when it

looks like she'll exceed the goal she set for herself, while there is still time to improve.

She spends another hour trying on dresses suggested by the store's shopping service, which taps into a history of past purchases that Josie has rated and posted for just this purpose. Then glancing at her wrist, she realises she has to get moving. She has promised to take her grandmother to a medical appointment and doesn't want to be late. As she walks towards the mall exit on floors that harvest energy from her footsteps, she passes a car-share wall display that has embedded smart tags. She waves her wrist-phone at the wall to find the nearest electric car — and sees there's one fully-charged just two blocks away.

During the medical appointment, Josie is relieved to see the specialist her grandmother is seeing for the first time pull up electronic records that provide a complete view of her medical history. She's heard stories about elderly patients suffering harmful drug interactions because one doctor doesn't know what the other is prescribing.

When she finally gets home that evening, it is dinner time and Josie's hoping a robot will appear with a gourmet meal — but then she sees Miguel waiting for her with a pizza box and figures that's close enough.

## Who sets the agenda?

So where do bright ideas that make cities smarter and citizens' lives better come from? Should elected officials develop a vision that they sell to residents? Or do citizens announce their needs and set priorities? Smart cities realise the answer is a combination of both.

The traditional top-down approach to city planning and decision-making tends to result either in improvements that are more iterative than innovative, or sweeping initiatives that get stuck. Plans that are developed using very limited input may miss out on unique viewpoints that can give the effort so much more strength. Further, since the entire project risk is on one person or a small group, these projects tend to avoid risk altogether, and therefore avoid making any dramatic improvement. Or, if the project is truly revolutionary, it may never get off the ground. There's always resistance to change, and even if the vision is good, some may try to stop it for political reasons if they can't claim at least part of the success as their own.

A top-down vision may also result in a city that few people want to live in. Do you really know what your residents want? Have you asked? An operations management lecturer at the University of Leeds decided to ask Boston residents what they wanted from a smart city,



and the answer was a bit surprising. They said they wanted a smarter version of what they already have. Thinking of the place their grandchildren may eventually call home, the workshop participants all wanted something that's more sustainable and liveable, but they also wanted it to be recognisable. They were concerned that only the rich and powerful have a say in shaping the city, and desperately wanted the smart city to enhance — not replace — the city that they know.

A bottom-up approach is typically much more innovative and inclusive. As Council member Oracle describes it, this approach turns citizens from end-users to begin-users.



### **A bottom-up approach can be more inclusive:**

*Centre for Civil Society is an independent public policy think tank based in New Delhi working on research, advocacy and outreach on critical public policy issues that affect India.*



### **Mixing top-down and bottom-up:**



*Communities need some governance, they just don't need heavy-handed governance.*

It brings together a wide variety of people with different backgrounds working toward a common interest. You will have groups of people trying different ideas. Some ideas will work; others won't. People adapt and will likely join together to work problems out. Eventually, the better ideas will float to the top, resulting in an imaginative vision that's not usually possible with centralised decision-making.

While this sounds ideal, it isn't a perfect model, either. With a large number of people acting spontaneously, this approach can be full of complexity. Their solutions may also miss the mark if the participants aren't representative of the community as a whole. They may work for themselves instead of for everyone.

That last point demands more attention, as it's one of the biggest sources of risk and missed opportunities in smart city projects. People in low-income neighbourhoods are typically left out of bottom-up planning. As Rick Robinson, IT Director for Big Data and smart cities at Amey, points out, these people are not without

a smart cities vision of their own. They just can't accomplish it on their own.

When people are left out of the discussion and the solution, they are deprived of the infrastructure and resources they need to succeed. It's not a case of charity. As cities become increasingly urban, the success of lower-income neighbourhoods is the success of the city as a whole.

A smart city incorporates all communities and devotes attention to providing the necessary infrastructure in those neighbourhoods that are falling behind. With populations swelling, providing equitable access and raising living standards of those typically left behind is the only way cities can become truly livable and sustainable.

An approach that mixes top-down with bottom-up brings together the best of both worlds and avoids common pitfalls. Communities need some governance; they just don't need heavy-handed 'my way or the highway' governance.

Under a light governance model, city leaders set guardrails for the citizens to work within. Rigid rules are replaced with conditional models. Instead of restrictive rules that tell people what they can't do, leaders enable the community to come up with innovative solutions within certain boundaries while ensuring that everyone has a voice.



## Building consensus:

# HOW CITIZENS TOGETHER REBUILD CONSTITUCIÓN AFTER EARTHQUAKE

**A**fter a devastating earthquake and tsunami levelled much of Constitución, Chile in 2010, residents came together and developed a new community master plan in just 90 days. And they did it largely without the Internet and without using tax revenue. The Brickstarter blog profiled the warp-speed project, which is remarkable. Constitución finished its sweeping plan and built consensus in just three months. Here's how it happened:

Shortly after the disaster, leaders opened a community centre in town and invited residents to stop by to not only see the progress being made, but also to help shape the work being done. Regular meetings were designed to put everyone in the city — from city officials and building experts to the citizens themselves — on the same level. The role of experts was completely redesigned.

Experts worked as facilitators. They helped shape concepts from brainstorming sessions into workable ideas; they did not dictate what would be done.

Internet access was spotty, so while social media was used to solicit some ideas, it wasn't the primary vehicle. Weekly town meetings were. To make sure everyone knew about the meetings, organisers drove around town with a loudhailer inviting people to attend. The meetings were packed and lively. Residents congregated around whiteboards to sketch out ideas. The experts served as valuable resources to answer questions and help refine ideas. Passionate debate was not only allowed, but encouraged. Those heated discussions helped identify and shape priorities. And participation remained strong throughout the process. Often a rebuilding process like this has strong initial interest but rapidly loses steam.



## Building consensus:

*After a devastating earthquake and tsunami, residents of Constitución finished a sweeping master plan for rebuilding their city and built support for it in just three months.*

The project was paid for by a forestry company — one of the biggest businesses in Constitución. Normally, that would be viewed as a huge liability. Instead, the company was just another participant in the discussions. It funded the work with no strings attached. Any unease about its potential influence quickly vanished due to the way it conducted itself. It ensured that it had no more of a voice than anyone else.

Within four years after the 50-foot (19-metre) tsunami washed away Constitución homes and businesses, nearly 500 new homes were built. So too were businesses and parks. There is a newly reconstructed foreshore, which gives the

public more prime area to enjoy the water and also provides more protection, should another tsunami ever hit.

Open space and recreation areas are a key feature of all the new housing developments. More riverfront areas were also turned into public walkways and parks. The city is also putting the finishing touches on its new cultural centre.

For its new downtown, which is truly something to envy, the city credits its hybrid planning approach. The disaster provided an incredible opportunity for the community to improve its livability and sustainability, and allowing the

public to drive the process resulted in a true transformation that most likely wouldn't have been possible if it had been driven by politics.

But the public also couldn't do it alone. The city started the process by preparing a very rough vision that it encouraged participants to attack. This jumpstarted the lively debates about the city's future.

Co-design is what the city called its approach; the city provided guidance and resources to help citizens achieve their vision. It also helped that people came together to discuss issues in public; in circumstances like this one, there's much to be said for talking face-to-face.

## Empowering citizens

Empowering citizens means that they not only have a voice, but they're also regarded as a key stakeholder helping shape a project. For citizens to be empowered, they also have to be engaged, and that may require a different mindset within city hall.

The business-as-usual approaches that cities have used for well over a 100 years to involve

citizens aren't typically effective today, if they ever really were. Unless there's a hot-button issue, citizen participation in public meetings tends to be weak. And cities get little out of them, too. Public meetings tend to be held near the end of the process, so forums on any controversial issue tend to be venting sessions where citizens yell at staff and elected leaders.

When you ask, the public is typically quite clear about why it doesn't participate in government more. Cary, North Carolina

surveys its residents every other year about various topics and the so-called barriers to citizen involvement rarely change. Nearly half of residents say they simply don't have time to participate. It's not that they feel it's a waste of time — the survey shows most people believe they can make a difference in their communities — they just don't have the time to participate, don't know about the opportunities, or the meetings are at inconvenient times.

Cary is hardly unique, and if you try to put yourself in your citizens' shoes, the problem becomes obvious. Most city meetings tend to be scheduled during the middle of the day or in the evening on a weeknight. How many people can afford to take off work to go to a committee meeting? Or if you spend all day working at a job, rush home to make dinner for the family and help the kids with their homework, would you have the energy to go to a council meeting at night?

Viewed from the perspective of citizens, it's pretty easy to see why the traditional public participation model doesn't work. And smart cities need to understand that if it doesn't work for their citizens, it won't work for them either.

The authors of "The Responsive City: Engaging Communities Through Data-Smart Governance" suggest many city staffers aren't particularly fond of public meetings either. For one, they can be painful. Either they are boring affairs attended by the same small group of people who complain about the same things, or they're very intense meetings where they are the focus of an angry mob. Says co-author Stephen Goldsmith, when you tell your staff to communicate more, they tend to think about doing more of the same thing they're already doing. But why would anyone want to conduct more of those dreaded meetings when there are so many more effective ways today to connect with citizens?



### Use multiple communications tools:

*Technology has changed the way people communicate in their personal lives and it only makes sense that cities trying to engage citizens should reflect these changing preferences.*



**Changing the engagement mindset** Today, building an engaged community requires communicating with citizens on their own terms.

- **Provide ample opportunities** for citizens to get involved in a time and manner that works for them.
- **Give updates early and often** so that people can be involved in the earliest stages, allowing them to help shape projects.
- **Use multiple communications tools** so citizens have a choice in how they want to interact with their city, for example, social media, text messages, online forums.

- **Continue the conversation** when the project is complete; share results and benefits so they can see their involvement was worthwhile.

Doing these things may require getting your city staff to think of citizen communication in a new way. The key is not just more communication; it's more effective communication which occurs when you put citizens' needs and preferences first. You'll see examples in the sections ahead.



knew it had to get citizens involved if it had any hope of achieving its Greenest City in the World 2020 initiative. But stuffy meetings didn't seem the right way to build engagement, especially when the subject was the outdoors.

So the Vancouver Planning Commission and neighbouring municipalities worked to bring engagement into the communities. The city of Burnaby held an environmental festival, full of music, food and family-oriented activities. Others organised 'walk shops', a moving conversation that allows community members and planners to get to know a neighbourhood better together. And the North Vancouver mayor organised a bike tour to help residents learn about new bikeways, cycling improvements and talk about future initiatives.

### Reducing traffic congestion and accidents:

*Parking can be made more efficient through instrumentation and mobile apps. 'Vertical Automatic Parking Lot' Chicago 1932. Original photo: British Pathe, Image: NY Daily News*

## Ideas that connect communities

The best communication method is one that meets the unique needs of a community. In the next section we'll talk about digital communications. But even in this day and age, cities are finding other effective ways to connect with citizens, and citizens to connect with each other. Below are examples both low-tech and high-tech.

**Events and 'walk shops' bring people together in Vancouver, BC** Vancouver, BC

**'Doors open' days in Halifax, Nova Scotia.** Halifax hosts 'Doors Open' days where citizens are invited to explore historic buildings and more contemporary venues for free. Halifax native Hugh MacKay, who brought the idea to his city after seeing Doors Open events in other Canadian and European cities, told the Chronicle Herald that he was encouraged by a comment he heard during the 2013 event: "It was the remark of a recent immigrant to Canada who commented that nothing in his experience had ever demonstrated to him the openness of Canadian government so much as walking into city hall and being greeted by the mayor and welcomed to Doors Open."



Applying the science of well-being to local governance:

## SANTA MONICA'S WELL-BEING INDEX HELPS SHAPE CITY PRIORITIES

**W**ith a million-dollar grant from Bloomberg Philanthropies' Mayors Challenge, the city of Santa Monica, California set out to scientifically identify and assess the well-being of its residents. Working with experts in the science of wellbeing, Santa Monica created the Wellbeing Index which brings together data from 100 distinct and wide-ranging data points to provide a comprehensive picture of how well city residents are doing so that the city can make more informed decisions.

The data was analysed to provide key findings across five areas — environment/place, health, economic opportunity, learning and community connectedness. Further breakdown identified wellbeing indicators based upon demographics such as geography, gender, age and ethnicity.

The findings are available on the city's Wellbeing Project website. A few key findings included:

- Strong civic engagement with large numbers of people voting (79%) and volunteering (38%)
- Yet 41% of residents feel that their civic influence is limited and 36% feel disengaged from the city
- Seniors showed the highest level of personal wellbeing and those ages 45-54 years old the lowest
- One in five younger adults (ages 18-24) reported loneliness all or most of the time; one in three reported concern about missing rent or mortgage payments

"In pioneering this innovation, we can more effectively improve the life experiences of our own residents, using an unprecedented level of data-driven knowledge about wellbeing to shape public policy," said Santa Monica Mayor Kevin McKeown.



Applying the science of well-being to local governance:

*Santa Monica's findings will provide a baseline the city can use to improve policies and focus resources to strengthen quality of life in the community.*



Another view from El Jones, the Halifax poet laureate: “You can live in this city and never be in city hall and never be to Province House and particularly sometimes people feel that these spaces are these kind of official spaces that they aren’t welcome in. I think it’s very important for people to claim those spaces in their own cities and go into these places and say I have a right to be here and I’m going to look at what’s on the walls and I’m going to be part of this city as well because it’s mine.”

**Participatory budgeting in Porto Alegre, Brazil.** Porto Alegre is credited with pioneering the concept of participatory budgeting back in the 1980s to empower people to participate in setting priorities for how public money should be spent to solve city challenges, from mobility to sanitation to education.

Prior to 1989, Porto Alegre faced significant financial challenges from de-industrialisation, in-migration, indebtedness and a poor revenue base. But thanks in part to participatory budgeting, the World Bank cites some spectacular achievements in the years that followed. Among them: Between 1989 and 1996, the percentage of the population served by the municipal sewage system rose from 46% to 85% and the number of children enrolled in public schools doubled.

**Bringing young people into the thick of civic affairs in Salisbury, Maryland.** Young people compete for seats on the Youth Civics Council — a student-inspired initiative that has each youth council member identify a community issue, develop a plan to address it and then present it to the city council. And the teens take it quite seriously, according to local media. Here’s an example: “Bennett High junior Ahmed Osman is focused on tourism, unemployment and recruiting businesses to locate in downtown Salisbury, and Davis has ideas designed to open up the Plaza to two-way traffic and encourage more businesses to open in that area in particular. Davis is also exploring the concept of city-county consolidation to reduce government costs.”

**Helping citizens help each other.** If given the choice between stuffy and fun, nobody would choose stuffy. Photo contests and other creative competitions not only boost

engagement, they can also result in truly innovative ideas. When given the opportunity to be artistic and creative, many will jump at it. The Burnaby Homeless Task Force, which serves part of Vancouver, BC, got a group of quilters together to produce a piece that illustrated the wide diversity of the homeless population that relies on its service. The quilt was displayed at the library to help tell the story of its important mission in a new way. The project attracted the attention of Quilts Etc., a national bedding retailer, which has since supported a number of projects to draw attention to the homeless population and collect supplies for them.

Here’s another example: Small communities often create tight bonds between neighbours, creating a tight-knit community where they may share resources, such as tools or food. But a first-of-its-kind neighbourhood near Austin, Texas, goes well beyond that. People who live there can also share electricity. Community First! Village is described as the world’s first neighbourhood powered by crowd-sourced energy. It’s the work of an organisation that’s been working for years to reduce homelessness. By allowing people to donate energy, it removes one more large worry for cash-strapped residents.

Council Lead Partner Itron is helping sponsor the project and built the infrastructure for the donation system.



Offer an integrated citizen portal for services:

## BOROUGH'S CITIZEN PORTAL CUTS COSTS, IMPROVES SERVICES

**A**s a leader in public sector IT, the London Borough of Newham wanted to improve its service delivery and digital engagement with citizens, while reducing costs. By sharing services with the neighboring local authority of Havering, Newham is pioneering a transformation in both councils using a trio of technologies from Council member Microsoft – Dynamics CRM, SharePoint Server and BizTalk Server.

Its online portal service, which is available to every resident, will encourage more people to conduct transactions online rather than at council offices. With reusable technology, the platform will contribute to Newham and Havering's target of more than

£11 million cashable savings between them, without cutting front-line services.

The council is starting with its most used citizen services in initiating greater digital engagement with residents. These include service requests for waste bins and recycling, parking enforcement and revenues and benefits.

Potential exists for other authorities – including the London Borough of Waltham Forest – to join them, further improving efficiency and providing high-quality customer service.

 Offer an integrated citizen portal for services:

*The Newham portal meets the challenge of delivering high-quality services with fewer resources, given the U.K.'s tight fiscal policies for local and regional government..*



### Mixing top-down and bottom-up:

*Communities need some governance; they just don't need heavy-handed governance.*

## Engaging communities digitally

While face-to-face conversation is often preferable, it isn't always possible. Thankfully, technology is helping make it easier than ever to engage those who don't have the time or ability to participate in traditional meetings or public events.

Yet because social media is so ubiquitous and easy to use, there is a temptation to use it as an only source for engaging the public. That can be short-sighted since social media only captures one segment of the population. In the US, for example, Facebook is by far the most popular social media platform. But even there, only 70% of adults who go online have Facebook accounts, according to the Pew Research Centre. About a quarter of online adults use Twitter, LinkedIn or Pinterest.

Another Pew study found that social networks overall attract people who make less than \$30,000 annually or more than \$75,000; the middle-class is under-represented.

That's not to suggest that cities shouldn't use social media in their engagement efforts — it can be quite valuable. But it's important to remember that the audience you'll reach is a subset of your community and therefore there are some limitations to the insights you glean. Digital engagement efforts primarily work in two ways. Digital tools can help you measure what people in your community are thinking and they can help you create an online forum where people can share and debate ideas. We'll cover both in more depth.

**Listening in on the social buzz.** Whether or not your city is listening, people are talking about it, from the challenges they face on their morning commutes to encounters with city staff. These conversations are happening on social media. In fact, on Twitter alone, more than a half a billion tweets are sent each day. Enter social sentiment analysis.

Council member IBM has combined natural language capabilities with its data analysis platform to transform online conversations into real-time, instant polls. For example, IBM's Social Sentiment Index helped Bangalore and Mumbai find their sources of headaches.

## Sparking online discussions

Online discussion forums aren't new, but they are experiencing something of a resurgence in the public sector. Cities are creating their own discussion forums as a way for citizens to post ideas and weigh in on city proposals and to encourage others to join the civic conversation.

The city of Reykjavík, which is home to about two-thirds of Iceland's residents, has had great success with online forums, which it uses to discuss everything from the budget to neighbourhood issues. About 40% of residents use the online forum, and the city council has committed to discussing the top topics each month.

But you may not need an elaborate online discussion forum. Cities may find they get more public feedback simply by making it easier for citizens to contact them. The Sheriff's Office in Stearns County, Minn., saw a 500% increase in crime tips when it added a simple email contact form to its website. As its site drew more traffic, the number of people downloading crime prevention information more than doubled as well.

For online discussions to thrive, cities must commit to a two-way dialogue. If people ask questions or present ideas, someone from the city should respond. If citizens decide nobody is listening, they'll quickly lose interest.



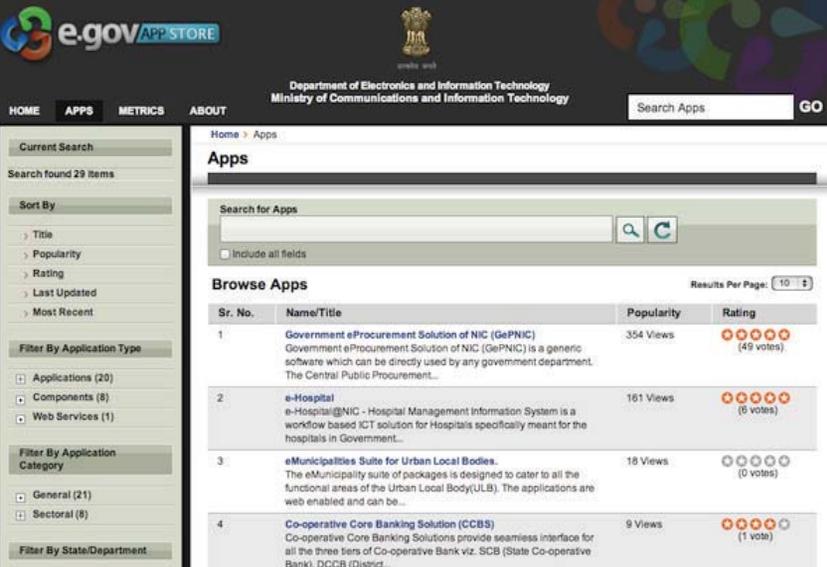
Scottsdale, Arizona launched Speak Up Scottsdale in 2012 to give citizens a way to present ideas and provide feedback. The website is a moderated discussion forum that also has the ability to launch polls and surveys.

The city has started open-ended discussions on everything from its vision statements to changes that would make its website more useful to the community. Residents can also start their own discussions, which have been wide ranging. When a resident starts a discussion, other citizens can vote on whether or not it's a high priority issue for them too.

One discussion thread led to safety improvements for pedestrians at a newly-expanded shopping center. The city quickly took notice after several other residents gave the initial post a thumbs up.

Most ideas can't be implemented immediately, but city staff typically acknowledge the suggestion the same day it is posted and post follow up messages in the discussion forum as they investigate the idea and come up with solutions.

One idea was for the city to encourage Internet service providers to bring gigabit Internet to the area; the city provides updates every few months on the progress it has been making.



## Offer a citizen-centric portal for services

We've talked about how important it is for citizens to be involved in the pursuit and realisation of a smart city. That's why it's crucial that cities create an integrated, comprehensive online portal for people to access their smart city services.

Today websites and mobile applications can recognise individual citizens and deliver personally tailored information to them. Such digital interactions with citizens allow smart cities to enhance their efficiency and effectiveness at the same time they heighten citizen satisfaction. Until recently, it was far too expensive to personalise service for each resident. Today, however, the technology exists



### Encourage innovation:

*Indian Government Debuts e-Gov Appstore Pilot Store which will act as a common repository for developed apps, components and web services used by various government agencies and departments at State and Centre level.*

to personalise virtually every interaction. In the Web 1.0 world, digital governmental services typically meant a series of websites. Those sites were typically designed from the point of view of the government. To navigate their way around to find what they needed, often time-consuming and frustrating.

Now we have the ability to create personalised customer portals and personalised outbound messages. More and more citizens are coming to expect personalisation, since they receive it in so many other parts of their lives. And when these portals are designed with mobility in mind, it helps people capitalise on the timeliness of their personalised data. Personalised e-government services increase citizen satisfaction and compliance while reducing mistakes and misunderstandings that can occur when they are forced to dig up information on their own.

## Next-generation eGovernment

Thanks to advanced technology, cities don't have to look far today for help providing a wide array of digital government — or eGovernment — services.

Council member Imex Systems, for example, helps cities turn a number of departmental systems into a single enterprise system for end-to-end service delivery. By doing so, public officials get a better understanding of citizens' interaction with the city. The eGov services that companies like Imex provide range from citizen portals to mobile payment systems to billing systems and cloud services.

Another example comes from Council member SunGard Public Sector, which offers a range of eGov services for not only cities, but also solutions specific to their public safety departments and courts. Additionally, SunGard's Click2Gov solution empowers citizens through interactive mapping capabilities, calendaring and self-service bill-pay options. And increasingly important in many cities today, Click2Gov supports multilingual communities, detecting and translating the user interface so language barriers don't interfere with access to city services.

## The role of city leadership

If citizens are empowered to set the agenda and craft solutions, what is there left for city leaders to do? A lot. To move cities forward, city leaders and staff need to partner with stakeholders — citizens, the business community, academia, non-profits, other public agencies, etc. With a smart cities project, that may mean inspiring stakeholders by educating them on the possibilities and encouraging them to get involved. It also means guiding the project's implementation to ensure that it is done correctly, on time and at reasonable cost.

To fulfil this end of your partnership with your community, you need a comprehensive plan. This plan is by no means static; it should be continually evaluated and updated as you prepare for and travel on your smart cities journey. It also encompasses all work streams in every single responsibility and enabler discussed in this Readiness Guide. The plan organises city efforts and resources across departments, identifies and articulates city priorities and plans action steps to achieve the recommended targets.

A comprehensive smart city plan calls for:

1. **Measurable targets** for livability, workability and sustainability

2. **Timely reports** of progress toward those targets.

This plan should be articulated in ways that citizens and other stakeholders will understand because they see its connection to their lives.

Arguably this may be the most important piece of the entire Readiness Guide since by definition a comprehensive plan will consider all the other aspects of an ICT-enabled smart city. A comprehensive plan sets the stage by:

### **Maximising synergies and minimising costs.**

Considering the big picture can help a city find ways to share infrastructure and share cost doing away with unnecessary duplication of ICT investments.

**Identifying the best places to start.** Picking the 'low-hanging fruit' — which are projects that have a big return for a relatively small investment in money and time — often makes most sense. If a city starts with those "big bang" projects, it can build momentum and public support. And it can potentially generate revenue for use on future projects.

### **Enabling cities to build separate projects.**

With a plan in place, you can be confident everything will work together in the end because you're adhering to principles and standards that ensure interoperability and collaboration.



### **Partner with stakeholders:**

*With a smart cities project, that may mean inspiring stakeholders by educating them on the possibilities and encouraging them to get involved.*

## Supporting practices

No matter how integral technology targets are, a smart city vision will never be fully realised if those targets aren't planned, deployed and managed correctly. That's why we've identified - supporting practices for cities to consider as they plot a course towards the future. As you'll see in the pages ahead, these supporting practices are all dependent on people making smart decisions to get maximum value out of their technology investments.

We've already covered citizen engagement extensively, so in the pages ahead our focus will be the other two supporting practices.

- 1. Policy and leadership.** This includes the management policies and leadership capabilities that cities use to plan for and support ICT investments. For example, ICT will benefit cities, their residents and businesses most when a comprehensive smart city plan has been created.
- 2. Finance and procurement.** These practices help cities buy and pay for the technologies they need. Employing proven techniques can help a city get the right technology, at the right time, at the right price. One example is developing an integrated procurement plan for technology across all city departments.

In the chart below you'll see supporting practices that will help cities realize the technology targets discussed in previous chapters. Unless otherwise noted, these supporting practices apply to every city responsibility area covered in this Guide. In the Ideas to Action chapter that follows this one, we will explore how cities can enact these policies to best achieve the technology targets and become smart cities.

## SUPPORTING PRACTICES

<p><b>Policy &amp; Leadership</b></p>	<ul style="list-style-type: none"> <li>• Utilize a bottom-up approach to city planning and decision-making</li> <li>• Promote a comprehensive smart city plan</li> <li>• Encourage shared infrastructure</li> <li>• Cultivate a smart workforce</li> <li>• Encourage a culture of innovation</li> </ul>
<p><b>Finance &amp; Procurement</b></p>	<ul style="list-style-type: none"> <li>• Adhere to a disciplined and integrated technology procurement plan</li> <li>• Consider all funding mechanisms</li> </ul>
<p><b>Citizen Engagement</b></p>	<ul style="list-style-type: none"> <li>• Continuously pursue two-way communication with citizens on strategies for and benefits of ICT before and after deployment</li> <li>• Offer an integrated, personalized citizen portal for services</li> <li>• Disseminate timely information about public safety, public health, transportation and other services that impact the public</li> </ul>



Encourage innovation in your city:

## MOBILE SHOPPING IN KOREA BRINGING CONVENIENCE TO CONSUMERS

A major retailer in South Korea set a challenging goal: to become the number one grocery retailer without adding new physical stores. Instead, they created “virtual” stores, starting with the city’s subway stations.

Displays at virtual stores are the same as physical stores. Wall-length billboards are installed in stations, designed to look like shelves and displaying images and prices of common products. Each sign includes a QR code; consumers shop by scanning products. Their order is then delivered within the day.

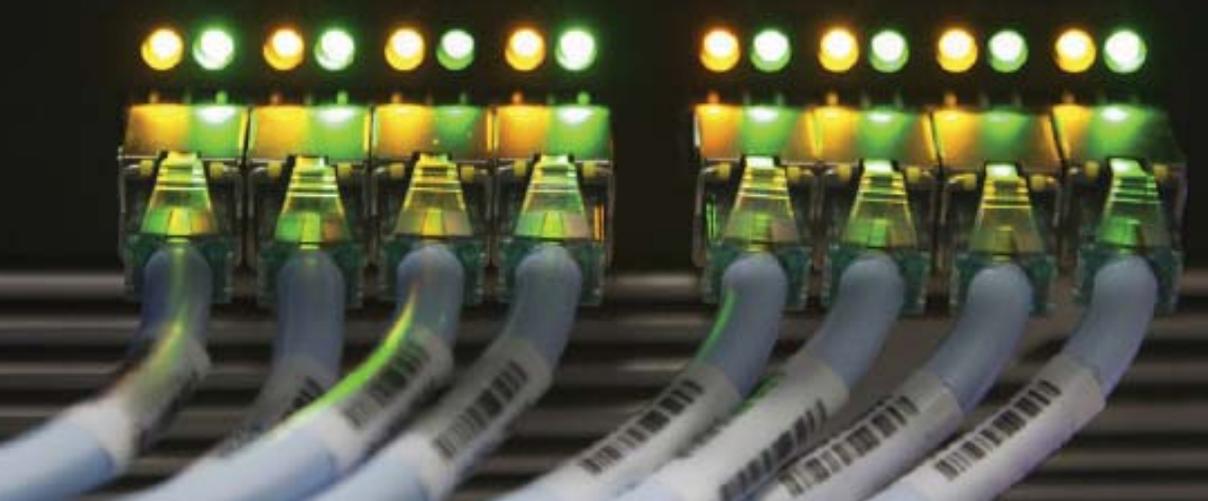
Workers in Korea typically work long hours and the strategy makes productive use of commuters’ waiting

time, while simultaneously saving shoppers’ time spent going to the supermarket. It’s the kind of innovation that can help cities attract and retain a talented, digitally savvy workforce and also show businesses that they support new ideas that benefit their citizens.

The retailer in this case not only helped consumers use their idle commute time by bringing the store to them. It has also become the number one player in the online market and second in physical stores.

 Encourage innovation in your city:

*The shoppers in this Korean subway station are not looking at physical products. Instead, they are viewing a wall of life-like pictures. They scan the products they want, which are delivered to their homes.*



With such a framework a city can move towards its targets one step at a time, knowing that individual projects will be compatible with each other, even if they are built separately at different times.

**Increasing public support.** Since a comprehensive plan promotes the future benefits and paints a picture of the future improvements in livability, workability and sustainability, it can have public understanding and support. It can also help rally support and financing from the private sector.

**Attracting talent and business.** A smart city wants to woo today's mobile professionals and easy-to-relocate high-tech businesses, but both are increasingly choosy when deciding where to establish themselves. They are attracted to cities that have a strong, compelling vision for

a better future and a path to get there, which is what your comprehensive plan lays out.

**Emphasising the need for change and change management.** Smart cities are visionary projects. As with all such projects, organisations undertaking them will be most successful if they are good at articulating and fostering change. Comprehensive smart city plans promote "change management" strategies that ensure minimum negative impacts and maximum positive outcomes in their pursuit of a smart city.

**Share infrastructure.** It doesn't take someone from the city budget office to see the value in reducing needless duplication and redundant spending. And that's what can happen when cities recognise interdependencies between departments and the value of cross-coordination. Actively seeking ways to share ICT infrastructure between city departments

— and having backup plans in place should problems occur — simply makes sense.

Beyond reducing redundant spending and effort, benefits of sharing infrastructure between departments can:

- Uncover wasteful duplication
- Surface potential synergies and new solution opportunities
- Reduce arguments and friction
- Unearth and enforce best practices citywide.

Another big benefit of sharing infrastructure is that a city can improve overall results by bringing multiple minds and multiple viewpoints to the table. Additionally, future expansion and applications are fast-tracked when infrastructure is shared because computing and information assets are no longer stranded in separate 'silos'.

In some cases, it may also make sense for a smart city to explore the benefits of sharing its infrastructure with the private sector. For example, this is important when it comes to broadband and cellular connectivity. Often it is private sector operators who are best suited to deploy and maintain these networks with a high degree of reliability, security and coverage.



Emphasising need for change and change management:

## PARLAN ACHIEVES COMMUNITY-BASED CAREGIVING

In order to deliver high-quality services in a transparent, well-coordinated, and cost-effective way, the Netherlands chose to decentralise its youth care system and transfer the responsibility to municipalities — while reducing youth care budgets. The new Youth Act passed in 2014 which mandated that municipalities would be responsible for delivering all youth care programmes beginning 2015, posed a huge challenge for healthcare and social services.

To ensure a consistent level of service in all cities and towns, the government divided the country's 408 municipalities into 41 service regions. Social service organisations work together within each region to support the nation's 394,000 youths. At the same time, budgets allocated for delivering these services are being reduced by as much as 20%, which challenges caregivers to deliver more care at a lower cost.

Parlan met that challenge by working with Council member Microsoft's Healthcare and City Next Partner, Winvision to develop WinCare, a mobile, cloud-based tool for managing client data that facilitates greater client engagement and cost savings. WinCare built on Office 365 and Microsoft Dynamics CRM Online to transform service delivery, improve caregiver job satisfaction and increase family engagement.

All caregivers in the childhood's network can now access the same information. The solution saves time and simplifies employee management by automatically tracking travel expenses and work hours. Caregivers are now able to do their jobs more efficiently and better engage with clients in their own homes, with fewer trips back and forth to the office for data entry — ultimately, benefiting caregivers, clients, families and the community as a whole.

 Emphasising need for change and change management:

*All caregivers in the childhood's network can now access the same information. The solution saves time and simplifies employee management by automatically tracking travel expenses and work hours.*

## Working smarter

A key factor that can affect your ability to deliver on your smart city promises is your workforce. There are two components to this:

1) Ensuring your staff has the skills that smart infrastructure deployments demand, and 2) Making sure they see the big picture and can abandon silos to work together effectively.

Working smarter won't happen overnight. It involves serious long-term planning and careful consideration of the resources you need today, over the next year, and several years from now. ICT projects have a lifecycle and it's critical to have the right resources with the right knowledge at the right time. Because highly-trained workers are in high demand, it's important that you plan now so that you will have the resources when you need them.

### Cultivating a smart workforce

For skilled ICT workers, you'll be competing not only with other cities and government agencies, but the private sector as well. To ensure you have the skilled workforce a smart city requires, developing policies and programs that cultivate that workforce will help. Building the skills necessary to install, maintain and

optimise smart city technologies should be a priority.

Many options exist for promoting a smart city workforce, and cities should find those that best fit their own needs and circumstances. For instance, you may choose to:

- Organise or partner with professional groups to identify skills needed
- Promote relevant licensing exams and continuing education curriculums
- Use a 'sustainable' designation for professionals
- Publish guidelines or create incentives to include smart technology topics in public and private education and workforce training.

### Encourage innovation in your city

In addition to an active campaign to train and groom a skilled ICT workforce inside city hall, cities that embrace and encourage a culture of innovation citywide will attract businesses and talent drawn to that kind of environment.

Chief Innovation Officers and Chief Data Officers are becoming increasingly common in larger cities and can play a critical role in

championing a city's "open for innovation" mantra. Whether it's hosting hackathons as New York City has been doing since 2009 or establishing an entrepreneur-in-residence program as San Francisco has, these are point people who can help foster a spirit of creativity and collaboration throughout city departments and also into the community-at-large.

On the next page, for example, read how a major South Korean retailer worked with transit authorities to launch an innovative virtual grocery store in a busy subway station.



## Use a common language:

*A common language framework helps reduce the potential for conflict.*

setting benchmarks, and communicating more clearly with all involved, including any vendors who will help execute the vision.

## Tell a story

Most of us can remember plenty of stories we were told as children. You may have retold them to your own children. By contrast, how many college lectures do you remember? Stories have remarkable power to capture our attention and imagination.

Your smart cities vision may resonate more with the public and city staff if you present your concept with the elements of a story. Set the stage for your vision. What can be improved and why does it need to be improved? The plot is the approach you will use to address and solve the challenge. The climax is where you paint a picture of the future of the city where everything is running smoothly. And every story needs characters; don't forget yours. They are the people who live and work in the city.

But as you're busy telling your story, just don't forget to listen to others who are telling theirs.

## What language are you speaking?

Communication is the overriding theme in this chapter. We've talked about various ways city leaders can engage the community in conversation and the information you should communicate. But the words you choose are also very important. If people misunderstand the plan or the progress the city is making toward it, your words can leave the community uninspired, gravely disappointed or both.

A new tool created by developer APQC with support from Council member Microsoft promotes common language to help eliminate

miscommunication. The City Government Process Classification Framework was based on discussions APQC has had with more than 750 organisations over the past 30 years. The Excel worksheet defines processes and language uses throughout government services, including legislative, executive and judicial, as well as related city service providers, such as public safety, health, zoning and licensing.

APQC says the common framework helps take things that were difficult to understand or articulate and make them more transparent. Having an objective standard helps reduce the potential for conflict. Microsoft adds that it gives cities a head start in their improvement efforts, by clarifying where opportunities are,

## Finance and procurement supporting practices

Implementing smart city technologies in an era when so many cities are budget-strapped is going to be a financial challenge. But it doesn't have to be an insurmountable one. Cities will need to get creative, though. In this section we'll discuss how to develop a solid procurement plan and how cities should look beyond traditional funding mechanisms for their technology needs.

**Adhere to a disciplined and integrated technology procurement plan.** There are two key words here: disciplined and integrated. First, a city's procurement plan for smart city technologies should include a disciplined business case that identifies and quantifies costs and benefits over the project lifetime. Secondly, all city departments need to be integrated in the procurement plan to ensure economies of scale, best practices, elimination of redundant purchases and interoperability.

It's also important to think of your procurement plan as a living document, one that includes (and regularly updates) a technology roadmap that identifies the optimal sequence of investments and implementations. Of course, cities should start with whatever project they want and be flexible about taking on new projects and changing plans as needed.

The important thing is that smart city projects are deployed so that they work together.

Your procurement plan should favour interchangeable hardware and software from diverse vendors, to stimulate innovation and competition and to allow for interoperable systems. The plan should also establish selection criteria that go beyond just the 'lowest price'. It prioritises for solutions:

- Least prone to obsolescence
- Most easily expanded to meet future needs
- Most resilient
- Most cost-effective
- Easiest to install and use
- Most relevant to addressing the objective

Adhering to a disciplined procurement plan can dramatically decrease overall costs. It can also greatly extend the life and value of the technologies purchased because the plan will include provisions to ensure interoperability and open standards.

**Consider all funding mechanisms.** Too often cities consider only a single 'traditional' method to finance the technology it needs. In some regions, that method may be funding from the central government. In other parts of the world, it may be municipal bonds. But in an era when so many municipal budgets are already strained, you'll need to explore the widest possible range of funding mechanisms. And the

results may surprise you.

There are dozens of different ways to finance infrastructure. Among them:

- Public/private partnerships
- Performance contracting
- Philanthropic grants
- Development bank loans
- Pay-as-you-go
- Sale/leaseback
- Revolving funds
- Guarantee schemes
- Utility incentives
- On-bill repayment through local utilities
- Local incentives and credit programs
- Reduced permitting time
- Density bonuses
- Pay-for-performance

To increase bargaining power, cities should also consider joint procurements and buying coalitions with other cities, states, regions, federal agencies and the military. By considering all financing options, a city may be able to afford smart city improvements years earlier than more traditional means might allow. The sooner installed, the sooner the city will realise the payback. For more on financing options, download the Council's smart cities Financing Guide. It provides detailed, expert analysis of 28 municipal finance tools for city leaders investing in the future.



# 5 Built Environment

**The built environment is an essential piece of the smart city puzzle. Buildings are the biggest single source of carbon emissions, accounting for about 40% of the world's carbon footprint, according to the World Business Council for Sustainable Development. Buildings are energy hogs too, eating up nearly half of all energy consumed in the United States. Any city serious about livability, workability and sustainability must raise the "intelligence quotient" of its built environment.**



## Urban Built Environment

'Built environment' that is designed and constructed by human – all places created or modified to live, work, educate and recreate, present both challenges as well as opportunities. It refers to buildings, of course, but also to parks and recreation areas, public spaces as well as communities. However, three aspects of the built environment – transportation infrastructure, energy infrastructure and water infrastructure – are not emphasized here because they are addressed in separate chapters later.

Today, urban built environments is a complex, dynamic mix of man-made surrounding and their relationship to human activities, which are achieved through every stage – themaster planning, design, construction, and management. Current built environments demands adequate energy-efficient buildings, safe drinking water, clean air, safe sanitation, less impact on environment due to urban infrastructure and require a structured framework approach for assimilating different components in a systematic approach.

**T**his chapter will give city leaders and planners the tools to make the built environment part of the solution. It begins by defining the terms and explaining how buildings interact with information and communications technologies (ICT). It turns next to the way smart buildings create benefits for a city. Finally, it lists the technology targets that allow a city to achieve those benefits. As we go along, we'll pause for brief case studies from around the world.



Improving occupant comfort, safety, and health:

## SHELTREX PLANS SMART, AFFORDABLE HOUSING FOR ORAGADAM

With most of the top automobile companies having set up operations, the fastest growing suburb in Chennai, Oragadam, is facing major challenges to provide sufficient infrastructure to accommodate growth. Sheltrex Developers entered into a technology partnership with Council member IBM to establish smart development in the heart of Oragadam, not only to provide solutions to the growing affordable housing scarcity, but also to create well planned urban infrastructure Technology integrated housing, spread over 26.6 acres.

Sheltrex's Oragadam project will build smart and cost effective homes targeted at people working in this industrial hub and is expected to be completed by 2021. The project is strategically located at the State Highway 57 just off Grand Southern Trunk Road in close vicinity to the automotive corridor of Southern India.

Sheltrex leveraged IBM's "Smart City Framework", integrating cutting-edge technological features within the township, to enrich lives of residents and facilitate better long-term township management. IBM has helped design the digital roadmap for the township with amenities like radio-frequency identification, Wi-Fi-enabled living spaces, online education networks, technology museum and smart infrastructure.

On the basis of discussions with leading consultants, IBM formulated the technology design to integrate multiple city agencies that will deliver a unified city operation, helping all departments to better collaborate and share information to improve the experience for its citizens. IBM will be advising across areas like township governance, public safety, utilities, transportation and community. The project is an extremely exciting development in the real estate industry.

 Improving occupant comfort, safety, and health:

*IBM formulated the technology design to integrate multiple city agencies that will deliver a unified city operation, helping all departments to better collaborate and share information to improve the experience for its citizens.*

One of the major causes of environmental degradation in India could be attributed to rapid growth of population and industrialization, which has adversely affected the natural and built environment, primarily through the excess use of natural resources, generation of waste, air-water pollution and increased pressure on land. Environmental pollution not only deteriorates the environmental conditions but also adversely affects the health of people. India is one of the most environmentally degraded countries in the world and it is paying heavy health and economic price for it.

With swelling urban population and poor implementation of rules and regulations, the cities are growing in unplanned way, leading to uncontrolled sprawl of slums. As professor Jagan Shah, National Institute of Urban Affairs, says 'this has resulted in the sprawling of urban centres with haphazard growth patterns and a corrosive effect on the surrounding region.'

Several of the smaller cities – Tier-II and Tier-III cities, once untapped assets – are showing sincere promise to be the next set of major metropolitan cities. But what will take it to develop these cities optimally? However, many of these cities do not have master

plans – but this may actually be a boon as they can now prepare their plans on the basis of improved standards, advanced knowledge about integrated city operations enhanced by technologies, and greater public participation.

Buildings are a prominent part of every city, from private homes to offices, institutions, factories, shops, schools, hotels, restaurants and theatres.

Fortunately, there are multiple ways cities can overcome the problems by deploying greener approach, innovative solutions and ICT technologies, as you'll read about in the following pages.

As the sustainable, green movement is increasingly adopted by the designers and building owner, now there are more than 3,124 green building projects, with a footprint of over 2.75 billion sq. ft. registered with the Indian Green Building Council (IGBC), of which 617 green building projects are already certified and functional. Going further, the local government, civic authorities and utilities providers are the key inceptors for formulation smart cities. However, individual, private building owners and businesses can significantly contribute by making and operating private and public buildings smarter.

'Smart Buildings' or 'Intelligent Buildings' – the common shorthands for structures empowered by ICT – are fundamental building block of a smart city. Smart buildings use sensors, meters, systems and software to monitor and control a wide range of building functions – lighting, energy, water, HVAC, communications, video monitoring, intrusion detection, elevator monitoring and fire safety among them.

Automation technologies to play a key role in the efficient operations of buildings. The industry estimates the Indian building automation and control systems market to grow three fold in revenue terms by 2019. Smart monitoring, cross-device compatibility, voice commands, wireless connectivity, lighting enabled by motion sensors are a few features of smart homes.

This chapter will give city leaders and planners the tools to make the built environment part of the solution. It begins by defining the terms and explaining how buildings interact with information and communications technologies (ICT). It turns next to the way smart buildings create benefits for a city. Finally, it lists the technology targets that allow a city to achieve those benefits.

## Why make built environment smarter?

Clearly it is at the community level that many of the most important aspects of environmental preservation and health are being addressed.

Why make buildings smarter? In its June 2013 Global Sustainability Perspective, real estate developer Jones Lang LaSalle put it this way: “Advances in smart building technology are enabling a new era in building energy efficiency and carbon footprint reduction, yielding a return on investment for building owners within one to two years. We can now perform real-time remote monitoring and control of entire portfolios of buildings, leading to dramatic improvements in building performance and meaningful energy savings.”

## The city-building connection

In most cities, the built environment is a patchwork of private and city-owned buildings. But even though a city government may own only a small fraction of the buildings, it can hold great sway over all buildings in its jurisdiction. For instance, it can:

**Lead by example** and ensure that its own buildings adhere to the targets explained in this chapter, unleashing the power of ICT in public buildings.

**Create and enforce codes** and standards that embody the changes it wants

**Create incentives** for owners to make their buildings smart

**Educate residents** through public awareness and outreach campaigns

**Provide support** and guidance by giving access to advice and trained staff via web, phone or in person



The methods cities adopt for driving change in built environments will vary, of course, but leaders pursuing a smart cities agenda will want smart buildings as an action item.

So what are the technologies and best practices targets that enable a smarter built environment? This chapter will discuss how targets introduced in the Universal chapter apply to the built environment. But first, a quick look at interdependencies between the built environment and other services, and then the benefits an intelligent built environment provides.



## Benefits of realising the targets

Here are just a few of the ways an intelligent built environment can enhance livability, workability and sustainability.

### Livability

**Improving occupant comfort.** With full situational awareness and optimisation of building conditions, a smart building can tailor light, heat and cooling to each area or even to each individual. As people are spending more time indoors, improving that environment improves their comfort quotient and health.

**Enhancing occupant safety.** ICT can greatly improve safety and security via access cards, video monitoring, fire and smoke alarms and similar means. Full situational awareness means that building operators have a complete picture of their building and its environs, and are able to respond to issues or threats in real time as well as optimise day-to-day building management. In some cases, these systems can even auto-correct problems remotely.

**Improving occupant health.** Indoor air can be more polluted than the air outdoors. Smart buildings monitor air conditions to ensure that occupants aren't exposed to high levels of carbon dioxide, radon, or other chemicals.

## Interconnectedness assessment

As cities envision planning improvements in the built environment it is paramount to take into consideration the interconnectedness among the various city services and systems. There are some straightforward interdependencies such as energy, water, telecommunications, and public safety.

Commercial, industrial and residential building systems alike all require electricity and/ or natural gas. Many will be adding electric

vehicle charging stations in the years ahead, which is something cities need to take into consideration. Building occupants require potable water and wastewater removal. And reliable communications are a requirement today for business and industry as well as residents. Improved public safety enriches the quality of life and enhances the built environment.

Conversely, smart buildings decrease CO2 emission and smart community planning enhances walkability, bikability and healthy food access, ultimately improving health, wellness and quality of life.



Reducing water and energy waste:

## ENVISION CHARLOTTE: CONNECTING PEOPLE WITH INFORMATION AND INSIGHTS

**B**uilding smarter, more sustainable cities requires the support of public, private and civic stakeholders. Envision Charlotte is charting a new course. By taking a holistic and integrated approach to engaging these disparate groups and demonstrating the benefits — both environmental and economic — of lasting change, the initiative has assembled a strong consortium of public and private interests with shared vision and momentum.

The ambitious project will transform the downtown — called Centre City — into an incubator for innovative technological solutions. The initiative's aims are not small: energy and water efficiency, waste reduction, green building and site planning, as well as engaged businesses and citizens.

Smart Cities Council member Itron is lending its

expertise to the Smart Water Now program, which will aggregate information into a single number representing total usage, then drive awareness and behavioural change to reduce consumption. The results will lower operational costs, improve sustainability, engage occupants and contribute to the overall value proposition of working and living in Centre City.

Awareness and knowledge are key ingredients of sustainability and change. But what's the best way to get information to people who need it? Measurement technology, like Itron's smart meters and communications, provide unprecedented insights with near real-time data. By rendering the data in intuitive ways — trending, benchmarking against other buildings in the area, or correlating with other data sets like weather—program participants are better able to assess how they can build, operate and live smarter.



**Reducing water and energy waste:**

*Kiosks in buildings throughout Centre City help participants see a more direct link between their daily business and personal activities, and the impacts to energy and water usage.*

**Providing convenience and “remote control” capabilities.** Who hasn't left for vacation only to wonder if you remembered to activate the burglar alarm? Thanks to advances in ICT, remote control capabilities can remotely monitor and manage security and energy systems from afar using a computer, tablet or smartphone.

## Workability

**Lowering business utility bills.** Smart buildings save on power, water, gas and waste, giving owners and occupants a competitive advantage.

**Increasing worker satisfaction.** Who doesn't want to work in a state-of-the-art building where the air is fresh, creature comforts are automated and safety and security are wired in? Businesses located in smart buildings are more attractive to potential employees, which allow them to compete for the best and brightest.

## Sustainability

The built environment can make a major contribution to lowering emissions and lowering resource use. It is not an exaggeration to say

that it is impossible to meet sustainability goals without using smart technology to improve the built environment. Examples include:

**Reducing energy waste.** Most buildings can save 10% to 30% on energy just by installing an intelligent building management system to manage devices such as occupancy sensors, light dimmers and smart thermostats.

There are many other ways a smart building can reduce overall costs too. For instance, buildings with smart meters or smart thermostats can participate in utility demand response programs. By briefly reducing consumption during peak times they allow the utility to make do with fewer expensive standby power plants. (See the Energy chapter for details.)

**Reducing water waste.** In the same way that ICT helps smart buildings save energy, it helps them save water too. Operational optimisation helps smart buildings manage water resources with precise efficiency, eliminating waste and reducing cost for owners and occupants. Sometimes it's just a matter of better scheduling. For instance, scheduling pumping and irrigation at night when power is cheaper.

**Reducing carbon emissions.** Smart buildings use less energy and less water – important because water requires large amounts of energy to pump and treat. As a result, carbon

and other greenhouse gas emissions are lower in smart cities.

### **Reducing the frequency and cost of repairs.**

Today's building management systems can monitor key equipment to notice problems as soon as they arrive -- or, in some cases, predict problems before they occur. They can prioritise work orders so the maintenance crew always works on the most important problem first. And since they can keep equipment fine-tuned, it operates at maximum efficiency.

**Enabling distributed generation.** Not only can ICT reduce energy waste, it can help buildings produce their own energy via on-site solar panels, wind turbines, fuel cells and the like. Distributed generation won't replace power plants outright. But together with energy storage and demand response, it can reduce the number of peaker power plants. (Peaker plants run only when there is high demand for power and sit idle the rest of the time and since most peaker plants run on fossil fuels, avoiding their use provides carbon reduction benefits.)

**Providing ROI for building owners.** Smart buildings are a win for building owners. Operational optimisation delivers both cost savings and enhanced value per square foot



Providing ROI for building owners:

## PANTANAL FOOTBALL STADIUM IN BRAZIL ACHIEVES HIGH SUSTAINABILITY

 Providing ROI for building owners:

*The robust and resilient network is designed to ensure the full functioning of the stadium at all times, connecting all equipment and controls. At the conclusion of the project, the Arena Pantanal was considered to be one of the best FIFA stadiums in the world, specifically with regard to sustainability.*

**T**he Arena Pantanal in Brazil, a multipurpose stadium envisioned by the Mato Grosso Special Secretariat (SECOPA) with world-class standards, was designed to be a modern, “smart stadium”.

SECOPA required the stadium to have a network infrastructure that was capable of supporting all IP telephony systems, security CCTV, Internet access, digital signage, and access control (RFID readers, cards and turnstiles) and sound systems.

The objective of the Arena Pantanal project was to transform the stadium into an arena, which would provide flexibility for multifunctional use, adapt to local weather conditions and be sustainable. The international importance of the FIFA World Cup 2014 that were to take place in the Arena Pantanal required high availability of all services, even minimal downtime during any match would not be acceptable.

Council member Allied Telesis commenced a partnership with Panasonic in 2013 on the IT network solution design and engineering — planning of firewall specifications, server settings, and dimensions of the network set up for the entire arena — and have collaborated throughout the project to ensure the successful integration of all parts of the system.

The completed project comprises two data centres, with each capable of supporting the entire network’s local traffic.

The robust and resilient Allied Telesis network is designed to ensure the full functioning of the stadium at all times, connecting all equipment and controls. At the conclusion of the project, the Arena Pantanal was considered to be one of the best FIFA stadiums in the world, specifically with regard to sustainability.



### Improving occupant comfort:

*The idea behind the crowdsourcing effort is to get people thinking about how a house could fit the way they actually live, rather than simply building homes the way its always been done.*

## Inclusivity

Smart cities value the citizens and look at them as both engine and catalyst for sustainable urban transformation. The cities that take into account the views of various stakeholders including the policy makers, planners, and users create a holistic, sustainable solution.

**Achieve accessibility optimisation**, both physical and Web accessibility. Smart city promotes physical accessibility for everyone, from their homes, to businesses to public spaces to outdoors. Developing stringent codes and creating supporting

Smart mobility is user-friendly both in terms of infrastructure and web accessibility, allowing a 5-year old and 80 year old to ride safely and conveniently. Informative and barrier-free environment helps all, senior citizens, families with kids, women, and children, apart from those with disabilities. Low-deck vehicle construction and aligned transit platforms not only allows easy street level boarding for passengers of all ages and abilities but also easy ensure optimal passenger flow. Taxibus, Brussel-based STIB transport service providing on-demand door-to-door service, now offer online service via a dedicated website, and within few days, number of online bookings reached almost 30%.

## Built environment targets

To this point we've defined the built environment, discussed how cities can influence their buildings and highlighted the benefits of smart buildings. We'll conclude by examining the technologies and best practices that can bring those benefits to your city.

We have already seen the targets that apply throughout a city in the Universal chapter. When it comes to the built environment, those

universal goals are sufficient – there are no additional building-specific targets.

For convenience, you will see a checklist at the end of the chapter that lists the universal targets. Below we point out refinements to several of them that demonstrate their relevance to the built environment.

Achieve full situational awareness:

## BRINGING TOGETHER MULTIPLE AND DISCREET SYSTEMS

One of the key challenges in today's smart solutions business is to utilise existing building management systems which are sufficiently functional and short of being flexible. Ranked under Top 75 of the Fortune 500 list, this multidimensional company needed an integrated, unified fire and security management system, meeting specific critical infrastructure requirements.

The key issue was to integrate multiple existing and discreet systems that had unique communication protocols. These systems included standalone energy management systems, fire protection and security management systems. The company chose to deploy PROXIMEX from Council member Tyco. Proximex Surveillint offers an open, flexible platform to service any security environment, and delivers commercial off-the-shelf (COTS) integration.

Designed using Council member Microsoft's solution Microsoft .NET and service-oriented architecture, the scalable platform can support thousands of sensors, and can flexibly support any type of security system.

Proximex constantly updates its library of integration modules with different systems and sensors varying from core security technologies, such as physical access control, video, and intrusion detection systems. These modules also extend to advanced security systems (e.g. video analytics); communication systems (e.g. two-way radio, mass notification, digital signage); and IT systems (e.g. network alarms, logical identity).

This customer of Tyco is provided with a full integration and visibility of all security, safety, HVAC and other building disciplines with a single and centralised view.



Achieve full situational awareness:

*Proximex constantly updates its library of integration modules with different systems and sensors varying from core security technologies. The client is provided with a full integration and visibility of all security, safety, HVAC and other building disciplines with a single and centralised view.*



## Collaborativity

In almost all cases, the cities tend to develop incrementally. Radically alter the complex and interconnected city infrastructure very rapidly, is very difficult if not impossible. In most cities a great deal of the built environment is in private hands, which needs collaborative effort to envision the rapidly changing landscape.

### **Formulate citizen reporting framework for outcome thinking.**

Almost all smart cities have creatively developed proposals with involvement and inspiration from its citizens. Citizen participation helps in creating most needed data for transportation planning and route optimization. Adopting outward thinking approach, easy access to data, status reports, and proactive, conscious communication enables more citizen-centric transportation solutions.

**Achieve citizen engagement.** Energy bill reduction Smart cities around the world successfully demonstrate that there is a strong relationship between energy use and user knowledge and behaviour, and fully engage the citizens with environmental challenges. Creating frameworks for developing deeper engagement of citizens in design of their public space.

**Create an institutional framework.** City built environment needs to be carry out in a collective and coordinated manner, using institutional framework, integrating all organizations – including domestic and international, and public and private sector.

Reconstruction and new built environment needs to ensure that it can withstand future disaster events with no or minimum impact. Built environment education is one of the important arenas that require the capacity building at present. It is essential to improve the capacities of the built environment in order to make it is less vulnerable to the impacts of disasters. In particular, capacity enhancement within different sectors in the society such as governments, non-state and private institutions and communities, in relation to the built environment enables to identify constraints and to plan and manage construction activities of

the built environment effectively, efficiently and sustainably.

## Governance

### **Achieve existing infrastructure optimisation.**

Rather than building new built environment, smart cities focus on optimizing the existing infrastructure. Encouraging brownfield development in a systematic manner, the smarter cities reduce new development, minimizing urban sprawls and population associated with new development. Supporting government policies and frameworks further reinforcing the brownfield redevelopment helps in creating compact urban development, while preventing new growth.

Going beyond cradle-to-grave concept towards the cradle-to-cradle concept, the designers needs to take a more holistic, responsible view to consider human needs and health when planning the places in which we will live and work. It is time to embrace the notion that everything can be recycled. A new vision of design is to accept responsibility for the consequences of construction, to create safe objects of long-term value, and to eliminate the concept of waste—even to consider the value of waste in producing new materials.



Achieve operational optimisation:

## CLEVELAND IMPROVES ENERGY EFFICIENCY, WHILE PROTECTING TREASURES

 Achieve operational optimisation:

*The film can reduce the temperature in direct sunlight by as much as nine degrees, making spaces more usable and comfortable. The Hall expects to begin seeing immediate energy savings to the tune of \$20,000–40,000 a year. In addition, by shielding its exhibits from harmful UV rays,*



Cleveland’s Rock & Roll Hall of Fame and Museum, since it opened in 1995, is home to a number of iconic artifacts, including John Lennon’s 1979 upright piano and Elvis Presley’s custom motorcycle, and has been a destination for millions of fans. The Hall and Museum are housed in an iconic geometric building designed by renowned architect I.M. Pei. The main tower soars more than 160 feet into the air and supports a dual-triangular-shaped glass “tent” that contains more than 55,000 square feet of exhibition space, along with administrative offices, shopping space and a cafe.

All of that glass allows the Hall to present priceless artifacts in natural light. However, protecting those treasures from the effects of ultraviolet (UV) rays and keeping the building cool on sunny days also presents a challenge to building managers.

The building managers for the Rock & Roll Hall of Fame and Museum used 3M Sun Control Window Films (Prestige Exterior Series) from Council member 3M. The film use Nano-technology without metal, resulting in overall reflectivity that’s actually lower than glass. These films selectively refract light from the spectrum and reject up to 97% of the sun’s heat-producing infrared light and 99.9% of UV rays to help keep tenants cool. They can reduce the temperature in direct sunlight by as much as nine degrees, making spaces more usable and comfortable.

The Hall expects to begin seeing immediate energy savings to the tune of \$20,000–40,000 a year. In addition, by shielding its exhibits from harmful UV rays, the film helps ensure that generation after generation will be able to see everything from Michael Jackson’s suits to Chuck Berry’s guitar in pristine condition.



### **Implement optimal instrumentation:**

*Building managers can use data captured from smart devices to make better decisions about resource usage.*

## Instrumentation and control

Buildings that use smart devices to monitor conditions like water use and heating and cooling can capture data that building managers can use to make better decisions about managing resources.

### **Implement optimal instrumentation.**

You'll want to keep several things in mind as you determine optimal instrumentation for buildings.

For one thing, don't think that building instrumentation simply means a smart meter. You can now remotely monitor almost any building condition – occupancy, light level, air quality, temperature, etc.

For another, you will want to distinguish between existing and new buildings. In existing buildings, you want to take full advantage of any sensors or switches that are already present. Fortunately, companies are starting to make software that can talk to legacy equipment from many different manufacturers. It is usually much less expensive to find a software "overseer" than to rip out old instrumentation and replace it with new.

When it comes to new buildings, you can be more ambitious. It is much less costly to put state-of-the-art instrumentation into a new

building than to retrofit it into an existing building. Thus, as you plan the city's building codes and incentives, you can raise the bar for new buildings as compared to old.

This is an area that will require holistic thinking and collaboration between departments and between outside stakeholders. For instance, the electric power utility may want smart meters, thermostats and appliances to adhere to communications protocols. Likewise, the fire department may have requirements for fire alarms and smoke detectors. Obviously, the city's codes and recommendations should be compatible.



Implement optimal instrumentation:

## UNINTERRUPTED RELIABLE CONNECTIVITY IN LAS VEGAS

Las Vegas, somewhere between the mountain's highest peaks and the desert's warmest winds, has some of the world's greatest events and business gatherings. Amongst the largest and most successful venues, the Sands Expo and Convention Centre, a 2.2 million square feet of flexible exhibition and meeting space, needed uninterrupted reliable connectivity to 100,000 clients simultaneously.

The Sands needed a reliable Wi-Fi network they could depend on, 24/7. Since downtime was not an option, they needed a strong and efficient system to complement their legacy wireless network. The main challenge was that the new system would have to support 2.2 million square feet of flexible exhibition and meeting space, including the main Sands Expo floor, adjacent meeting rooms, and common areas at The Palazzo and The Venetian hotels.

The Sands contracted SignalShare, Council member Allied Telesis's US partner, to set up a hybrid network alongside the Sands' existing WLAN. SignalShare installed Extricom Series' patented Channel Blanket™ technology from Allied Telesis, which was quick to deliver a working network — even for a flexible, open configuration that changed daily — with instant availability, low total access point count, and seamless wireless communication.

With Allied Telesis supporting the current infrastructure, the Sands show floor and adjacent spaces were sufficiently covered with uninterrupted, high-quality Internet connectivity. The Extricom Series, working in parallel to the existing network, was an immediate success, resulting in 100,000 clients enjoying quality Internet access simultaneously.

 Implement optimal instrumentation:

*The Extricom Series, working in parallel to the existing network, was an immediate success, resulting in 100,000 clients enjoying quality Internet access simultaneously.*

## Connectivity

Once you've deployed smart sensors and systems in a building, the next step is to allow them to communicate the information they gather.

**Connect devices with citywide, multi-service communications.** In a few cases, a building's sensors and systems may communicate directly with the citywide communications system. For instance, a smart meter or a smart thermostat may tie in directly so it can talk to the electric power utility. In a similar fashion, some utilities talk directly to building load control switches to turn equipment off if the grid is under stress. (The owners get compensation from the utility.)

In most cases, though, the building's sensors will communicate internally to a building management system. That software then monitors and summarises that internal data and shares it externally as permitted by building owners.

When it comes to new buildings – and sometimes even for old ones -- many forward thinking building owners are choosing a single, "merged" IP network – one that can carry all traffic, whether data, voice or video.

## Interoperability

Interoperability targets ensure that your built environment plays nicely with others. Of the three universal interoperability targets, two require additional discussion.

**Adhere to open standards.** Building technology must adhere to the same communications standards as all other smart city gear – even when the building industry is a barrier to this smart city goal. And it must also contend with standards unique to the built environment.

When it comes to communicating between the building and the rest of the city, you can rely on the standards set forth in the Telecommunications chapter, notably IPv6. But when it comes to the equipment and the communications within the building, you will have to navigate a maze of options.

The buildings sector has been slow to adopt open standards. In areas such as internal communications within a building, the sector has several competing "standards," including BAC net and Lon Works. In short, you will need a) the help of an expert to make the right choices and b) a firm determination to stay open no matter what inducements are offered to use a proprietary system instead.

We mentioned earlier how a group of cities is collaborating on Open Data applications. Cities could also benefit from participating in ICT standards organisations such as the World Wide Web Consortium (W3C), the Open Geospatial Consortium (OGC) and buildingSMART International. The cost is minimal and ROI can be substantial. Standards for Building Information Models (BIM), indoor location, indoor/outdoor information integration, etc. are being developed with virtually no city input. If cities don't express their interoperability requirements, there's no guarantee they will get what they need. Cities need to be smart about standards development so they know which standards to ask for in procurement documents.

**Prioritise the use of legacy investments.** It bears repeating – cities and building owners should make every effort to tap into existing devices and equipment before retrofitting buildings with new gear. Older devices can often be integrated with building management systems, thereby avoiding unnecessary replacement. Using existing equipment when possible is a wise way to get maximum value from your investments. For an example, see the 88 Acres case study linked at the end of this chapter; it explains how Microsoft leveraged legacy investments when it rolled out smart buildings on its campus in Redmond, Washington.



Connect devices with  
citywide, multi-service  
communications:

## PALAVA BUILDS SMARTER CITY FOUNDATION WITH IBM

**S**trategically located at the junction of Navi Mumbai and Dombivali, Palava is envisaged to become the largest ever private, completely planned development in urban India. Envisioned as a city of opportunity and spanning over 4,000 acres, Palava would not just offer an unparalleled quality of life to its citizens but also become an ecosystem—nurturing business, creating jobs and delivering growth.

Lodha Group partnered with Council member IBM to develop the vision and detailed roadmap for building and managing smart city infrastructure for Palava. Lodha Group incorporated IBM's smarter cities technology using advanced, data-driven systems to integrate information from all city operations into a single system — this unified view will improve efficiency and deliver an enhanced quality of life for residents. IBM implemented the following solution:

**Participative Governance.** Citizens can interact with the city administration and manage various services offered by the city, with mobile and social technology using the IBM service platform. This will enable city officials to better handle citizen concerns, rapidly gather feedback, and effectively manage city resources.

**Intelligent Operations.** A central command and control centre will monitor the health of major city systems and take coordinated action to handle any disruptions or emergency situations. This will also facilitate the use of Big Data Analytics, enabling the city to predict and prevent issues that could affect quality of life, ranging from traffic congestion to emergencies.

**Public Safety.** Centralised city operations will allow for real-time monitoring of incidents and enable public safety personnel to take quick, coordinated actions.

 **Connect devices  
with citywide,  
multi-service  
communications:**

*A central command and control centre will monitor the health of major city systems and take coordinated action to handle any disruptions or emergency situations.*

## Data management

Our universal data management target deserves emphasis for the built environment.

**Create and adhere to a citywide data management, transparency and sharing policy.** The information that can be gleaned from buildings is invaluable for city goals such as energy efficiency, carbon footprint reduction, economic development, transit planning and land use planning. It is crucial that your built environment initiatives adhere to careful data architecture so that information can flow seamlessly as needed.

## Computing resources

Local governments are typically responsible for many buildings – everything from jails to public swimming pools to sewage treatment facilities to bus barns and city hall itself.

**Consider a cloud computing framework.** A few years ago, only the biggest buildings could cost-justify a top-of-the-line building management system. And until recently, only a few large property owners could afford a system to over-see a whole portfolio of buildings in different neighbourhoods or even different cities.

Today, thanks to cloud computing, these advanced capabilities are affordable and widely available. Cloud computing gives access to:

- High-powered computers
- Sophisticated software
- Expert staff
- 24x7 staffing and monitoring
- Redundant backup
- Advanced security - cybe and physical

Instead of financing a huge data centre and staffing it with specialists, often a city can simply rent all the hardware and software power it needs via the cloud.

**Have access to a central GIS.** A robust geographic information system is invaluable for many city functions related to buildings, including maintenance, public works, parks, building codes, planning and many more.

## Analytics

Below we explain how the four universal analytics targets apply to the built environment.

**Achieve full situational awareness.** Situational awareness has two aspects in the built environment. The first is awareness

of individual buildings (or collections of buildings). Today's systems can monitor and display every important parameter. They can even be programmed to alert operators when conditions go out of bounds. Building managers can quickly spot problems and dispatch resources to restore functionality. In some cases, problem identification and resolution can be automated, or even predictive, so that problems are resolved before they cause damage.

**Achieve operational optimisation.** The ultimate goal of a smart building is to have everything running as smoothly and efficiently as possible. Smart buildings use analytics to ensure that a building's resource usage is efficient. And with the power of analytics, buildings can optimise their conditions to ensure the continued health, productivity and comfort of occupants.

**Achieve asset optimisation.** Sophisticated asset management software can calculate which buildings should be replaced or repaired and when.

**Pursue predictive analytics.** Unexpected equipment failures can take a toll on maintenance budgets; so can work stoppages caused by equipment failures. Predictive maintenance uses analytics to predict which building equipment is close to failure so it can be repaired or replaced before it fails.



Consider a cloud computing framework:

## MICROSOFT BRINGS SMART BUILDINGS TO SEATTLE

Seattle, Washington has a goal to better understand how to create economic opportunity for the city while saving energy and developing a sustainable urban environment.

Council member Microsoft has been working with Seattle's Office of Economic Development to develop an approach to driving energy efficiency at city scale. The result is a smart buildings pilot for the downtown area inspired by the smart buildings pilot implemented on Microsoft's Redmond campus. That pilot used Big Data to provide forecasted energy savings of 10% per year. It's anticipated those savings will be surpassed by the Seattle pilot with energy and maintenance savings between 10 and 25%. Working with Seattle and its utility Seattle City Light, Microsoft has joined with the Seattle 2030 District, a public-private collaborative of downtown Seattle property owners and managers

that has established a 50% energy use reduction goal by 2030. The pilot will increase energy efficiency in large commercial buildings across Seattle's downtown corridor; the initial set of buildings totals approximately 2 million square feet. It's a mix of unique building uses, from the Seattle Municipal Tower and the Sheraton Hotel to Boeing facilities and a University of Washington School of Medicine research building.

A cloud solution based on Microsoft Azure cloud technology will collect data from the myriad systems in those buildings and use data analytics to provide a prescriptive approach to how the building management systems can be tuned to improve energy efficiency.

 Consider a cloud computing framework:

*Thanks to the advent of cloud computing,, building management systems that monitor and control energy usage are more affordable and more widely available than they were just a few years ago.*

## ISO 37120: A yardstick for measuring city performance



In 2014, the International Organisation for Standards announced an ISO standard that applies strictly to city performance. The document -- known as ISO 37120:2014

--establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more. In the table at right, we have indicated how the standards related to Shelter and Urban Planning intersect with the Council's Built Environment targets identified on the next page.

Proper city planning and investment are essential to, at a minimum, keep slums and homeless populations from overwhelming city resources and turning the shining 'cities of the future' envisioned by many into dystopian urban landscapes.

### Shelter Indicator

Category	Indicator ID	Description	Target 1	Target 2	Target 3
Core	15.1	Total residential electrical energy use per capita (kWh/year)	●	●	
Supporting	15.2	Average number of electrical interruptions per customer per year	●	●	
	15.3	Average length of electrical interruptions (in hours)	●	●	

Create citywide data management policy

Have access to a central GIS

Pursue predictive analysis

### Urban Planning Indicator

Category	Indicator ID	Description	Target 1	Target 2	Target 3
Core	19.1	Green area (hectares) per 100,000 population	●	●	
Supporting	19.2	Annual number of trees planted per 100,000 population	●	●	
	19.3	Areal size of informal settlements as a percentage of city area	●	●	
	19.4	Jobs/housing ratio	●	●	●

# BUILT ENVIRONMENT TARGETS

In the checklist below, targets specifically pertaining to the built environment responsibility are in **bold**, universal targets are not

	Enabler	Built Environment Targets How smart cities deploy and use ICT to enhance their built environment	Implementation Progress			
			None	Partial	Over 50%	Complete
Human	<b>Inclusivity</b>	Achieve accessibility optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate citizen reporting framework for outcome thinking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	<b>Collaborativity</b>	Achieve citizen engagement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Create institutional framework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	<b>Governance</b>	Pursue multilateral collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Achieve existing infrastructure optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate new supporting policy frameworks and regulatory mandates	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# BUILT ENVIRONMENT TARGETS

Technology	Enabler	Built Environment Targets How smart cities deploy and use ICT to enhance their built environment	Implementation Progress			
			None	Partial	Over 50%	Complete
	<b>Instrumentation and Control</b>	Implement optimal instrumentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Connectivity</b>	Connect devices with citywide, multi-service communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Interoperability</b>	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritise use of legacy investments	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Security and Privacy</b>	Publish privacy rules Create a security framework Implement cyber security	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Data Management</b>	Create a citywide data management, transparency and sharing policy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Computing Resources</b>	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Analytics</b>	Achieve full situational awareness Achieve operational optimisation Achieve asset optimisation Pursue predictive analytics	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			

# 6

# Energy



**Cities can't function without energy. It fuels our cars, subways and trains. It lights, cools, and heats our homes and businesses. It pumps our water and processes the food we eat. And it powers the technologies that are the foundation of a smart city. To ensure a smart energy future, cities and utilities must work together – regardless of whether the utility is part of local government or a private investor-owned utility that supplies the city's energy.**



### Fossil-fuel dependency in energy generation:

*Coal is the main fuel source of energy production, and together with oil constitutes over 84% of fuel source. Even though India is a leading producer of coal, the country's fossil fuel import will rise tremendously by 2035.*

Coal is the main fuel source of energy production, and together with oil constitutes over 84% of fuel source. Even though India is a leading producer of coal, the country's fossil fuel import will rise tremendously by 2035.

Along with fossil fuel combustion, the use of dirty energy by a significant number of households in India — such as kerosene and firewood — has severe negative impacts on health and the environment. Already one of the world's largest carbon dioxide and other greenhouse gas emitter, India needs to pursue alternative energy sources, and the nation has started taking steps in that direction. While India has undertaken various programmes and initiatives to address energy poverty, these projects have faced logistical problems and inadequate implementation locally.

This chapter covers energy's critical role in smart cities, from enabling small-scale power plants that generate energy close to where it's used, to advanced technologies that help keep the lights on during power outages. We use the term "energy" broadly throughout to encompass all infrastructures that cities use to produce and deliver energy — electricity, gas, steam, renewables, etc. Whether or not your city directly provides electricity or natural gas as a city service (as in a municipal utility), you'll want to make energy the foundation of your smart city planning.

As we have seen, energy has become an integral part of modern existence, touching almost all parts of life and profoundly impacting liveability, workability and sustainability. However, 1.3 billion people — 1/5th of world population — lack access to electricity. Energy is essential for economic, social, and human development.

Around 290 million people without access to electricity live in India — 1/5th of the un-electrified population in the world — while another quarter billion are under-electrified, without quality power. The demand-supply gap has been increasingly widening over the past few decades.

Currently, the energy deficit is 5.10%, with per capita energy consumption of 1,000 kWh, almost three times less than the world's average per capita consumption.

India is facing a huge challenge to satisfy the exploding energy demand. With increasing population and escalating GDP growth, the energy demand is expected to grow 132% by 2030, making India the leading consumer of energy in the world even outpacing China, according to the BP Energy Outlook report.



Energy as a smart city starting place:

## PIONEERING MUNICIPAL UTILITY - A SMART GRID POSTER CHILD

**A**s the first American utility to receive smart grid stimulus funding and as the first to be “completely operational with smart grid technology,” Glendale Water and Power (GWP), located in Southern California, is a bit of a smart grid poster child.

In the GWP system, a single communication system is handling both power and water. Anchored by a suite of technology from smart cities Council member Itron, the system includes an Itron advanced wireless communication network that integrates both electric and water meters.

It also features leak detection technology for the water system and Itron’s meter data management solution to manage the huge volumes of data the system generates and enable other smart grid programs and applications.

GWP completed installation of the system, which included 83,000 Itron smart electric meters and 33,000 smart water meters, in 2011. Components of the overall smart grid system included in-home display units that provide electricity and water usage information, costs and control to consumers as well as thermal storage units, electric vehicle smart charging, demand response and distribution automation.

Speaking at a conference after the installation was complete, GWP General Manager Glenn Steiger talked about the project. “The key thing to remember is that a smart grid is really an IT communication system,” he explained. “The heart of the system and the ongoing applications are IT-driven. To be successful, you have to shift focus from hardware and infrastructure to IT.”



Energy as a SmartCity starting place:

*Anchored by a suite of technology from Itron, the GWP system uses a single communication system is handling both power and water.*

On the water side, the system is providing leak detection capability that is saving precious water in perennially water-challenged Southern California, and also saving money in water they didn't have to purchase. "We're actually optimising the water system with the data we're collecting through the electric system," Steiger said, referring to the energy costs associated with treating and delivering clean water to Glendale residents.

Smart grid technology ultimately comes down to saving money, Steiger said, for the municipal utility but also cost containment for its customers. GWP's system and the data it delivers have enabled it to streamline operations, improve business processes, and roll fewer trucks, he added. That means keeping costs low for customers, which leads to strong customer support.

## Why make energy smart?

**Exploding future energy demand.** In India, demand is far outpacing supply in meeting the rapidly growing energy needs. While growing demand is part of the problem, poor infrastructure equally contributes to electricity shortfalls, severely affecting the quality of life as well as impacting the industrial sector, hurting overall economic growth. Electricity shortages have resulted in loss of profits for many companies, and loss in productivity as plants and businesses have been forced to shut down for a few days a month. Outages have also caused a slowdown in manufacturing, and added operational costs, as some businesses have been forced to pay for power back-up units.

**Energy as a smart cities starting place.** Since city leaders are aware of their own city's

pain points, we said in the introduction to this Readiness Guide that we won't recommend which responsibility areas cities should tackle first. But given the critical role energy plays in just about everything that happens in a city, leaders uncertain where to start their smart city journey should consider making smart energy a priority.

**Significant depletion of natural resources.** Currently in India, there is a heavy reliance on fossil fuels for energy generation. Escalating energy demand will further the implementation of smart energy systems, which also helps preserve precious natural resources and gives residents, businesses and cities a whole host of ways to monitor and control their energy consumption to save money.

**Energy optimisation.** Information and communications technologies (ICT) help cities optimise these energy systems, making them

more efficient and resilient. That's because the success of a smart city relies on creating and supporting a smart energy system. That's a system that knows in real time where a transformer has blown and automatically reroutes power to keep the lights on in homes and businesses. It's a system that collects and manipulates data from sensors and smart devices to give operators a complete view of the energy infrastructure — for instance, how much power solar installations are generating or when they need to signal a demand response call to help balance the load on the electric and gas grids.

There are a number of components of a smart energy system. In the pages that follow we'll identify the technologies and technology-supporting practices involved and the array of benefits that accrue to cities when they implement them.

## Interconnectedness assessment

Energy is integral to all city responsibilities, and planning improvement in a city's energy infrastructure and services cannot be formulated without an understanding of the interdependencies between energy and other city systems and services, such as communications, transportation, the built environment and water.

A smart grid is by definition a specialised communications network that moves electricity and data to balance supply and demand and maintain reliable service. The distribution lines and underground cables that are part of the energy grid often follow the layout of city streets, creating dependencies between utility services and the various transportation systems that also rely on streets.

The built environment is also a major consumer of electricity and natural gas and potentially a producer of electricity too. As distributed generation evolves and building owners adopt solar, fuel cell and related technologies, utilities and city governments will form even closer alliances. The water-energy nexus indicates reliance on each other, while other utilities like health and education increasingly become heavily energy dependent due to higher levels of technology integration.



## Smart solutions by integrating innovative concepts and technology

Achieving energy-efficiency is a key requirement of smart cities formulation. The available energy resources have to be optimized taking into account higher energy efficiency requirements. Smart cities deploy energy innovations from different domains to realise the eco-design requirement.



### ICT's role in more sustainable cities:

*Amsterdam leveraged public-private partnerships to build a broadband platform for service delivery to achieve social, economic and environmental sustainability.*



grids allow integration of renewable and local energy production from multi-carrier grids in the system in the most economic and efficient way.

#### **Integrate renewable energy sources.**

'Cleaner' energy sources such as solar, wind and hydropower not only help in drastically reduce fossil-fuel consumption, but also increase the hosting capacity of the grid in a cost-effective way. The clean energy carriers like biomethane, hydrogen, fuel cells creates greener energy systems.

#### **Initiate efficient energy management.**

The concept of smart city is modelled on the smart asset management and capacity control, which uses digital technology through Advance Metering Infrastructure – smart metering, cloud computing and wireless connected sensors. The two-way monitoring from both – the utility providers as well as the end-user for observing consumption, peak hour loads, etc. using smart meters is proving very crucial today. The use of better, more sustainable materials in the grids will provide more cost-effectiveness and long-term performance.

Innovations in flexibility such as Demand Response and ancillary services, Demand Side Management (DSM) and Time of Use tariffs (ToU) leads to further improving energy efficiency.

#### **Integrate renewable energy sources:**

*'Cleaner' energy sources such as solar, wind and hydropower not only help in drastically reduce fossil-fuel consumption, but also increase the hosting capacity of the grid in a cost-effective way.*

**Create smart grids.** Smart grids create two-way connections between customers and utility for more efficient transmission of electricity and quick digital response. It integrates smart meters, controls, automation and new technologies allows efficient distribution of power, quicker power restoration, reduction in overall operation and management costs, as well as renewable energy systems.

These integrated systems give financial incentives for the consumer to shift the electrical demand during off-peak hours. Overall, smart grids offer opportunities to save energy while reducing dependency on fossil fuels and greenhouse gas emission. Smart



**Initiate efficient energy management:**

## **TATA POWER DELHI ACCELERATES SMART GRID DEPLOYMENT**

India struggles with electrical grids that are inefficient and unreliable. Aggregated technical and commercial losses that occur due to power system overload, electricity transmission and theft are estimated at about 26.4%, a national average among the highest in the world. Tata Power Delhi Distribution formed a joint venture with Council member IBM to better manage energy output and further reduce outages in the northern and north-western part of Delhi.

IBM helped Tata Power Delhi to conceptualise, design and deliver an Advanced Smart Grid solution that collects and analyses real-time information from smart meters and data from the management infrastructure. IBM supported Tata Power to create system architecture, ensure adherence to international smart grid standards, optimise business process and incorporate dynamic business analytics function to offer actionable insights. Additionally, the solution would also help empower its over 1.3 million electric consumers to manage their own energy usage.

As part of the smart grid initiative, IBM developed an end-to-end intelligent utility system to manage shortfall by peak shaving of actual load, using advanced metering infrastructure and demand response pilot program that automates and regulates supply of electricity in sync with fluctuating demand. Peak shaving technique enables consumers to redistribute loads to different period of the day, thus saving substantial amounts of money due to peaking charges.

This project helps to add a layer of digital intelligence to the grid and ensure reliability when the demand rises exponentially and the supply falls due to heavy consumption, managing demand and boosting operational efficiency. The customer service improvements including new digital meters, improved self-service options and access to a customer portal to manage energy use, give customers more visibility and control in managing energy, thereby enhancing customer satisfaction and enabling more efficient consumption of electricity.



**Initiate efficient energy management:**

*The customer service improvements including new digital meters, improved self-service options, and access to a customer portal, give customers more visibility and control in managing energy, thereby enhancing customer satisfaction and enabling more efficient consumption of electricity.*



## Benefits of realising energy targets

We've highlighted many of the smart energy results below, based on their relevance to livability, workability and sustainability.

### Livability

**Empowering customers with choice and control.** Instrumentation, connectivity and analytics combine to give electric and gas customers more information about when and where they are using energy, along with tools to help them control that usage.

**Improving reliability and resilience.** Smart grids can "self-heal" from simple problems, making them more resilient to storms and disasters. With outage management systems, trouble areas can be pinpointed, shaving restoration times. And most smart grids make it easy to combine "long-distance" generation with local distributed generation, making the system more resistant to supply interruptions.

**Lowering costs for citizens.** Operational optimisation means fewer resources are consumed and paid for. These savings can be passed along to citizens, resulting in lower energy bills.

**Empower e-Mobility.** Devising Electric Vehicles (EV) charging stations and management platforms will encourage adaptation of plug-in electric vehicle and hybrid electric vehicles. EV charging islands implemented by the smart cities facilitate grid-friendly rollout of the new technology creating potentially large impact on the grid, including wide-spread adoption and fast charging of EVs. Additionally, fleet of electric bus are also incorporated in public transit system.

For example, Norway is leader in the implementation of EV initiatives, as a result of huge effort from the Norwegian

government, by creating convenient supporting infrastructure. Norway's fleet of electric cars is one of the cleanest in world, as almost 100% of the electricity is generated in the country is comes from hydropower.

**Devise smart public systems and assets.** Public lighting is one of the key cost components in the city/community budget. Intelligent Streetlights provide increased energy savings and reduced maintenance costs, without compromising the comfort or safety of road users.



## Using less energy:

# INTELLIGENT LED STREET LIGHTS TRANSFORMS CITY OF SAN DIEGO

**A**fter the successful installation of LightGrid, an outdoor wireless lighting system that allowed the city to remotely assess and control streetlights, the City of San Diego chose to move to LED street lighting from Council member GE, making it the first city in the United States to adopt sensor technology to the existing LightGrid.

The City of San Diego and GE are transforming LED street lights into intelligent, connected devices through the GE's 'Intelligent Cities' solution. These lights do much more than illuminate; they connect, collect and analyse data to help the city run more efficiently. Equipped with sensors and microprocessors, the LED fixtures are able to connect to Predix (GE's cloud-based platform for the Industrial Internet) so the city can access valuable data and insights.

The city of San Diego collaborated with GE in 2014, and installed the LightGrid system that remotely assesses and controls 3,000 streetlights. San Diego is already saving more than \$250,000 annually in electricity and maintenance costs as a result of the LED solution and added dimming capability.

Installing the Intelligent Cities solution in 2015 took those savings and benefits a step further, opening the door to a world of connected possibilities such as parking optimisation, improved traffic flow, construction delays, weather and environmental updates, and enhanced emergency response.

The networked, intelligent LED street lights will have the ability to direct drivers to available spaces with the help of built-in sensors and wireless transceivers.



## Using less energy:

*San Diego is already saving more than \$250,000 annually in electricity and maintenance costs as a result of the LED solution and added dimming capability.*



### Creating new jobs:

*Renewable energy and local energy typically produce more local jobs than "traditional" energy.*

## Workability

**Improving competitive advantage.** A US Department of Energy lab estimates that economic losses from outages cost \$80-130 billion per year in the US alone. Businesses in cities with modern, ultra-reliable energy systems have a competitive advantage.

**Creating new jobs.** Renewable energy and local energy typically produce more local jobs than "traditional" energy (where energy may be shipped from large centralised plants outside the region).

**Generating business investment in cities.** A study of the correlation between smart grids — a key component of the smart city — and economic growth discovered that cities with a smart grid have an annual GDP growth rate that is 0.7% higher, office occupancy rates 2.5% higher, and an unemployment rate 1% lower when compared to less advanced cities.

## Sustainability

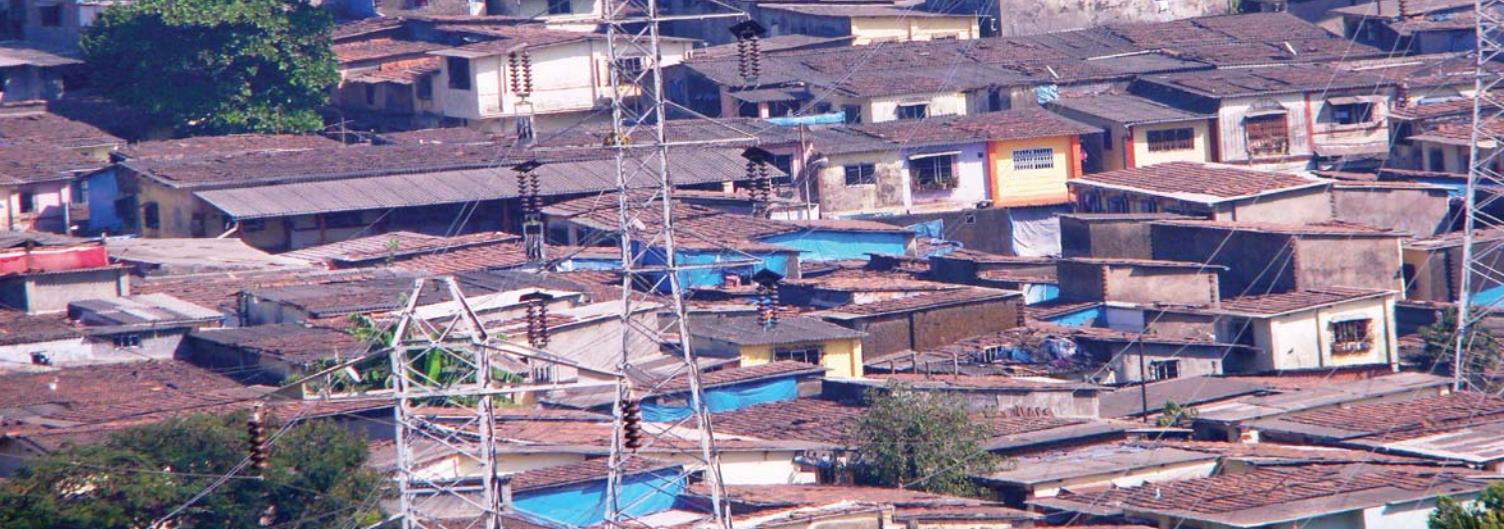
**Using less energy.** Smart energy means energy that is cleaner, more efficient and produces less impact on the environment. A smart grid makes it easier to use wind, solar and other renewable sources and wastes less energy during transmission and delivery. A smart energy strategy gives customers tools to reduce their energy usage and costs.

So a key benefit of a smart energy system — e.g., smart grid plus distributed generation plus ways to engage the consumer — is in reduced carbon production from avoided fossil fuel-based generation.

**Decreasing reliance on non-renewable energy sources.** Smart grids make it far easier for customers to generate energy on premise (for instance, via rooftop solar) and to trade energy back and forth with the grid. Implementing the right devices and instrumentation, such as improved solar meters, have led many financiers to offer \$0 down residential and commercial solar programs, reducing the barriers to solar generation. And smart energy, with the help of reliable two-way communications, makes grids more flexible overall to customer demand.

**Lessening energy operating costs.** Smart energy reduces operating costs compared to traditional methods. For example, sensors and monitors can report on the actual condition of expensive equipment so that it can be serviced based on actual condition and not a guess.

This kind of asset management can squeeze many extra years of use from an asset, without compromising safety. For another, smart systems can manage peak times by briefly reducing demand (called demand response) instead of building new standby power plants that will only get used a few times per year, and can even dim LED streetlights to enable lower operating costs.



Lessening operating costs:

## TATA POWER DOUBLES ENERGY DELIVERY WITH OLD INFRASTRUCTURE

**P**ower Utilities are faced with a major challenge in keeping up with exponential growth in the heavily populated urban areas, often needing to upgrade existing transmission lines to carry more power. TATA Power faced this situation in Mumbai, where population density was approximately 27,000 people per sq. km. The lines were upgraded from a single to a bundled ACSR only 2 years before, but they could not keep pace with the rapid demand growth in the area, because of which they again needed to upgrade their 110kv Borivali-Malad&Salsette-Saki transmission lines.

TATA Power was looking for a solution that would survive the harsh Mumbai heat and heavy monsoons, making its reliability under harsh environmental and operating conditions an essential requirement. To further complicate things, two-storey residences had sprung up under the lines severely violating the sag levels. TATA Power wanted to improve clearances over them without disturbing the structures while doing so.

TATA Power deployed Aluminum Conductor Composite Reinforced (ACCR) from Council member 3M, as these conductors are capable of more than doubling overhead line transfer capacity, often without needing larger towers. The low coefficient of thermal expansion reduces the problems associated with conductor sag.

Also, as the ACCR conductor has been installed in many applications in US since 2001 including the hot deserts near Phoenix, Arizona, densely populated areas near Washington DC and environmentally sensitive areas in Minnesota, the conductor's reliability under harsh environmental and operating conditions has been adequately proven.

200 km of conductor installation was completed using existing structures and without displacing people living nearby, while increasing capacity enough from 900 to 1800 amps to last for 10 years. Both the lines are working successfully since 2008-2009.



**Lessening energy  
operating costs:**

*200 km of conductor installation was completed using existing structures and without displacing people living nearby, while increasing capacity enough from 900 to 1800 amps to last for 10 years.*

## Energy targets

The energy targets described in this chapter can help cities develop a smart energy environment that uses intelligence to reduce dependences on fossil-fuel.

## Inclusivity

**Achieve accessibility optimisation.** Modern energy for all — assured electricity supply for all is the basic and foremost foundation of any smart city. The smart cities take multiple actions — from building renewable energy infrastructure to deploying smart energy metering with advanced analytics to encouraging e-mobility — to reduce the energy consumption and deliver cleanest energy to all.

**Formulate citizen reporting framework for outcome thinking.** When citizens are provided with data collected from smart meters in the form of clear, systematic reports illustrating the energy usage over time and effective solutions to reduce it, the citizens take voluntarily actions to further reduce the energy carbon footprint. The smart grid systems not only provide necessary information to the citizens to help them manage and plan their tariffs, but also empower them to create energy efficient communities.

**Achieve citizen engagement.** Smart grids offer financial incentives to the consumer to shift the electrical demand during off-peak hours, with a mutually benefiting approach, giving the consumer an opportunity to save energy and money.

## Collaborativity

**Pursue multilateral collaboration.** The exploding energy demand and the shortage of energy supply necessities a need for a collaborative public and private partnerships as well as non-profits providing expertise. Multiple small-scale utility providers are working with corporates or foundations to achieve the inclusivity goals. For example, Rockefeller Foundation is working with local, small-scale entrepreneurial start-ups to provide solar power using mini-grids.

Another example, the CLEAN Coalition is a non-profit helping to transition from outdated energy systems built around large, centralised, fossil-fuel-based power plants and lengthy inefficient networks towards small-scale, efficient, renewable energy projects. It provides free tools to help city leaders and utilities to deliver affordable and reliable power to communities.

## Governance

**Formulate new guidelines.** India has targeted to build 100 GW solar capacity by 2022, from the current 4.4 GW. The Ministry of New and Renewable Energy is working towards evolving guidelines as per which all power producers in the private and public sectors would have to generate 10 per cent of solar power of their total installed capacities to light up smart cities.

**Create a stable policy framework for private investors.** Almost all smart cities focus on improvement in the clarity of various regulations and commercial policies to attract and retain investors. For example, given growing demand and reliance on natural gas for power, the continued trend of falling domestic natural gas production needed to be reversed with clear and comprehensive policies and regulations.



GE imagination at work



Implement optimal instrumentation:

## SMART METERS GIVE FP&L CUSTOMERS CONTROL OF THEIR ENERGY USE

In 2013, GE and Florida Power & Light Company (FPL) celebrated completion of Energy Smart Florida (ESF), an initiative implemented to modernize the electric grid and build out a more reliable and efficient electrical infrastructure.

As part of the effort, FPL installed 4.5 million GE smart meters across its 35-county service territory, empowering FPL's customers to take control of their energy use.

Council member GE's smart grid solutions enable effective two-way communication between FPL and its customers. For example, FPL's advanced metering infrastructure provides its customers with hourly data on their energy usage. Each customer with an activated smart meter can view his or her own "Energy Dashboard" through FPL's website.

The dashboard displays information about consumption and costs a day after it has been recorded by the smart meter. Each customer can view his or her own power use by the hour, day and month and can receive bill estimates based on current usage patterns.

Many customers are regular dashboard users and have provided comments to FPL on how much they like it. For example, one FPL customer said, "If people choose to use the customer portal, they will definitely see benefits. Changing our energy habits has saved our family about \$100 dollars a month compared to similar homes in our area." Another customer noted, "I think the online portal is the greatest tool FPL has to offer. In today's economy, every dollar is important. Thanks to the smart grid, my family is saving as much as \$30 a month."

Implement optimal instrumentation:

*GE smart meters installed in Florida Power & Light's service territory, along with an online dashboard, are helping utility customers take control of their energy use.*



## Instrumentation and control

We start our discussion of this chapter's targets with optimal instrumentation which, when applied to smart energy, refers to smart devices such as sensors and smart meters that gather information about the flow and condition of power and about the condition of equipment within the energy infrastructure.

### Implement optimal instrumentation.

Thanks to real-time information supplied by smart devices, system operators can predict, diagnose and mitigate issues that might previously have caused an outage or blackout. Examples of energy instrumentation include the deployment of smart meters and distribution system sensors.

Smart meters, which are installed in homes and businesses, are perhaps the most visible instrument in a smart energy network and certainly the most controversial due to concerns about potential health impacts and privacy. All of which points to the importance of developing an effective citizen engagement strategy long before you start deploying them.

Today there are smart meters for electricity, gas and water. They provide two-way communication between the customer's premises and the utility. In the old days meters had to be read manually; smart meters

transmit energy usage details directly to the utility. When smart meters are combined with smart thermostats, smart appliances and/or energy management devices, consumers can participate in energy saving demand response programs where they voluntarily allow the utility to send a signal to the smart meter or other device to temporarily make a modest adjustment in energy usage.

## Connectivity

Not only are smart meters and sensors part of the smart energy network, they are also part of a citywide two-way communications system — that "system of systems" discussed earlier.

**Connect devices with citywide, multi-service communications.** Connectivity allows data collected throughout the smart energy network to be transmitted for analysis and action. For example, connectivity might mean that your smart meters, distribution system sensors and utility are connected through two-way communications.

### Implement optimal instrumentation:

*Today there are smart meters for electricity, gas and water. They provide two-way communication between the customer's premises and the utility.*

## Interoperability

Utilities around the world have started building smart electric grids and smart gas grids, both of which are part of what this Guide refers to as the all-encompassing smart energy network. But one of the stumbling blocks early on was a lack of standards — and as you can imagine there are numerous pieces of a smart grid that have to work together and talk to each other. Thanks to a number of standard bodies around the world that undertook the task of developing specifications, a lot of the issues that plagued smart grid pioneers have been resolved. Below is a quick look at interoperability targets, including one that specifically applies to energy.

**Adhere to open standards** to increase choice and decrease costs. With open standards, products can be mixed and matched from different vendors. There are hundreds of standards just for the energy responsibility of a smart city.

As we discussed in the Universal chapter, selecting standards is a job for specialists. Your job is first to insist on using them whenever possible and second to hire a supplier with demonstrated knowledge and commitment to open standards.

But the standards selection process is easier in the energy sector with the free Smart Grid Standards Mapping Tool from the International Electrotechnical Commission, a Council advisor. You can simply point and click to identify any standard in relation to its role within the smart grid. New standards are added regularly. Also see the Sensor Web Enablement standards of the Open Geospatial Consortium.

**Enable distributed generation with interconnection standards.** Recent decades have seen the proliferation of “distributed generation” of small, decentralised power plants located at or near the spot energy source. Think rooftop solar installations on high-rise apartment buildings or wind turbines helping power a shopping mall.

What is required to make distributed generation work effectively is straightforward, easy-to-use interconnection standards that define how the energy sources tie in to the energy grid. It’s a relatively new business model for utilities, although many have or are in the process of developing protocols to accommodate distributed generation.



### **Enable distributed generation with interconnection standards:**

*When utility customers have access to data about when and how they use energy they can make choices and tradeoffs that can reduce their energy usage and utility bills.*



### **Economic and clean power generation:**

*Distributed generation has enormous potential, including reduced dependence on fossil fuels and higher efficiency and greater resilience against natural or man-made disasters.*

Getting it right gives the city and its residents more options for economical and clean power generation without compromising secure and reliable grid operations.

Cities that own their local energy or gas utility can prioritise development of interconnection standards. Those with energy providers that are not municipally owned may need to find ways to encourage them to modernise their interconnection standards to accommodate what is clearly the wave of the future.

Distributed generation has enormous potential, including reduced dependence on fossil fuels and higher efficiency and greater resilience against natural or man-made disasters.

## Security and privacy

There are at least three extremely compelling reasons why smart cities take security and privacy seriously in the context of energy as these three targets demonstrate.

**Publish privacy rules.** Smart meters have raised privacy concerns around the world. People worry that their daily habits are being tracked by their local utility via smart meters, which is why smart cities not only publish and adhere to privacy rules, but also let citizens

know about it proactively. Making privacy a priority can help ward off consumer backlash that could stall smart energy deployments.

**Create a security framework.** Security breaches can have a ripple effect. Developing a comprehensive security framework mitigates risk by identifying and addressing threats before they can cause damage. This is critical in the energy infrastructure — even more so given its inherent importance to the operation of other key infrastructures.

**Implement cyber security.** Cyber attacks against energy companies in the US have been well-documented. But what were once thought to be attempts to steal information or trade secrets are now focused on causing serious damage to networks and equipment, according to warnings from the US government.

The take away here for cities is that implementing cyber-security safeguards early on, maximises protection while avoiding the potentially significant costs associated with an attack.



Enable distributed generation:

## MONITORING AN EXTENSIVE NETWORK OF RENEWABLE ENERGY PLANTS

**9**REN Group designs, develops, builds and operates renewable turnkey power plants using photovoltaics, solar thermal energy and wind. The Spanish company operates some 570 photovoltaic installations, mainly in Spain and Italy. In addition to photovoltaic plants, the company has built 183 solar thermal plants as well as mini-wind installations. 9REN plants generate more than 10,000 megawatt-hours (MWh) of clean energy each month.

To manage and monitor its photovoltaic plant facilities, 9REN created EOSystem, a solution built on the Wonderware® System Platform from Council member Schneider Electric. EOSystem is a real-time monitoring technology that provides instantaneous information from all photovoltaic installations operated by 9REN through out Europe and the Middle East.

System Platform provides a single, scalable software solution for all the supervisory control and data acquisition (SCADA) and supervisory human machine interface (HMI) needs for monitoring 9REN’s renewable energy installations.

From a single control center, 9REN can effectively monitor the operations infrastructure at each facility. “The Wonderware System Platform lets us access all our installations in real time,” said Antonio Palacios Higuera, services technical manager for 9REN. “Because of this, we only require one person to control the operation of all of the 568 plants, regardless of location. We also have achieved a significant cost reduction in time per designer and project.”

**Enable distributed generation:**

*From a single control center, 9REN can effectively monitor the operations infrastructure at each of its renewable energy facilities, which includes some 570 photovoltaic installations.*

## Data management

There is a tremendous amount of data pouring in from sensors, smart meters and other intelligent devices deployed throughout the energy infrastructure of a smart city.

### **Create and adhere to a citywide data management, transparency and sharing policy.**

Energy usage data should be integrated in the policy that was discussed in detail in the Universal chapter. And as noted in the previous section, energy usage data needs to comply with overall security and privacy rules.

That said, access to timely, accurate energy usage data is an essential component of a cleaner, more efficient energy system. So it's imperative that local utilities grant cities access to aggregated, summary usage data which can be invaluable for city planning, for carbon reduction programs, for energy efficiency programs, for low-income assistance programs, for improving city performance and for many other purposes.

To promote energy efficiency, it's also important for smart cities to encourage utilities to give electric and gas customers access to their own usage data. For example, cities can provide a Web portal for viewing and managing energy usage in real time for customers to see their energy usage and utility bills.

## Computing resources

Basically all of the computing resources that cities use rely on energy in some way, shape or form, so it makes sense for cities to constantly monitor for efficiencies and economies as they use, deploy and procure computing resources.

**Consider a cloud computing framework** to enable scalability of systems, reduce costs and improve reliability.

**Use an open innovation platform** to empower innovators, increase accountability, generate new revenue streams and stimulate economic growth.

**Have access to a central Geographic Information System (GIS)** to improve decision-making capabilities, enable efficiency gains through more intelligent scheduling and routing, provide improved accuracy of essential records and boost resiliency of key assets.

**Have access to a comprehensive device management system** to improve infrastructure security and resiliency, deliver cost savings and enforce compliance with city data management, security and privacy policies. This target takes on special importance in the energy discussion due to the numerous smart devices and other computing resources deployed throughout smart cities.

## Analytics

As we've said previously, analytics are absolutely critical to smart city success and perhaps nowhere is that more evident than in a smart energy network that powers so much of what a city is and does. We'll quickly review three of the analytics targets already discussed in the Universal chapter and then introduce two more that speak volumes about energy's importance in a smart city.

**Achieve full situational awareness.** This refers to giving operators a complete picture of their energy system at any given moment to increase its reliability and resiliency and quickly respond to trouble. A complete operating picture is incredibly important to city energy systems. One example: It helps operators detect energy theft and thereby conserves resources.

**Achieve operational optimisation.** Building the very best smart energy network possible is what cities want to achieve from the instrumentation and connectivity investments they make in their energy infrastructure.

Optimised energy systems help conserve energy, delivering cost savings to cities, residents and businesses and also reducing the drain on energy resources.



Consider a cloud computing framework:

**RESIDENTS TRIM ENERGY USE BY 20% WHEN GIVEN REAL-TIME DATA**

**Consider a cloud computing framework:**

*IssyGrid collects energy consumption data and processes it in real time using Windows Azure, the Microsoft cloud services platform.*

**A** consortium of companies is taking energy conservation to the next level by creating an entire eco-minded neighbourhood just outside of Paris, France.

IssyGrid is France's first smart grid neighbourhood, a demonstration project aimed at reducing energy use in the French town of Issy-les-Moulineaux. It is run by a consortium of corporate partners and local utilities that consider energy conservation an opportunity for businesses to solve. Around 200 test homes and four commercial buildings in the community have been outfit- ted with energy consumption monitoring devices, with the goal of ultimately expanding the program to the entire town. IssyGrid collects energy

consumption data and processes it in real time using Windows Azure, the cloud services platform from Council member Microsoft.

The consortium analyses the data by using Microsoft SQL Server 2012 data management software. After that, IssyGrid provides the data to citizens so that they can see how they are using electricity. This enables them to take specific actions to conserve — by turning off the television or lowering the temperature by two degrees.

The result: They reduce their consumption — and their energy bills — by 10 to 20%.



### **Automate fault and outage management.**

*Automated solutions help make the energy supply more reliable and improve outage response.*

incident. Before the advent of these advanced technologies, utilities often didn't know about an outage until customers started calling in.

A quick look at economic losses incurred from power outages explains why this is so important. A study by the Berkeley National Lab back in 2004 estimated that outages cost \$80-130 billion per year in economic losses in the US alone. After Super storm Sandy, which wreaked havoc across north-eastern America in 2012, the US Congress approved more than \$60 billion in emergency aid, which is roughly what state governments reported in damages and other losses. By encouraging automated solutions a city or utility can make the energy supply more reliable, improve response to outages which in turn makes businesses more competitive and residents more comfortable.

**Segment and personalise programs for customers.** This is one of the big pluses of today's smart energy networks. They can consider multiple variables — like a utility customer's preferences, system parameters, weather, cost of energy — to optimise and personalise rates and programs. As part of that personalisation, a smart city's utility, whether municipally owned or a private utility that operates in the city, can identify energy use patterns and then make customised recommendations to help customers get the best possible rates or assist with fraud and service connection issues.

**Achieve asset optimisation.** This target plays an important role in the energy sphere, helping cities maximise the value of their assets by 1) calculating which energy assets need to be repaired or replaced and when, and 2) by predictive maintenance, which uses analytics to spot equipment that is close to failure so that it can be repaired or replaced before problems arise.

**Pursue predictive analytics.** Drawing from instrumentation deployed across a city, analytics can enable advanced forecasting and management of a diverse, secure and resilient energy system. ICT helps cities account for demand, weather effects from distributed resources that may be variable and other operational considerations. Understanding what to expect helps cities save on costs, conserve resources and prepare for extreme events.

Now we'll introduce two new energy-specific targets that are critical to smart city success.

**Automate fault and outage management.** This is about the "self-healing" grid we referred to earlier. The idea is that the utility that serves your city would enable remote sensors, smartmeters and other advanced smart grid technologies deployed throughout the energy network to automatically reduce the number of outages and the duration of those that do occur. For instance, a sensor might detect a fault on the electric grid and be able to locate it and isolate it before it has time to affect other areas.

Or smart meters may alert a utility's outage management system of trouble, allowing the utility to immediately dispatch crews and keep customers updated during and after the



Segment and personalize programs for customers:

## COMPANY'S DEMAND RESPONSE INCENTIVES PAY FOR MORE TECHNOLOGY

**W**hen energy demand is high and supply is short, San Francisco, California-based Pacific Gas & Electric (PG&E) offers financial incentives to companies that reduce their load in response to a request.

NetApp, a Sunnyvale, California company that creates storage and data management solutions, signed up for PG&E's Demand Bidding Program, which means the utility pays NetApp \$0.50/kWh when the request is made the day before and \$0.60/kWh if the request is made the same day.

It started several years ago when NetApp saw an opportunity to significantly reduce energy consumption

at its headquarters, which has 1.2 million square feet of space in 10 buildings. The headquarters uses 54 million kilowatt hours annually, with a peak demand of 7.6 megawatts. In 2008, NetApp's annual utility bill was \$7.7 million, 89% of that for electricity.

Energy-efficient equipment is only part of the solution. "You also need to make intelligent decisions about equipment settings, and that requires gathering and analysing information from disparate building systems, including metering systems and PDUs [power distribution units]," says David Shroyer, a NetApp controls engineer.



**Segment and personalize programs for customers:**

*California's Pacific Gas & Electric offers financial incentives to companies that reduce their energy load in response to a request. NetApp installed Cisco's Network Building Mediator to enable its participation in the program.*

To aid that effort, the company deployed the Network Building Mediator from Council member Cisco, which aggregates information from all of NetApp's building systems, including lighting, heating, ventilation, air conditioning, temperature sensors and PDUs, from multiple vendors.

Building engineers and facilities personnel can control systems in any building using a Web-based interface. Demand response payments

from PG&E paid for the system and NetApp has since deployed Network Building Mediator for automated demand response at its properties in Europe and India.

Within 20 minutes of the demand-response signal from the utility, the Cisco Network Building Mediator reduces lighting by 50% and raises the temperature set point by four degrees, shedding 1.1 megawatts.



 **Implement optimal instrumentation.**

*Optimal instrumentation is what creates a data critical to a smart city.*

Today many electric and gas utilities charge a single rate for every residential customer at every time of the day. In reality, the cost of energy varies widely depending on the time. In particular, electric energy can be very inexpensive at night when demand is low and the output from wind farms is high. But it can be very costly during hot summer days when air-conditioners are cranked up, demand is very high and energy is scarce.

Smart meters and smart grids make it possible for utilities to offer a variety of programs to encourage energy efficiency and cost savings. Examples include time-of-use rates, peak-time rebates, efficiency incentives and demand response programs.

Centre Point Energy in Texas completed installation of more than 2.2 million smart meters from Council member Itron as part of its smart grid initiative, which was designed to give consumers more control over their energy

consumption. Now CenterPoint customers have a 15-minute interval access to their energy data from the Smart Meter Texas online web portal, and have wireless capabilities to install in home energy management devices.

“Our smart meter deployment has been extremely successful. Not only have we had compliments from our customers and the Public Utility Commission of Texas, we’ve also had compliments from the Department of Energy,” said Kenny Mercado, division senior vice president of grid and market operations for Centre Point Energy.

The Smart Grid Consumer Collaborative (SGCC) is a non-profit organisation focused on advancing a consumer-safe, consumer-friendly smart grid and has researched consumers and published reports on smart grid consumer education and segmentation. SGCC’s research shows that consumers fall into five broad segments ranging from Concerned Greens, those people who want a cleaner energy portfolio, to Do-It-Yourself and Save, those people who want to save money and are likely to enrol in programs that will help personalise programs that match their values around energy. Joining with organisations like SGCC to obtain materials, collaborate with others and learn best practices for citizen engagement is one way to increase the likelihood that smart energy projects receive consumer support.



### **Facility helps public and private sector researchers scale up clean energy technologies**

Located at the National Renewable Energy Laboratory’s campus in Golden, Colorado, the new 182,500-square-foot Energy Systems Integration Facility (ESIF) is the first facility in the United States to help both public and private sector researchers scale up promising clean energy technologies — from solar modules and wind turbines to electric vehicles and efficient, interactive home appliances — and test how they interact with each other and the grid at utility-scale.

The US Congress provided \$135 million to construct and equip the facility.

ESIF, which opened in 2013, houses more than 15 experimental laboratories and several outdoor test beds, including an interactive hardware-in-the-loop system that lets researchers and manufacturers test their products at full power and real grid load levels.

The facility will also feature a peta scale super computer that can support large-scale modelling and simulation at one quadrillion operations per second.

# ISO 37120: A yardstick for measuring city performance



In 2014, the International Organisation for Standards announced an ISO standard that applies strictly to city performance. The document known as ISO 37120:2014 establishes

a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right we have indicated how the standard related to energy intersect with the Council's Energy targets identified on the next page. While there are many aspects of energy to consider, ISO 37120 focuses on a city's energy efficiency, energy availability and energy mix.

## Energy Indicator

			Implement optimal instrumentation	Enable distributed generation	Create energy data management policy	Achieve operational optimization	Achieve asset optimization	Pursue predictive analytics	Automate fault and outage management	Achieve full situational analysis
<b>Core</b>	7.1	Total residential electrical energy use per capita (kWh/year)	●	●	●	●	●	●		
	7.2	Percentage of city population with authorised electrical service	●	●						
	7.3	Energy consumption of public buildings per year (kWh/m <sup>2</sup> )	●	●	●	●	●	●		
	7.4	The percentage of total energy derived from renewable sources; as a share of the city's total energy consumption	●	●	●	●	●	●		
<b>Supporting</b>	7.5	Total electrical energy use per capita (kWh/year)	●	●	●	●	●	●		
	7.6	Average number of electrical interruptions per customer per year						●	●	●
	7.7	Average length of electrical interruptions (in hours)						●	●	●

# ENERGY TARGETS

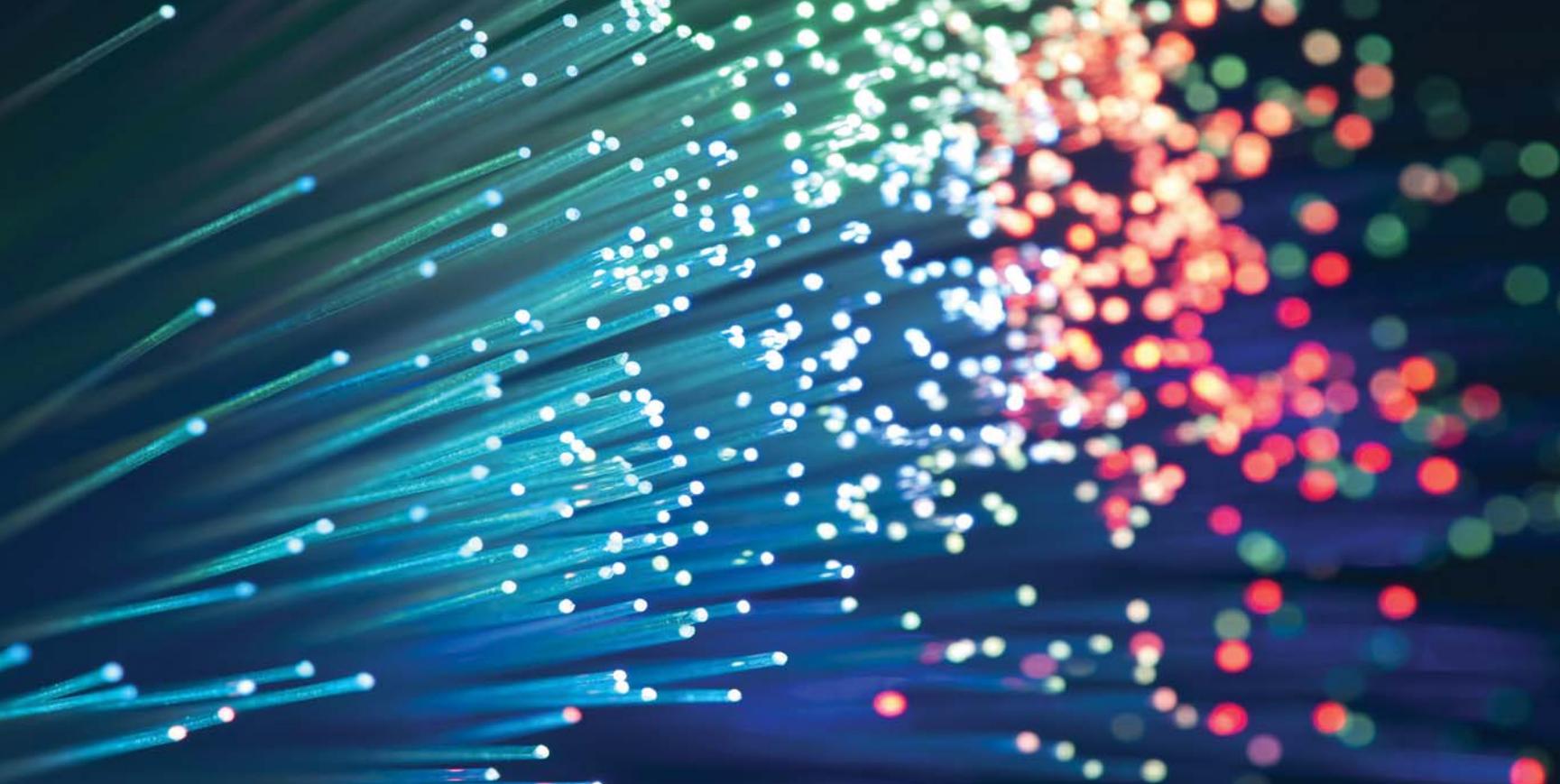
In the checklist below, targets specifically pertaining to the energy responsibility are in **bold**, universal targets are not.

	Enabler	Energy Targets How smart cities deploy and use ICT to enhance their energy infrastructures	Implementation Progress			
			None	Partial	Over 50%	Complete
Human	Inclusivity	Achieve accessibility optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate citizen reporting framework for outcome thinking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Achieve citizen engagement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	Collaborativity	Create institutional framework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Pursue multilateral collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Governance	Achieve existing infrastructure optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate new supporting policy frameworks and regulatory mandates	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<b>Create a stable policy framework for private investors</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# ENERGY TARGETS

In the checklist below, targets specifically pertaining to the energy responsibility are in **bold**, universal targets are not.

Technology	Enabler	Energy Targets	Implementation Progress			
		How smart cities deploy and use ICT to enhance their energy infrastructures	None	Partial	Over 50%	Complete
	<b>Instrumentation and Control</b>	Implement optimal instrumentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Connectivity</b>	Connect devices with citywide, multi-service communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Interoperability</b>	Adhere to open standards	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Use open integration architectures and loosely coupled interfaces	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<b>Prioritise use of legacy investments</b> <b>Enable multi-channel access to integrated customer transportation account</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Security and Privacy</b>	Publish privacy rules	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Create a security framework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Implement cyber security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Data Management</b>	Create a citywide data management, transparency and sharing policy <b>(Supplement : including energy usage data)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Computing Resources</b>	Consider a cloud computing framework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Use an open innovation platform	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Have access to a central GIS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Have access to comprehensive device management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Analytics</b>	Achieve full situational awareness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Achieve operational optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Achieve asset optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Pursue predictive analytics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<b>Automate fault and outage management</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	



# 7 Telecommunications

**Ubiquitous broadband telecommunication is a prerequisite for a smart city. Digitisation in India offers an unprecedented opportunity for connecting cities for the first time to the information grid and empowering citizens. This chapter explains how to achieve a telecommunications architecture that can serve as the foundation of a smart city and the foundation for major improvements in livability, workability and sustainability.**



However, city responsibilities such as power, public safety and transportation depend on telecommunications. In that sense, telecommunications is also an enabler. When we are talking about the technology in that sense, we use the term “connectivity” to make the distinction. You’ll see the word “connectivity” listed in the smart cities Council Framework along with other enablers such as instrumentation and computing resources.

In the 21st century, people and businesses consume telecommunications like a resource, just as they consume electricity to light their homes and water to quench their thirst. As a result, it is vital that cities take on the responsibility of ensuring adequate telecommunications so their residents have access to high-quality communications. Cities don’t have to build, own and operate the infrastructure — in fact, most will not. But they must at least continue to set the conditions and policies that incentivise the private sector to install state-of-the-art telecommunications.

Telecommunications also acts as an enabler by providing connectivity. All the other responsibilities — water, power, transportation, etc. — require connectivity to communicate with the sensors and devices they use to collect data.

## Telecommunications is also an enabler:

*City responsibilities such as power, public safety and transportation depend on telecommunications. When we are talking about the technology in that sense, we use the term “connectivity” to make the distinction.*

**W**e begin by defining telecommunications, both as it exists today and as it will evolve tomorrow. After we discuss the “what,” we’ll talk about the “why” — why telecommunications is so vital to smart city success. We’ll finish by discussing the targets for telecommunications — the end states at which you should aim your efforts. Along the way, we will pay brief visits to telecommunications success stories from around the world.

First, a word about our use of the terms “telecommunications” and “connectivity.” Dictionaries define telecommunications as the electronic transmission of signals. When we use the word in this Guide, we are talking about a city’s responsibility to provide the policy environment and incentives to achieve high-quality telecommunications.

That's why the Universal chapter already specified a universal target of "Connect devices with citywide, multi-service communications." You've got two important reasons to pay close attention to telecommunications: 1) for the value it creates on its own, and 2) for the value it enables for all the other responsibilities.

## Telecommunications today and tomorrow

Before we define the targets for tomorrow's telecommunications, we should first examine how it works today. Most cities already have many existing communications networks operating side-by-side. A typical city may have multiple cellular/mobile networks plus cable, satellite, RF mesh, microwave, radio, fibre optics, Wi-Fi for homes and offices, ZigBee for smart meters and appliances and more (see list on the next page). Sadly, it can be challenging to bridge between today's networks, making it difficult to achieve the seamless, end-to-end connectivity required for a true smart city.

Telecommunications in India has witnessed an exponential growth in the wireless segment in the last few years, and is now facing huge disruption in conceptualising and delivery of communication services. Increasing adaptation of smartphones and broadband is hugely based

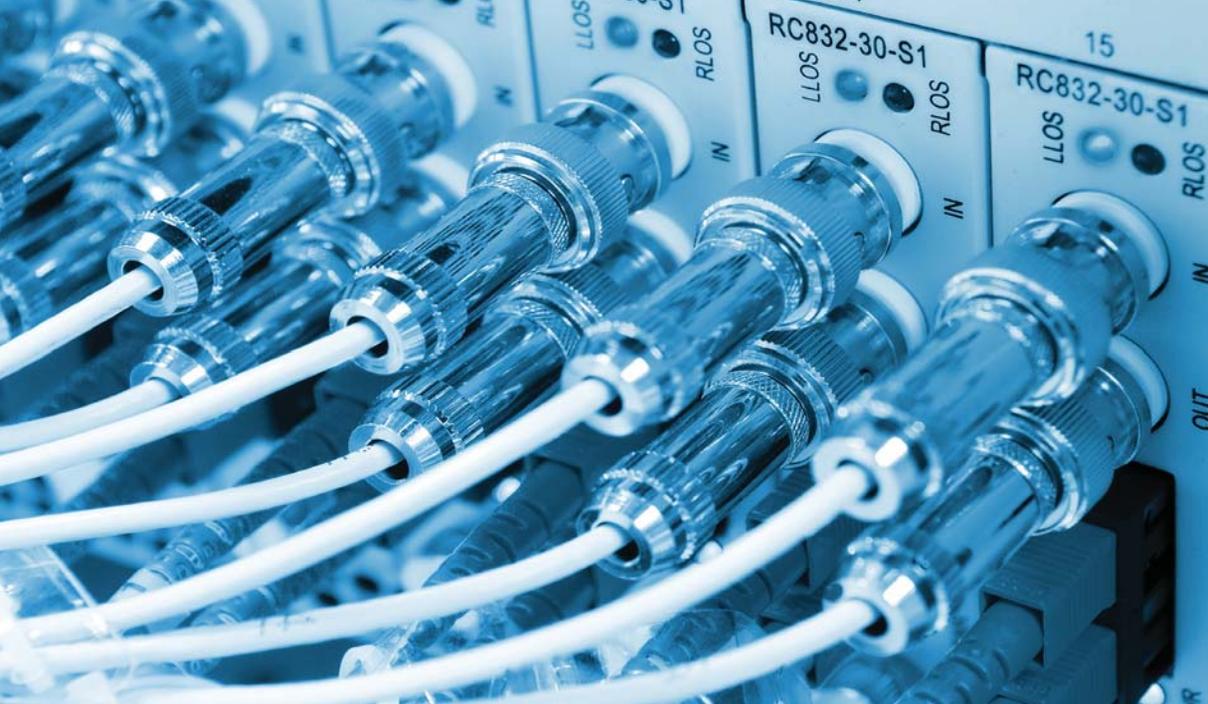
on affordability. Telecommunications in India is still at a very low level with international standards, but it offers a promising growth. With the country's thrust towards 'Digital India', there is an unprecedented opportunity to connect the cities for the first time to the information grid.

The tremendous increase in wireless utilisation in India is constantly constrained by the lack of radio spectrum availability and telecommunications infrastructure. Limitations in spectrum and mobile network results in poor quality of voice and data services, reduced availability, or high prices.



### Telecommunications today and tomorrow:

*Most cities already have many existing communications networks operating side-by-side. Sadly, it can be challenging to bridge between today's networks, making it difficult to achieve the seamless, end-to-end connectivity required for a true smart city.*



Some businesses have taken steps to support this high-speed fibre backbone. These fibre optic networks provide the bandwidth and speed demanded by the Digital Age. The optical network will terminate in network equipment (for example, an optical network unit) that will then break out and deliver IP and other traffic types to their destinations via a local access network. But a city also needs omnipresent wireless to provide access to sensors, controllers, laptops, tablets, smartphones and other mobile devices.

Most importantly, this future city will have a converged architecture embodied in an all-IP, packet-based core network — a unified infrastructure that integrates various wired and wireless technologies, thereby achieving the seamless connectivity required. When we say “converged” or “unified” we do not mean that a city will end up with a single telecommunications system. Rather, we mean that it will end up with a single architecture — a single set of standards — that allow multiple networks to transmit information smoothly. As we move towards the future, interoperability will be the key.

Those three elements — fibre plus wireless plus a converged, delayed architecture are the essentials to achieve the high speed, high reliability and high availability telecommunications required in a modern city.

## **The telecommunications foundation:**

*The smart city of the future will have a fiber optic loop that reaches most buildings, combined with citywide wireless communications such as 3G/4G cellular, Ethernet, WiFi, RF mesh or some combination.*

If that is today’s reality, then where do we want to go next? The smart city of the future is likely to have an underlying fibre optic network as both a Metro loop around the city (like a ring road for traffic) and then local access that links buildings to this loop. Incredibly, tests have been able to send 100 terabits per second through a single optical fibre — enough to download the entire contents of the Library of Congress in seconds! Although fibres do not run at this speed in normal usage, the extraordinary headroom in terms of performance increases is clear. Wireless access to this underlying network may be provided by Wi-Fi, by RF Mesh, by cellular/mobile technologies or some combination.

# TELECOMMUNICATIONS TERMINOLOGY

Most cities already have multiple telecommunications networks in place. Here are 10 of the telecommunications terms and technologies seen most often.

**Cable** — Coaxial cable, an inner conductor surrounded by insulation and a conductive shield, originally used for cable television but increasingly used for voice and data as well.

**Cellular/mobile** — A radio network of transceivers called base stations distributed over land areas called cells. Cellular/mobile uses licensed frequencies and services provided by regional and/or nationwide operators. It is typically used for mobile broadband data, voice and text services. It is increasingly being used in machine-to-machine applications, for example, to collect data from smart meters and other sensors. It comes in various flavours including 3G (3rd generation) and 4G-LTE (Long-Term Evolution).

**Fibre /FTTH** — Fibre optics are thin, flexible strands of glass that transmit signals as light. The bandwidth enables single fibre optic cables to easily deliver 1 Gbps (one thousand million bits per second) services and even faster. Fibre to the Home, or FTTH, describes fibre being

deployed to directly connect an operator's central distribution office to individual homes.

**Microwave** — Line-of-sight devices that must typically be placed in high locations so the sender and receiver can "see" each other, often relayed from station to station.

**POTS** — or Plain Old Telephone Service, typically delivered to homes and businesses over twisted pair wires. POTS is a part of the Public Switch Telecom Network (PTSN).

**Power line** — Transmitting data over existing electric power lines both inside the home (HomePlug) or outside (Broadband over Power line). It's typically used to collect data from smart meters and other sensors.

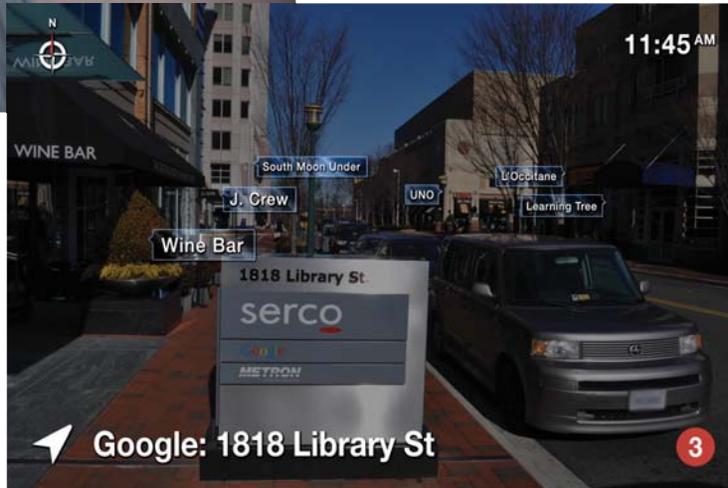
**RF Mesh** — A system using radio frequency (RF) in a "mesh" configuration such that individual nodes pass a message along until it reaches a "collector" or "gateway" that can forward it to the backhaul network. It's typically used to collect data from smart meters and other sensors.

**Satellite** — Communications satellites can be thought of as microwave relay stations placed very, very high (typically 22,000 miles above the Earth). They are often used to relay global positioning signals or to deliver television services to homes and businesses.



**Wi-Fi** — A popular networking technology that uses unlicensed radio waves for short- to medium-range wireless connections.

**ZigBee** — A communication protocol for "personal area networks" (PANs) created by small, low-power digital radios. It's typically used to connect smart meters to thermostats and home appliances that are a short distance apart.



## The importance of telecommunications

Telecommunications is used in two ways:

1. To connect to devices people use indirectly such as sensors and switches. By 2020 there could be upwards of 50 billion devices and sensors connected in M2M (machine to machine) applications.
2. To connect to devices people use directly. Today that means computers, tablets and smartphones. Soon it may also mean smart watches and smart "glasses"

In both ways, telecommunications plays a pivotal role in the daily pulse of a city:

- Banks rely on it to process transactions
- Online retailers use it to receive and acknowledge orders
- Cloud computing data centres require it to communicate with thousands or even millions of computers
- Emergency responders need it to receive and act upon life-saving alerts
- Parents rely on it to stay in touch with their children
- Families use it to get access to movies, television and the Internet

### Connecting to telecommunications:

*Today most people connect via phones, tablets or computers. Soon many people may use smart watches and smart glasses as well. For instance, Google Glass is a technology that allows users to see information overlaid on top of their normal view of the world. It accepts commands via voice recognition.*

The list of ways telecommunications factors into daily life could go on and on, of course. Telecommunications is a necessity for the digital lifestyle increasingly demanded by citizens. (In a 2011 Reuters survey, for instance, 61% of Americans said it would be easier to live without air travel than without the Internet).

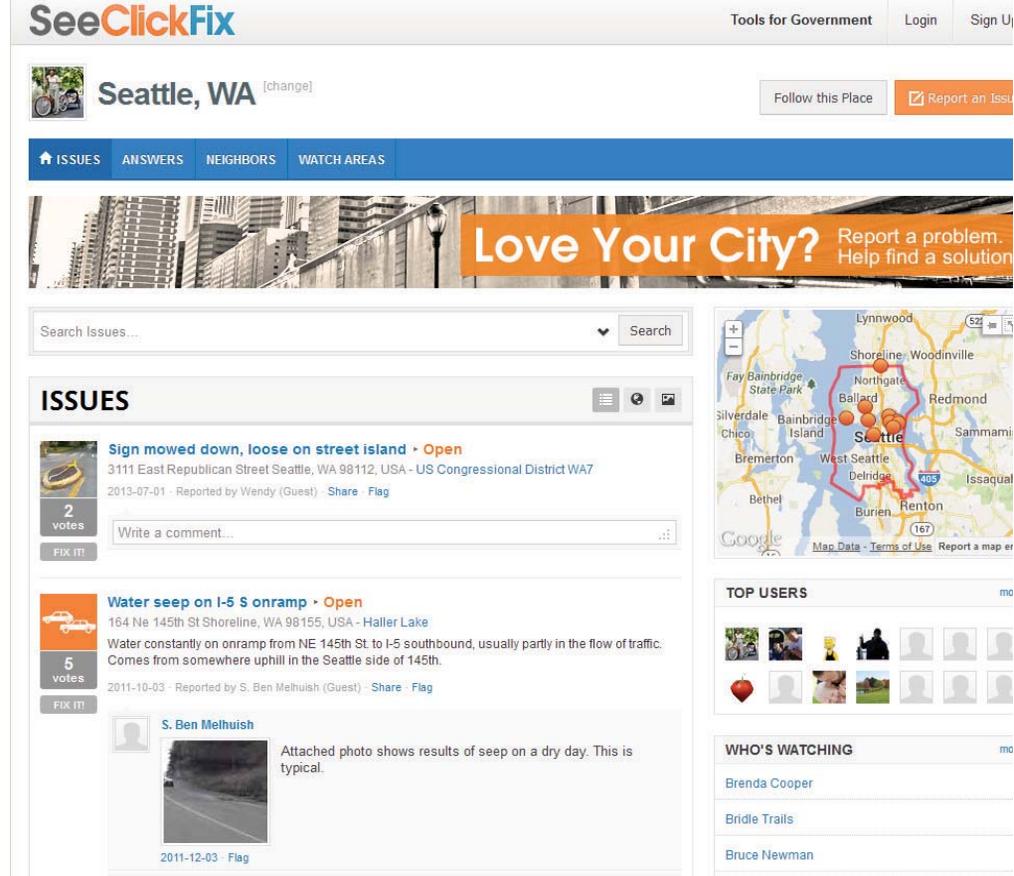
Our reliance on telecommunications will only increase as more people are connected to the Internet each day, and as we invent new use from tablets, to video streaming, to video phone calls. Council member Qualcomm — a world leader in 3G, 4G and next-generation wireless technologies — estimates that the world will soon demand 1,000 times more mobile data traffic than consumed in 2012.

## Interconnectedness assessment

For improvements in telecommunications services, cities will need to plan them with an understanding of the interdependencies with other city responsibilities and services, such as energy, built environment, security, health, and one more important resource, the radiofrequency (RF) spectrum.

### Better ways to deliver services:

*SeeClickFix allows anyone to report and track non-emergency issues anywhere in world via computer or mobile devis, empowering citizens, communities and governments to improve their neighbourhoods.*



Telecommunications runs on power, while its role in almost all city responsibilities like security and health is paramount, and we will see that in more detail in the following chapters.

The RF spectrum requirement is on the radar now for very few cities, but it will emerge as an important issue. RF spectrum is an always-local and limited natural resource that

smart cities increasingly depend on and will ultimately need to manage. RF transmissions — from cell phones, Wi-Fi, WiMax, positioning systems, Bluetooth, etc. — interact with the environment. Understanding RF — and an open standard for encoding RF spectrum data — will be important as it becomes necessary for cities to optimise their use of this resource.

# Benefits of telecommunications

Telecommunications play a critical role in promoting livability, workability and sustainability in cities.

## Livability

**Reducing the “digital divide”.** Residents without access to the Internet are at an educational and economic disadvantage. By ensuring top-notch telecommunications everywhere, cities can help the disadvantaged level the playing field.

**Empowering a connected lifestyle.** Access to the Internet and mobile apps delivers an amazing body of human knowledge and connection, ranging from personal interests and hobbies to entertainment options, to job searching, to social media, to online courses and more. In developing countries around the world, mobile devices are now enabling people to have their first experiences with the Internet.

**Better ways to deliver services.** High-speed broadband creates a whole new way to deliver services. Government can deliver personalised

alerts and applications directly to residents’ smartphones. M2M solutions can be supported. Schools can make education available 24x7 to anyone with a computer or mobile device. Medical professionals can deliver advice and perform simple examinations remotely.

**Enabling safe e-transactions.** Many people have come to rely on online shopping and banking. Building a telecommunications infrastructure with solid cyber security makes citizens’ life more convenient and more secure. Enabling safe, easy online and mobile payments reduces the “friction” of the local economy, leading to higher sales and more jobs.

**Improving access to health and education.** Telecommunications is the bedrock for online education and telemedicine, enabling the delivery of these services above and beyond their traditional boundaries, and allowing health and education professionals to serve a far wider audience than ever before.

## Workability

**Enhancing mobility.** All over the world, mobile apps are helping people plan their routes, make better use of mass transit, and otherwise travel with greater convenience and speed and less congestion and pollution.

**Enabling telecommuting** Fast, reliable Internet access enables telecommuting, creating a more flexible and satisfying lifestyle while improving productivity.

### **Attracting business and investment.**

Broadband and high-speed Internet access are no longer a convenience, they are an economic and business requirement. Cities with superior telecommunications have an edge when courting business investment. This advantage was captured in a stunning 2011 study by the World Bank that found that GDP rises 1.3% for every 10% increase in broadband penetration. Similar effects have been found for mobile broadband.

Real estate developers and business owners consider a robust telecommunications infrastructure a requirement. A city’s attractiveness is directly related to its ability to offer the services that support growth and create competitive differentiation. What’s more, citywide telecommunications help attract investment to areas that would not otherwise see it, such as low-income inner-city neighbourhoods.

**Creating jobs.** A 2010 Communications Workers of America study found that every \$5 billion investment in broadband creates 100,000 direct jobs plus another 150,000 “spinoff” positions.



## Reducing the digital divide:

# NYC REIMAGINES COMMUNICATIONS WITH FAST, FREE MUNI WI-FI

Despite being one of the most advanced cities in the world, New York City has an antiquated and broken communications infrastructure with approximately 7,500 payphones located throughout its five boroughs. The city recognized an opportunity to utilise this real estate to transform NYC into a smart city platform to provide services and bridge the digital divide by making Wi-Fi more accessible to its citizens as well as its visitors, and help creating connected communities.

To turn this vision into a reality, the city awarded a contract to CityBridge, a consortium of leading experts in technology, advertising and user experience that includes Council member Qualcomm to create LinkNYC.

LinkNYC will be the world's largest and fastest free municipal Wi-Fi network, offering up to gigabit speeds and paid for by advertising.

These state-of-the-art kiosks, called Links, will not only provide wireless connectivity throughout the boroughs, they will also provide free national calls, touchscreen Web browsing, rapid charging stations and access to city services. The installation began in December 2015. However, this is just the beginning — LinkNYC will also provide an open platform that businesses, academic institutions and municipalities can utilise to produce original content and apps that can spur a new generation of data-centric startups, or to tap into information to help steer public policy.

To ensure that it stays at the forefront, the LinkNYC network will support both hardware and software updates over time. Additionally, through advertising screens located on certain Links, the city will generate more than \$500 million over the next 12 years. LinkNYC will usher in a new generation of technology and set the standard for urban connectivity globally.



## Reducing the digital divide:

*New York City is leveraging advertising revenues to bring new digital infrastructure to citizens. Additionally, through advertising screens located on certain Links, the city will generate more than \$500 million over the next 12 years.*



## Sustainability

### Reducing the need for transportation

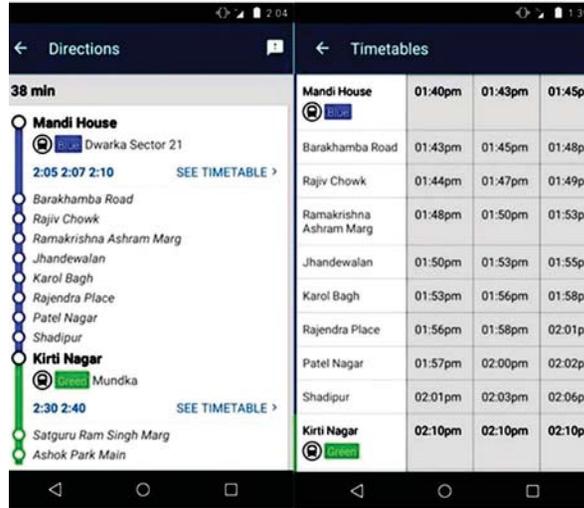
Advanced telecommunications enables video-conferencing, telecommuting, telemedicine and online education — all things that lessen the need for lengthy commutes that pollute the air and prolong our dependence on fossil fuels.

**Getting more from existing assets.** When expensive equipment — transformers, pumps, power plants, power lines — can be remotely monitored, it can be pushed to its maximum capacity without fear of overload. By the same token, its actual condition can be monitored so that repairs can be made before the equipment fails, thereby extending its life.

**Reducing energy and water use** Smart grids need to connect their embedded devices to technicians and control centres if they are to succeed and reduce resource waste — and they rely on telecommunications for this service. Likewise, telecommunications enables smart buildings to report their conditions and optimise their systems to use as little water and power as possible.

### Enhancing mobility:

*It can be challenging to use public transport, especially if riders don't know which bus to take and when the bus is going to arrive. Delhi Public Transport Offline app by Google is designed to help people navigate their way around the capital's public transportation system even without an active Internet connection. The app is free to install and use, and supports DMRC Metro, DTC bus, Gurgaon Rapid Metro, as well as DIMTS Orange buses.*



**Helping people boost their professional skills.** Expanded access to broadband gives people better access to online professional training programs, online tertiary education and city employment services.

**Increasing business access to the global economy.** A smart telecommunications network allows local businesses to gain access to national and international markets, and for rural areas to connect to the world economy.

Getting more from existing assets:

## MANAGEMENT FRAMEWORK HELPS IN SERVING RELIABLE POWER SUPPLY FOR MUMBAI

**T**ATA Power, India's largest integrated power company, serving more than 500,000 residential and industrial customers, has its own fibre optic-based communication network across Mumbai for data, voice, tele-protection services, and corporate WAN services. With the growth in capacity of Tata's power network, the existing network of 100 Mbps was not capable of meeting increasing demand and did not had provisions to protect the network against link and switch failures, resulting in huge revenue losses.

Tata Power deployed a highly resilient solution from Council member Allied Telesis, based on two-tier network design that ensured higher availability, resiliency and greater scalability. With Allied Telesis, Tata Power created a centralised monitoring and control of transmission and distribution network that effectively utilises assets and efficiently serves customers.

Allied Telesis Management Framework (AMF) is a sophisticated suite of protocols and management tools designed to simplify network management. The total cost of ownership is minimised with high-value products and easier to maintain technologies — resulting in low daily operating costs.

Dual load-sharing power supplies and the virtual chassis cluster connected 21 power stations, the main control centre, and the backup control centre ensuring active-active switch redundancy and link redundancy. The redundant links and equal-cost path routing provide the restoration of all voice, data, automation SCADA traffic flows in less than a sub-second, in the event of either a link or node failure without having to wait for a routing protocol convergence. Now, Tata Power can effectively serve uninterrupted reliable power supply to Mumbai's growing needs.

 **Getting more from existing assets:**

*The redundant links and equal-cost path routing provide the restoration of all voice, data, automation SCADA traffic flows in less than a sub-second, in the event of either a link or node failure without having to wait for a routing protocol convergence.*



### **Ensure ubiquitous broadband access:**

*Smart cities ensure best-of-breed, high-speed broadband access across their geography to all or most buildings.*

smart cities around the world are implementing solutions and progressing by taking all citizens along, irrespective of class differences, and catering to everyone's need equally.

**Formulate citizen reporting framework for outcome thinking** To bridge this digital divide inclusively is huge and much more difficult of a leap with socioeconomic conditions in India. However, success examples in India and around the world show that citizen participation, the users of telecommunications, is often the best source of ideas to inspire intelligent solutions. Creating frameworks and platforms via smartphones and social media, the much larger spectrum of citizens can be empowered to contribute to idea creation as well as take advantage of other responsibilities from digitalization.

**Achieve citizen engagement.** The two-way interaction between the citizens and the city at all stages of the policy or project development ensures cross-pollination of ideas and better inclusive solutions. 'Think tanks', cross-disciplinary teams in non-profit organisations or educational research centres, are an extremely fecund source of innovative and revolutionary ideas, and with the collaboration with the city and leading technology companies, can develop innovative citizen-centric solutions.

## Telecommunications targets

To this point, we've defined telecommunications and discussed its importance. Now we'll discuss the specific targets that will allow a city to enjoy benefits like those described above.

## Inclusivity

The Indian telecommunications space is showing tremendous growth opportunity. However, there is a huge leap to take to bridge the 'digital divide' and provide quality

digital access for citizens and businesses to city responsibilities such as health, education, finance, government services to improve quality of life and working environment.

**Achieve accessibility optimisation.** City projects need to be designed by taking a citizen-centric approach, and one has to be careful as to not widen the already present huge gap between economic sectors.

By providing and ensuring first-class telecommunications, including high-speed connectivity everywhere, the cities can provide superior opportunities for its citizens to contribute to their own advancement as well as the city's economic growth.



**Achieve accessibility optimisation:**

## **SAN DIEGO CAMPUS BECOMES SMART WITH INTELLIGENT CONNECTIVITY**

**A** company campus site can be viewed as a mini-city — with many of the same challenges in areas such as lighting, energy, waste management, water usage, security surveillance, parking, and employee (or citizen) engagement. Therefore, as Smart Council member Qualcomm Technologies, Inc. develops smart city solutions for the market, it is using its own campus in San Diego as a test bed to drive increased resource efficiencies and demonstrate real value.

Qualcomm looked at its campus of over 40 buildings in San Diego and selected six to be used as the test bed for the project. These buildings, built between 1980s and 2015, include parking structures, offices, labs and research spaces covering almost 1 million sq ft. Existing infrastructure, including water, waste, power and HVAC systems were being monitored manually, were “siloesd” from each other and also used incompatible

management software. This approach was not optimal and resulted in resource inefficiencies, lower response times and increased operational expenses.

In order to increase efficiency in such an environment, it is crucial to gather real-time data — this data will be the source for analysis and then insight. Therefore, for any such smart city or campus project, the first step is always to deploy intelligent connectivity solutions to enable the collection of real-time data.

Qualcomm Technologies deployed a campus-wide connectivity foundation, utilising over 10 solution providers, and deploying smart sensors to collect data from water, power, waste and Central Heating Ventilation and Air-Conditioning (HVAC) systems as well as retrofitted new smarter, connected products across the campus.



**Achieve accessibility optimisation:**

*Qualcomm Technologies deployed a campus-wide connectivity foundation, deploying smart sensors to collect data from water, power, waste and HVAC systems as well as retrofitted new smarter, connected products across the campus.*

## Collaborativity

### **Pursue multilateral collaboration.**

Achieving smart telecommunication is a huge collaborative effort across public-private sectors, and smart cities employ competitive ingenuity of a multi-disciplinary private sector — from leading technology companies to start-ups — to improve public services and bridge the digital divide.

## Governance

**Ensure new supportive policies.** Mobile broadband give an unprecedented opportunity for the city to empower its citizens. In order to support this digitisation, smart cities devise and implement policies to promote healthy competition for widespread affordable adoption of technology.

The successful examples prove that by opening up spectrum space, revamping the auctions and making sure the costs are affordable, and creating harmonised, supportive regulation across the country, Indian cities can bridge the gap.

## Instrumentation and control

We use the term “smart cities” but they are also referred to as “digital cities.” And for good reason, as you’ll see in this section, where we introduce the two telecommunications-specific targets — broadband access and citywide wireless.

**Ensure ubiquitous high-speed broadband access.** This is the first target exclusive to the telecommunications responsibility. Smart cities ensure best-of-breed, high-speed broadband access across their geography to all or most buildings. Since cities have different legacy investments and circumstances, and because technology will change rapidly in 20 years, we cannot make a definitive technical.

**Ensure a citywide wireless network.** This is the second and final target unique to telecommunications. A citywide wireless network ensures that people — whether at work, at play or otherwise on the go — are not tethered to stationary points of Internet access. A cellular or Wi-Fi network empowers a city and everyone in it, creating competitive advantage and convenience.

Local-area wireless networks relying on unlicensed spectrum (i.e., Wi-Fi) cannot be

guaranteed to deliver this service reliably and in 100% of the areas needed. The optimal solution would be 3G/4G operator-managed networks (operating in licensed spectrum), likely augmented by Wi-Fi and in the future, small cells, to handle more data in high-usage areas. Because cities have several technology choices, most will want to work with private providers to identify the solution(s) right for them.

Citywide public wireless has been a luxury until recently. But we are seeing evidence that it is gradually becoming a must-have, at least for those cities that hope to attract high-income technology professionals. For instance, Austin, Texas in the spring of 2013 hammered out an agreement to deploy an ultra-high-speed Google Fibre network and later announced that a significant Wi-Fi network would hook into it. The city of Vancouver, B.C. began deploying a citywide wireless network as outlined in its 2013 Digital Strategy, which calls wireless access “a fundamental aspect of any digital city” and one that “is expected by citizens.” And many cities are using mobile/cellular, including LTE, to ensure citywide coverage. Going forward, citywide wireless access is likely to be heterogeneous — that is, citizens and businesses will access a variety of wireless technologies in both licensed and unlicensed bands to get the best experiences.



Ensure high-speed broadband access:

## ROBUST LE COMMUNICATIONS HELP AMSTERDAM COMPETE

**A**msterdam, the financial and cultural capital of the Netherlands, strives to be one of Europe's greenest, most sustainable cities while continuing to maintain economic growth. Over the past decade, the city has developed a plan for collaborating, envisioning, developing and testing connected solutions that could pave the way to a smarter, greener urban environment.

It teamed with numerous public-private partnerships to create the platforms and services needed to help achieve its goals. SmartCities Amsterdam is the public-private organisation that oversees projects with more than 70 partners, including Council member Cisco and many other organisations.

"Broadband is the essential infrastructure for SmartCities projects," says Maaïke Osieck,

Communications Lead for SmartCities Amsterdam. "From connected buildings, to fibre to the home for residential service delivery, Cisco routing and switching solutions power the core network and aggregation capabilities that underlie projects designed to improve sustainable living and working, public spaces and mobility." Those solutions adhere to IPv7.

Amsterdam's vision evolved into a Cisco Smart+Connected Communities initiative to transform into a connected community. Its vision is wide-ranging, aiming to provide services for connected real estate, government services, utilities, transportation and healthcare. Teaming with a large ecosystem of private and commercial partners, Amsterdam deployed a citywide network that forms a strong foundation for the delivery of smart services and a wide-open marketplace supporting economic growth.

 Ensure high-speed broadband access:

*Amsterdam has worked with Cisco and other companies to achieve broadband access throughout the city. As a result, says one official, Amsterdam has "a wide-open marketplace for innovative services and economic growth, as well as a fast track for the smarter and cheaper delivery of healthcare, education and other public services."*

A citywide broadband network creates the foundation. Initiated in 2008, the network originally connected 40,000 households and small businesses through fibre to the home. Three years later, 140,000 homes and businesses had been connected and the city continues to deploy fibre across all areas of the city.

With widespread connectivity in place, the city and Cisco created a foundation to develop Smart Work Centres, which are sustainable work environments designed to deliver information to users, no matter where they choose to work. Located near residential communities, they help reduce or eliminate commuting while enabling workers to access their

full corporate resources. Space can be rented by anyone from sole proprietors to multinational corporations. Workers have access to office space, meeting rooms, broadband connectivity, and Cisco TelePresence collaboration systems.

“This robust broadband foundation enables our city to compete with other European cities,” says Frans-Anton Vermast, Advisor, Public and International Affairs, Physical Planning Department, City of Amsterdam. “In this way, we help ensure a wide open marketplace for innovative services and economic growth, as well as a fast track for the smarter and cheaper delivery of healthcare, education and other public services.

## Connectivity

So far we’ve talked about the telecommunications responsibility — how telecommunication can empower a smart city and its residents. In this section, we highlight how connectivity acts as an enabler of smart cities.

**Connect all devices with a citywide, multi-service communications system (s)** This universal target deserves additional discussion as it applies to telecommunications.

Earlier we discussed the importance of high-speed access and citywide wireless. For connectivity purposes — connecting sensors, switches and devices — it is not strictly

necessary to have either one. In theory, connectivity can be accomplished with low-speed wire line technology. Many electric power utilities, for instance, use low-speed power line technology to talk to their smart meters and sensors.

Regardless of the telecommunications technology you choose for device connectivity, strive to make it a “multi-service” network. That is, try to use it for a variety of purposes across different city departments. If each department stands up its own special-purpose network, your city will spend far more than needed. What’s more, it will have a harder time managing and maintaining all those disparate networks. And a harder time passing data back and forth between departments. In fact, the services architecture layer should be

abstracted from the underlying access network technologies. This enables the network to be continually upgraded with less disruption of the service layer.

The clear trend worldwide is to move away from slow, single-purpose communications to fast, multi-service networks. This implies that you may be able to achieve device connectivity by using a high-capacity network that is already in place — be it cellular/mobile 3G or 4G-LTE, Wi-Fi or other solutions like RF mesh, though data rates vary dramatically. You should identify which technology makes the most sense for your city according to your performance and cost requirements, and your circumstances.

Connect devices with a multi-service communications system:

## LEICESTER CITY MAKES SIGNIFICANT SAVINGS WITH UNIFIED COMMUNICATIONS

Leicester City Council provides universal public services to the largest city in the East Midlands, UK, with a population of more than 300,000. Faced with the challenge of funding cuts, rising customer expectations and having to move premises, the council embarked on a business transformation strategy. It needed to take control of its data, enhance customer experience, and modernize its ICT infrastructure to support flexible, collaborative working.

As part of this modernization program the council looked to replace its Novell email, diary and file and print solution, along with its existing private branch exchange (PBX) telephone system, supporting more than 8,000 unique numbers.

It deployed a solution using Council member Microsoft's desktop, server, collaboration, unified communications, business intelligence and mapping technologies – replacing the Novell systems with a Microsoft platform.

As a result, efficiencies have been achieved across the council through the adoption of new ways of working and the migration to Microsoft technology. Having documents in electronic format has helped staff access key information quickly and securely, resulting in better service productivity, improved decision making and increased staff sense of worth. The council's carbon footprint has been reduced through green ICT and collaboration with other agencies has been enhanced through better data management.

 **Connect devices with a multi-service communications system:**

*The Leicester City Council's business transformation strategy included Microsoft desktop, server, collaboration, unified communications, business intelligence and mapping technologies.*

The data captured from these sensors and other edge devices has given Qualcomm a more granular view of system usage, including real-time data for situational awareness as well as historical data from the buildings, to labs, to the water pumps across campus. This data is analysed and acted upon by an algorithm developed by Qualcomm to drive efficiencies and reduce operational expenses.

Using this data from sensors across the campus, Qualcomm's goal is to reduce operational expenses by 8-10%, while increasing efficiencies by 10-15%, in the first phase of deployment.

If you are approaching device connectivity for the first time, then your technical team must take a hard look at two aspects: bandwidth and latency. Bandwidth is the amount of data that can flow through at one time (just as the width of a pipe determines how much water can flow through). Latency is the time lag to get data back and forth. A network can be high bandwidth (lots of data at the same time) but also high latency (a slow round trip). Or vice versa.

Your technical team must carefully determine your bandwidth and latency requirements. For instance, a network for monitoring streetlights may be able to get by with high latency (a slow round trip). After all, it doesn't really matter if a light turns on or off a few seconds late. But a network for monitoring electric power substations may need very low latency (a fast round trip). That network must be able to send and receive signals very rapidly so that it can prevent a small outage from cascading to a big blackout. Whatever your current requirements, try to leave headroom for future growth. At the

very least, make sure that the products you choose are "future-friendly" — are capable of expansion when the time comes.

In the early days of the smart grid, for instance, some pioneering utilities selected underpowered connectivity solutions in the hopes of saving money. But they spent more money in the long run. Many of them had to go back and upgrade their initial network a few years later. Others had to put in a new system parallel to the old one to get enough capacity. If you build it, they will come, so build in as much extra capacity as your budget allows.

## Interoperability

Telecommunications networks are major expenditures that cities must get right. These interoperability targets ensure that the systems you use will not strand you with a dead-end system, or tie you to a single vendor.

**Adhere to open standards.** By insisting on open standards, cities increase choice and decrease cost, as products can be mixed and matched from different vendors. Telecommunications has dozens of relevant standards, but the most important is IPv6 (Internet Protocol version 6), since IPv6 has the huge address space required to accommodate the millions of devices that will ultimately connect to the network. In addition to building the core architecture around IPv6, cities should adhere to published standards from accredited groups such as IEEE, Wi-Fi Alliance, IEC, 3GPP and the ITU.

Cities can get ahead by leveraging standards that have global scale and interoperability, with strong vendor base and widespread demand. If the standards don't meet cities' requirements, city telecommunications experts can join standards organisations to ensure their particular requirements help shape the standards development.

### **Prioritise the use of legacy investments.**

Every city wants to wring maximum value out of its technology investments. If there are ways to use existing assets in the build-out of a telecommunications network, it will save money for other purposes and reduce the number of stranded assets.

During the dot-com bubble, many different companies built optical fibre networks, each hoping to corner the market. However, the advent of a technique called “wavelength-division multiplexing” increased the capacity of a single fibre by a factor of 100. As a result, the value of those networks collapsed. The misfortune of those companies means that many cities have miles of “dark fibre” under the streets — fibre that can be repurposed at a fraction of its original cost.

Longmont, Colorado, for example, located and repurposed an 18-mile fibre optic loop that was installed in 1997 for \$1.1 million by a local power company. It was abandoned after an early partner in the broadband venture went bankrupt. Finding and repurposing fibre can

save cities millions in installation costs while re-invigorating the local economy.



## Privacy and security

For all of the benefits that broadband and wireless technologies provide, there are important privacy and security considerations that need to be addressed. In particular:

**Create a security framework** This universal target is especially important to telecommunications, since the telecommunications network is one of the “access points” for cyber criminals. There is no point in hardening the rest of the city if the telecommunications system has its door unlocked. Your citywide security framework should explicitly lay out minimum security standards for any telecommunications network it employs.



### **Prioritize the use of legacy investments:**

*Longmont, Colorado has repurposed a fiber optic loop abandoned in 1997. Cities can often find ways to reduce costs by using existing assets to build out their telecommunications networks.*

**Implement cyber security** The same is true for this universal target. More the telecommunications, the more is the vulnerability to cyber-attack. Insisting on cyber security measures early on maximises protection while minimising costs.

## Computing resources

An advanced telecommunications system that includes high-speed broadband and citywide wireless not only makes it easier for city residents and businesses to access the Internet anytime from anywhere — it also enables these important targets.

**Have access to a central GIS** The point of citywide wireless is to empower residents as they move about the city. Once they are mobile, they will of course want access to global positioning and geographic information. For instance, city employees will want the ability to see field assets on a map with descriptions — traffic signals, streetlights, water mains, park facilities, etc.

**Have access to comprehensive network and device management** Once a city has high-speed access and citywide wireless, the number of connected devices will skyrocket. You will need device management software

to provision and manage those devices. Departments with maintenance operations will need to manage mobile phones, tablets and laptops connected to the network. Municipal power and water utilities may need to monitor and manage thousands or even millions of smart meters and sensors. Likewise, if the city operates any telecommunications networks of its own, it will need network management software.

For instance, some municipal electric power utilities seek “hybrid” management software that can oversee multiple networks from a single console. (Many utilities have multiple networks in place side-by-side). And don’t forget the importance of a comprehensive device management program to enforce compliance with city data management, security and privacy policies. Partnering with suppliers, operators and service providers is the typical path to get access to network and device management.

## Analytics

We mentioned in an earlier chapter how smartphones create the equivalent of sensors that collect and broadcast data over telecommunications networks. These add to the data stream that cities can use to analyse

patterns and trends and improve city services.

One of the universal targets for analytics deserves additional discussion in the context of telecommunications.

**Achieve asset optimisation.** This universal target refers primarily to the use of sophisticated software to a) run equipment to capacity while still staying safe and b) predicting when expensive equipment will need repair and c) calculating which equipment is most critical to prioritise replacements and upgrades. When it comes to telecommunications, it can also refer to a “manual” process — namely, the idea of multi-service networks — using a single telecommunications network for multiple purposes to extract maximum value from your investment.



Have access to comprehensive network and device management:

## NAGAHAMA CITY SIMPLIFIES NETWORK MANAGEMENT, WHILE REDUCING ICT COSTS

**N**agahama City is located in the Shiga Prefecture of Japan. In 2006, Nagahama City, Asai Town and Biwa Town were merged into one city. Then in 2010, the city merged with a further six municipalities. All of these now form the current Nagahama City.

As Nagahama City has expanded the scope of its ICT systems through repeated mergers, their employees have experienced a number of challenges. The city deliberately operated separate backbone, information and Voice over Internet Protocol (VoIP) networks, for security reasons.

Though this setup was effective for security, it was relatively costly because different sets of network equipment were needed for each of the three networks.

To reduce ICT costs, simplify network operation and management, and build a long-lasting, stable ICT infrastructure, the city leaders wanted to converge their information and IP Telephony (VoIP) systems onto a single network.

The city chose Allied Telesis to provide its new network solution. Their converged network has been constructed from Allied Telesis Management Framework (AMF) capable switches.

Utilising AMF greatly reduces the city's network operation and management workload, by automating switch configuration and consolidating network management.

 Have access to comprehensive network and device management:

*An added advantage of the high bandwidth LAN is that broadcasts of city council committee meetings, which have been provided for some time via an online video and streaming website, are now running smoothly as live feeds with no interruption.*

# ISO 37120: A yardstick for measuring city performance



In 2014, the International Organisation for Standards announced an ISO standard that applies strictly to city performance. The document-- known as

ISO 37120:2014 --establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right we have indicated how the standard related to Water and Sanitation and the one on Wasterwater correspond with the Council’s Water and Wastewater targets on the next page. The ISO smart city wastewater standard attempts to capture all the risk to the water supply with five core indicators designed to measure the availability of wastewater treatment, the number of people who have access to it and the quality of the treatment.

## Telecommunications and Innovation Indicators

			Ensure ubquit ous boardband access	Ensure a citywide wireless network	City-wide, multi-service communication
<b>Core</b>	17.1	Number of internet connections per 100,000 population	●	●	●
	17.2	Number of cell phone connections per 100,000 population			●
<b>Supt.</b>	17.3	Number of landline phone connections per 100,000 population			●

# TELECOMMUNICATIONS TARGETS

In the checklist below, targets specifically pertaining to the telecommunications responsibility are in **bold**, universal targets are not.

	Enabler	Telecommunications Targets How smart cities deploy and use ICT to enhance their telecommunications	Implementation Progress			
			None	Partial	Over 50%	Complete
Human	<b>Inclusivity</b>	Achieve accessibility optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate citizen reporting framework for outcome thinking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	<b>Collaborativity</b>	Achieve citizen engagement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Create institutional framework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Governance</b>	Pursue multilateral collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Achieve existing infrastructure optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate new supporting policy frameworks and regulatory mandates	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# TELECOMMUNICATIONS TARGETS

In the checklist below, targets specifically pertaining to the telecommunications responsibility are in **bold**, universal targets are not.

Technology	Enabler	Telecommunications Targets	Implementation Progress			
		How smart cities deploy and use ICT to enhance their telecommunications	None	Partial	Over 50%	Complete
	<b>Instrumentation and Control</b>	Implement optimal instrumentation <b>Ensure ubiquitous high-speed broadband access</b> <b>Ensure a citywide wireless network</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Connectivity</b>	Connect devices with citywide, multi-service communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Interoperability</b>	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritise use of legacy investments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Security and Privacy</b>	Publish privacy rules Create a security framework Implement cyber security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Data Management</b>	Create a citywide data management, transparency and sharing policy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Computing Resources</b>	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Analytics</b>	Achieve full situational awareness Achieve operational optimisation Achieve asset optimisation Pursue predictive analytics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



# 8

## Transportation

**Mobility is a key driver of economic growth, as well as and societal redevelopment. Rapid urbanisation, surging pace of living and rising lucrative employment opportunities has made urban cities the centre of economic grown in India. Urban transportation is highly complex due to the interaction between multiple modes, the multitude of origins and destinations, and the quantum and variety of traffic. Innovative and ICT-driven mobility solutions help in providing smart and efficient transport options as well as reducing traffic congestion and environmental degradation to achieve smarter mobility.**



Urban population in Indian cities has been growing at an alarming rate as a result of unprecedented population growth and unchecked mass-migration to cities due to increasing lucrative employment opportunities. By 2031, cities will account for nearly 70% of India's GDP and around 600 million people are expected to live in India's cities, according to the World Bank.

As Indian cities continue to expand, infrastructure growth is unable to keep pace with urbanisation. Lack of adequate, safe and quality public transportation, overloaded road network, ineffective traffic management, safety concerns, poor road conditions, parking issues, lack of amenities for 'non-vehicular traffic' such as walkways, bike paths and , bike parking are the key issues that most cities face today.

Currently mass transportation in Indian cities is primarily by roads. Except for rail-based transport – Electric Multiple Unit suburban trains and metro rails in the metropolitan cities of Mumbai, Kolkata, Chennai, Delhi and Bangalore, buses are almost the only means of public transport in the country. Even with rapid transit infrastructure development in the last decade, only about 20 Indian cities with populations over 500,000 have any kind of organised public transport systems. The share of public transport in large Indian cities actually declined from around 70% in 1994 to almost 40% in 2007, as per the World Bank.

## Growing urbanisation drives changes:

*By 2031, cities will account for nearly 70% of India's GDP and about 600 million people are expected to live in India's cities, according to World Bank. Even with rapid transit infrastructure development in last decade, only about 20 Indian cities with populations over 500,000 have any kind of organised public transport systems.*

**R**apid urbanisation experienced in recent decades, particularly in developing economies, has placed a huge burden on public administrations to finance and build urban infrastructure including roads, transit systems and public utilities. Though, we are going to focus on transport systems that move people around, these systems are connected or share resources with goods, services and information accessibility.

## Urban Transportation

By 2050, urban mobility infrastructure is expected to triple; consequently, the average time spent in traffic jams will be three times more than today.

Rising per capita income has resulted in a steep rise in passenger car and two-wheeler growth, which currently account for more than 80% of the vehicle population, largely concentrated in major cities.

By 2025, the motorisation rate in India is predicted to grow at 12.5%, surpassing all countries including China, according to an ET bureau report. Roads are a common property resource, and people are free to use them with little restriction. Car-driven infrastructure needs about 40 times more space per person than buses. Space for car parking is an additional need and most under-utilised resource, and so does the private cars, being idle for 90% of the time, by some accounts.

Furthermore, ultra-urban traffic congestion is associated with high opportunity costs. Currently, urban transport is the single largest source of transport-related carbon emissions and local source of urban atmospheric pollution. High operating costs associated with extensive personalised mode use are further associated with extra traveling time and loss of productivity. These financial and welfare costs to cities and citizens can be substantial.

According to a study conducted by the IIM and Transport Corporation of India in 2012, India faces a loss of Rs 600bn (\$10.8bn) a year due to congestion, and slow speed and waiting time at toll plazas.



Opportunely, smart urban transport infrastructure generates massive capital cost savings and reduces pollution, as a result of a shift away from private car infrastructure towards public transport, walking and cycling. Adequate, efficient and cost-effective transport system permits cities and towns to become catalysts for economic, social and human development.

In the pages that follow we'll see the key drivers of smart transportation, the benefits it brings and strategies to choose. Then we will talk about the targets that cities need to achieve to put smart transportation in top gear.



### **The promise of smart transportation:**

*According to study conducted by the Transport Corporation of India and IIM in 2012, India faces a loss of Rs 600bn (\$10.8bn) a year due to congestion, and slow speed and waiting time at toll plazas.*

## Why make transportation systems Smart?

Mobility and congestion are challenges for almost every city around the world. With increasing pace of urban migration, most of the cities in India are not just falling short of best practices, but in a state of crisis. Smart cities use information and communications technology (ICT) to achieve available, safer, sustainable, faster and effective transportation systems. Smart and sustainable transport is driven by multiple issues, including:

**Urban complexities.** Urban transport not only involves various modes of transport systems, but also co-produces accessibility jointly with spatial development. Surging urban population and escalating pace of living are exerting increasing pressure on decades-old physical infrastructure in most large cities.

**Environmental degradation.** Significant and increasing proportion of transport pollution emission is by high carbon and energy-intensive and mostly fossil-fuel based private motorised vehicles. Around 80% of the increase in global transport emissions since 1970 has been due to road vehicles. Last year, a report by the World Health Organisation showed that 13 of the top 20 most polluted cities (from 1,600 cities) in the world are in India. In fact, Delhi is the world's most polluted

city with highest concentration of PM 2.5 — particulate matters less than 2.5 microns. Such high levels of air pollution can cause serious health problems and even fatalities.

**Lock-in.** Land-use and transportation infrastructure changes at a much slower pace than lifestyles and technology. Long-range plans and huge capital investment creates significant lock-in effect. Lock-in occurs at both at strategic planning and implementation levels. The long span between planning to execution leads to cost overruns and inflexibility of alternatives.

**Safety.** India's mobility accidents and fatality rates are among the highest in the world, around 3% of the country's GDP by government estimation, mainly affecting the poor and vulnerable. Female safety concerns are another key issue related to public transport.

**Absence of vision.** Development of urban infrastructure is often driven by certain shareholder conflicts or interest groups, without formulating a sustainable vision for the mobility concept. For instance, the proposed coastal highway for Mumbai is biased towards isolated individual vehicle-driven mobility, which will affect spatial, ecological and cultural equilibrium, and in turn leads to a change-inhibiting attitude.

## Interconnectedness assessment

Planning improvement in the city's transportation infrastructure and services cannot be undertaken without understanding the interdependencies, such as built environment, energy, telecommunication, safety and health, to name a few.

Each city has developed its own unique spatial structures and transportation modes to provide access to people, goods, services and information. Transportation and the built environment have overlapping elements — roads, rails and ports are typically essential components of a smart transportation system — but can also represent massive construction investments. City densities, level of mixed-use and centralisation also considerably impacts transport systems.

Any mode of smart transportation needs energy, in some form, and communications systems for effective functioning within the system. Smart payment systems and public safety measures make smart transportation more effective.

On the other hand, smart transportation results in decreasing congestion and CO2 emission and improves water and health.

## Smart solutions by integrating innovative concepts and technology

Promoting and expanding smart mobility ecosystems require rethinking of transportation investments, focusing on moving commuters as efficiently as possible through multiple modes of transport. Innovative concepts and technologies together can solve most of the challenges by improving efficiency and resilience of transportation systems, while minimising the need to upgrade and expand the physical infrastructure and reducing per capita vehicles-miles travelled. Smart solutions in transport, infrastructure, traffic management and information and payment systems together can help in creating people-oriented, intelligent transportation in at least 10 ways:

**1. Build resilient, safer and affordable public transportation.** A comprehensive sustainable mobility vision and focused implementation create a formally organised public transport. Investments in absolutely-needed and well-planned mass transit systems, such as bus rapid transit (BRT), railways, metro, light rail, with investments digital systems such as GPS, IVR and intelligent data exchange, achieve efficiency, high-travel speed and higher safety standards.

**2. Create integrated multimodal transportation:** An alternative to roadway expansion, well-connected multimodal transportation system coordinates for speedy, safe, economic and convenient travel, provide an efficient solution to manage growing transportation demand. Seamless connectivity with various transit modes within a trip channel, such as walking, cycling, automobile and public transit provides increased capacity, enhanced accessibility and minimised waiting time.



### **Build resilient, safer and affordable public transportation:**

*A comprehensive sustainable mobility vision and focused implementation create a formally organised, efficient public transport. The image above shows Mumbai metro that opened in 2015.*

- **Facilitate infrastructure, operational and institutional integration.** Public transit systems are more user-friendly when connected with each other, physically and operationally, through multimodal hubs, transfer stations and non-motorised facilities. Using ICT to optimise transit resources, by jointly using facilities, equipment, parking and safety provisions of passengers, and coordinating services eliminates wasteful duplications.
  - **Integrate information sharing.** ICT helps in creating seamless connectivity through real-time information sharing interface and multimodal trip planning applications, and user devices such as smart phones. For instance, the SmartSantander app in the city of Santander provides residents with real time data on transit connectivity, road closures, parking, and bus delays.
  - **Enable unified fare systems.** Comprehensive, interconnected fare payment like smart single fare card with Web-based accessibility allows seamless access and payment across different modes. For instance, Mexico City, Mexico and Sao Paulo, Brazil are expanding the smart card payment systems for use on multiple modes, while the city of Chicago offers Chicago Card Plus IGO Smart Card that provides integrated access to public transport and car-sharing services.
  - **Improve first- and last-mile connectivity.** Developing 'non-automobile' infrastructure for safe walking and bicycling not only provides connectivity to mass transport but also reduces congestion. ICT creates real-time data integration and data sharing to give accurate situational data about traffic, weather, and pollution to allow riders to make informed decisions about choosing the optimal path. While space-efficient local shuttle buses and intermediate para-transit (IPT) such as shared rickshaw and taxies improve connectivity, park-n-ride services shorten car-trips.
- 3. Achieve asset optimization.** Rail automation, electrification solutions, and fully automated light rail vehicles can be flexibly adapted to passenger volume, thus making more efficient use of the existing infrastructure. Web-based platforms optimises car-sharing among co-workers and in finding commute partners from the existing network or even with strangers with matching preference.
  - 4. Empower innovative vehicle ownership.** Smart people are realising that it is too expensive and wasteful to own a vehicle, which would be left parked, by some accounts, 90% of the time. The arrival of four modes of alternative mobility: (1) on-demand ride services such as Uber and Ola; (2) real-time carpooling services like Zimride; (3) car-sharing via a system of third-party ownership such as Zoomcar and Car2Go (with more than 1 million members around the world) that allowed car renting by minute or hour; and (4) bicycle commuting and bike-sharing programs like city bikes are redefining vehicle ownership and are changing how people get around. Even availability of autonomous driving vehicles is in the near future, despite the high design costs and fast depreciation and high utilisation can make these shared, high-tech mobility cars economically compelling.
- 5. Initiate eco-friendly alternative energy transport vehicles.**
    - **Sustainable public transportation.** For instance, hybrid and electric buses and low-emission or even zero-emission fleets can be made more efficient with smart-charging infrastructure and solar powered lighting. The University of California at San Diego implemented an award-winning electrical vehicle (EV) program, with its fleet consisting of more than 50% hybrid and alternative-fuel vehicles. Shuttle buses use cleaner-burning ultra-low-sulphur diesel fuel. Council member OSISO's PI system can integrate with solar energy on parking structures to manage charging and supporting modeling.



Achieve asset optimisation:

## DATA MANAGEMENT HELPS BUILD SMARTER RAILROAD

India's youngest rail operator, Konkan Railway, connecting north and west with the southern part of India, covering total distance of 740 km along the Western Coast and Ghats, was facing growth management and safety problems due to hostile terrain and difficult weather conditions in Konkan.

Due to rail inaccessibility earlier, the route became quite popular from the day the first phase was opened in 1993. While managing a large network of passenger and freight trains resulting from rapid growth, Konkan Railway's primary goal was to improve commuters' safety and services, and replace redundant manual procedures with efficient solutions to bring greater operating efficiency.

To overcome the problems and lay the foundation for smarter railway transport, Konkan Railway leveraged Informix Dynamic Server solution from Council India member IBM. The software provided availability and cost-effective performance, requiring only two database administrators managing 66 database servers.

IBM developed 'Railway Application Package' (RAP) system, where real-time data is fed into the management system that uses smart analytics to respond to information in real time such as scheduling delays, abnormalities or passenger queries.

- **Improved services**, as the system offering a Web-based train location system, train-operations and ticketing management operations.
- **Reduced energy costs** by 20% by developing information-flow systems and analytics to manage timely air-circulation and platform lights automation.
- **Improved commuter safety** by significantly improving the ability to analyse, maintain and present data, helped in reducing the likelihood of passenger delays and cultivated better decision-making.
- **Minimised staff** for train management, collecting ticket revenue, etc., reduced supporting and IT costs.



**Achieve operational optimisation:**

*Reduced energy costs by 20% by developing information-flow systems and analytics, while significantly improving commuters safety.*



### Hybrid e-bikes:

*Ordinary bicycle transformed into hybrid e-bikes and mobile sensing units, mapping air and noise pollution levels, traffic congestion and road conditions in real-time to make better informed decisions.*

*Image: MIT*

systems make economic use of space and free up blocked spaces. Optimising existing infrastructure, such as creating parking under flyovers with systematic free-right-hand lanes can optimise urban space use.

- **Hybrid e-bikes.** Ordinary bicycles transformed into hybrid e-bikes and mobile sensing units, mapping air and noise pollution levels, traffic congestion and road conditions in real-time will make better informed decisions. For instance, Copenhagen Green Wheel, captures energy dissipated while cycling and braking and saves it when need a bit of boosting.
- **Electric and hybrid cars.** Renaissance of electric cars is the need of the hour in India. Smart cities are spending billions on spurring electric and hybrid vehicle infrastructure. Automobile manufacturers are being encouraged by city governments by developing supporting infrastructure such as charging stations, to invest in research and development to manufacture safe, energy-efficient, technologically advanced cars, trucks and buses.

6. **Traffic management and control.** Complexities of modern traffic can be significantly mitigated using real-time data and creative solutions. City and state governments around the world are investing in technology and engineering to develop dynamic, intelligent traffic management systems that interconnect roads and rails, while information systems help passengers find an efficient trip route. Public transport (buses and light rails) are given priority at traffic signals and dedicated lanes ensure speed and reliability — the two crucial factors for promoting public transport.
7. **Innovative parking system.** Unchecked, illegal parking creates traffic congestion on most of the interior roads. Multilayered integrated parking and use of digital technology to create intelligent parking

8. **Map and monitor transport and physical infrastructure.** Transportation administrations face an enormous challenge in keeping their infrastructure operating uninterrupted and efficiently. ICT gives a highly accurate picture of location and condition. Throughout the transport and infrastructure life-cycle, GIS technology helps create a seamless flow of information from one stage to the next.
9. **Formulate transportation assessment and planning** Transportation development requires careful prediction of demand-supply gap. GIS integrates factors such as land-use, housing and employment density to evaluate smart transportation-growth alternatives.
10. **Instigate land-management.** Integrate transit systems and land use in order to achieve high levels of non-motorised travel and transit use, reduced vehicle mileage, and shorter average trip length while providing a high level of accessibility.



Traffic management and control:

## PUBLIC TRANSPORT PRIORITY REDUCES TRIP TIME IN INDORE CITY

Indore, the financial hub and most populous city of Madhya Pradesh was facing huge challenges in traffic management, pressured by motor vehicles doubling in the last decade. One of the solutions, Indore BRTS, began operations in May 2013, carrying air-conditioned buses equipped with services like GPS and IVR running, over 22 km of a dedicated corridor.

Intersection delays are a key impediment to faster movement of buses. Giving buses priority over other road users at traffic signals ensures speed and reliability. The Indore BRTS employed a pan-corridor wireless traffic signal system (WiTrac), developed by a leading advanced computing centre. WiTrac signals are solar-powered and wireless, allowing rapid installation. The network is fitted with a camera-based vehicle actuated system that detects BRT vehicles and adjusts cycle times according to the traffic conditions.

TSP is an intelligent traffic signal system that takes external input, in the form of video or loop-based vehicle detectors, in order to identify the arrival of a bus at an intersection. This information is used to prioritise bus movement by expediting the green phase for buses alone at a signal.

For TSP at MR-9 intersection along the BRT corridor, the automated controller was set to detect traffic in the bus lane twice during each signal cycle. This resulted in saving around 25% of total trip time, about 10 minutes during every trip. Elongation of green for BRTS bus extended the red signal by 20 seconds for other traffic and showed negligible effect on overall working of the traffic signals. Significantly reduced intersection waiting time and integrated ticketing for BRT and existing city buses reduced the delays at intersections and minimised passenger trip times.

 Traffic management and control:

*TSP installed by Indore BRT was set to detect traffic in the bus lane twice during each signal cycle. This resulted in saving about 25% of total trip time, about 10 minutes during every trip.*



### Reducing traffic congestion and accidents:

*Parking can be made more efficient through instrumentation and mobile apps. 'Vertical Automatic Parking Lot' Chicago 1932. Original photo: British Pathe, Image: NY Daily News.*

## Benefits of smart urban transportation

Case studies clearly demonstrate the correlation between use of ITC and innovative mobility concepts, and transportation efficiency and effectiveness. Cities that promote high level of public transport use, cycling, bike and car sharing, along with smart mobility cards, do reduce travel time, fatal accidents and environmental impacts.

### Livability

#### Reducing traffic congestion and accidents.

Advanced analytics and instrumentation can provide cities with the information they need to minimise congestion. Traffic lights can be synchronised and adjusted for optimal traffic flow. In-vehicle collision-avoidance systems can take action to prevent congestion-causing accidents. Parking can be made more efficient through instrumentation and mobile apps.

**Reducing travel time.** With the help of analytics and ICT, traveller information systems and real-time route planning can plot multi-modal routes for travelers. Integrated transit systems direct people when and where to switch from a bus to the subway, to arrive at destinations at the fastest time. And traffic and weather alerts can be delivered via smartphone applications to alleviate commute times.

#### Lowering travel costs for citizens.

Innovative urban transport systems such as bus rapid transit (BRT) offer significant cost savings compared to traditional metro and regional rail at similar capacity levels and has been demonstrated to significantly reduce congestion related costs in numerous cities including Ahmedabad, Bogota, Lagos, Guangzhou and Johannesburg.



Reducing traffic congestion:

## BANGKOK MANAGES TRAFFIC WITH SMART NETWORK

**B**angkok is the capital, and largest city, of Thailand – a population of nine million, which in addition enjoys huge influx of visitors each year. With large volumes of public, private and traditional transportation – tuk-tuks (motorised rickshaws) using city roads, the Bangkok Metropolitan Administration was looking for ways to improve both efficiency and safety for commuters.

One key issue facing BMA was the size of the network required to provide sufficient real-time information around the city. It was imperative that the new network provide high availability, reliable speed, weather protection and ease of maintenance.

BMA chose Council member Allied Telesis solution to provide an IP video surveillance system, capable of providing real-time images and information from thousands of locations around Bangkok to BMA district offices. Excellent multicast features support streaming of a huge amount of real-time video feeds.

Under the 'Healthy City' development framework implementation, the 3000 IP camera surveillance network installed by BMA provides substantial and time-sensitive information where and when it's needed. The Allied Telesis advanced switching products provide high availability with features such as dual load-sharing, for maximum uptime.

Two key technologies at the network core and distribution layers ensures continuous access to critical real-time data ensures moment-by-moment decisions, along with contingency planning, to ease traffic congestion, speed up emergency response time and improve quality of travel around the city.

This integrated solution provides BMA with the unrestricted access to citywide information and videos, ease of management, and network performance, reliability and resilience, and helps BMA successfully manage the Bangkok transportation and traffic management system.



### Reducing traffic congestion:

This integrated solution provides BMA with the unrestricted access to citywide information and videos, ease of management, and network performance, reliability and resilience.



### **Empowering people with choice and control.**

Smart transportation gives people the power to make better transportation decisions. In smart cities, multimodal fare cards are used to pay for all forms of city transportation or parking. And data-gathering instrumentation and open data policies empower them with their own transportation information. People create ridesharing apps to optimally pair passengers and drivers, neighbourhood-specific parking and traffic maps, apps that publish wait times for parking lots and so on.

**Improving public safety.** Accurate and real-time information about accident locations frequently hold the key to improving safety for motorists, freight carriers, railways and

even pedestrians. Mobility is paramount for emergency responders, and ICT can assist them by optimising traffic lights when necessary and empowering them to see potential traffic problems in real time, so they can select the most efficient travel routes. GIS maps can display crash records paired with spatial analysis of congestion, construction zones and weather; combined with statistical and business intelligence tools, these maps can help pinpoint the root causes of accidents and determine effective counter-measures for the future.

With data exchange and real-time information, ICT can assist in improving female safety, both in public transport and ride-sharing.



### **Empowering people with choice and control:**

*Smart transportation gives people the power to make better transportation decisions.*

## **Workability**

### **Increasing cities' competitive advantage.**

The quality of a city's transportation infrastructure is a major factor in business and industry investment decisions. Business and industry often depend on reliable employee travel and/or transport of goods. Transportation networks that offer reliability are sought out.

### **Becoming more attractive to talent.**

Professionals, like businesses, consider mobility when deciding where to locate. Cities with efficient transport will see their businesses thrive, thereby increasing the tax and employment base.

## **Sustainability**

### **Reducing de-densification of cities.**

The non-integrated growth in transportation has adverse impacts on land-use, leading to sprawling private vehicles-oriented cities. Smart transportation leads to transit-oriented urban development (walkable, mixed-use) that can reduce per capita use of automobiles by 50% and household transport expenditure by 20%. Efficient, compact and cost-effective public transportation reduces the need for individualised motorised transport modes and prevents urban sprawls.



Becoming more attractive to talent:

## AUTOMATED ACCESS AND PARKING FOR MAGARPATTA

With huge infrastructure developed to cater to the needs of a number of IT companies, Cybercity Magarpatta in Pune needed an efficient parking management system. Multi-structured and busy parking lot operations, with multiple entry and exit points at both basement and podium level of Cybercity, posed significant challenges.

The parking area needed to be secure with barrier-enforced entry and exits. The city wanted to change its manual processes of colour-coded tokens for parking lot management. Streamlining personal and visitor access control were the other areas the Cybercity was looking to achieve.

Working with a leading technology-enabled IT solutions company in India, the Cybercity developed automated parking management and personnel access systems.

The automated parking management system for Magarpatta provided multiple immediate benefits. These were: ID card (RF) based entry to parking lots, display of company allotted available parking space at entry points based on real time transactions, separate readers for cars and two-wheelers, and automatic Boom Barrier movement based on availability and authentication. With RFID vehicle tracking system with high identification accuracy, Cybercity is able to manage its vehicles efficiently with low human intervention, and low deployment and operation costs, as well as provide easy access for drivers.

Access control featured solutions such as RF-based ID card and readers and turnstile entry/exit gates for employees, and photo ID cards and PC application-based registration for visitor management, automated the access control and tracking system.



Becoming more attractive to talent:

*Solutions such as RF-based ID card and readers and turnstile entry / exit gates for employees. While photo ID cards and PC application-based registration for visitor management.*



### **Reducing de-densification of cities:**

*Efficient, compact and cost-effective public transportation reduces need for individualised motorised transport modes and prevents urban sprawls.*

### **Reducing environmental degradation.**

Transport poses a dilemma in that it is necessary for economic and social development, yet it has very adverse effects on the environment such as air pollution, noise pollution, etc. The environmental effects of fossil-fuels like oil and petroleum products are of growing concern owing to increasing consumption levels. Smart technologies and practices can significantly reduce transportation's environmental impact. Traffic management creates a more efficient road network and reduces travel time and reduces vehicle emissions. And smart public transit is easier and more convenient, attracting more riders and reducing reliance on automobiles.

### **Lowering non-renewable resource use:**

Smart cities aim to reduce the use of fossil-fuel driven mobility and encourage various alternatives such as hybrid or low-emission public transport and electric vehicles, sourced from renewable energy sources, choosing them whenever possible for their own fleets and providing charging stations in public buildings.

### **Improving transportation budgets.**

Cities spend billions on their public transportation systems, and yet they are often inefficient, with capacity not in line with demand. Smart technologies unleash the savings and efficiency potential of transportation investments. For example, information from embedded smart devices can be analysed to determine subway system expansion needs with respect to highest transit priority, future demand needs - and then servicing that demand at the lowest cost.

Additionally, analytics can make the most out of expensive transportation assets. Sensors and monitors can report on the actual condition of infrastructure so that operators can make better decisions, servicing equipment based on actual condition and not on a guess. This kind of asset management can squeeze many extra years of use from an investment, improving return on investment, and all without compromising equipment or passenger safety.



Improving transportation budgets:

## AUCKLAND BOOSTS TRANSPORTATION SERVICES WITH CITIZEN-CENTRIC IT

**T**he antiquated, disjointed transportation system of one of the world’s most liveable cities, Auckland, New Zealand, was barely meeting the needs of the current population of 1.4 million citizens and would not be able to accommodate an expected doubling of the population by 2040. To accommodate the city’s growing ridership, the city needed to increase efficiency and capacity, while keeping costs down and maintaining a positive experience for residents.

Auckland Transport consolidated and standardised its core data centre infrastructure, using Council member Microsoft’s data centre, desktop, and cloud-based software. To manage complex capital projects such as the NZ\$2.4 billion City Rail Link, the agency teamed up with IT service provider LeapThought to implement Fulcrum, an end-to-end Microsoft SharePoint Server-based customisable digital solution.

By using Microsoft technology, Auckland Transport— 1) created a flexible, highly secure IT foundation for future citizen services delivery, 2) offered online, personalised citizen access to transportation services, such as filling bus cards online and reporting potholes from a smartphone, 3) empowered employees with modern, easy-to-learn tools that improve employee productivity, and 4) reduced cost by taking advantage of the existing technology and platform.

The cost savings after rolling out Fulcrum have been dramatic. Auckland Transport estimates quantifiable savings of \$3 million in the first 10 years — and it expects the savings to continue to grow as the solution is rolled out to 200+ launched capital projects — small or large projects. This has boosted efficiency, increased the use of public transportation, and made Auckland a better place to live.

 **Improving transportation budgets:**

*Auckland Transport estimates quantifiable savings of \$3 million in the first 10 years — and it expects the savings to continue to grow as the solution is rolled out to 200+ launched capital projects.*



To meet urban mobility challenges, cities need to implement one of the following three strategies dependent on their mobility system advancement and spatial development.

- 1. Optimise the system.** For cities that have some well-established transport modes, the aim must be to move towards creating an integrated travel system with entire travel value-chain with last minute connectivity, and improving any problem areas, such as safety and customer ease.
- 2. Redesign the system.** Cities that have high proportion of motorised individual transport need to fundamentally redesign their mobility systems and supporting infrastructure, emphasising on sustainable transport and walkability.
- 3. Formulate a sustainable system.** Cities that are starting to build organised transportation systems need to focus on establishing a sustainable transportation core, which can satisfy short-term demand at reasonable cost, without creating an individual motorised system that needs redesigning in the future.

### **Optimise the system:**

*For cities that have some well-established transport modes, the aim must be to move towards creating an integrated travel system with entire travel value-chain, and improving any problem areas, such as safety and customer ease.*

## Transportation strategies

Improving modal split from individual mobility-based system to public mobility-based system is becoming paramount. Cities that promote multimodal transport and land use patterns that support the high level of public transport use, and walking, cycling, bike and car sharing, automated single cards, non-fossil fuel based vehicles and new concepts of vehicle ownership as a part of an integrated mobility vision and strategy do reduce travel time, fatal accidents and environmental impact.



Improving transportation budgets:

## HELSINKI BUS FIRM CUTS FUEL USE, OFFERS IMPROVED TRANSPORT

Unlike some other major cities, Helsinki has a transportation system that is operated by multiple vendors rather than a single private company or municipal department. So although Helsingin Bussiliikenne Oy (HelB), a city owned bus company, must compete with privately owned bus operators in a public bidding system to serve the city's bus routes. As a result, HelB needs to find ways to lower costs and operate more efficiently to win business.

HelB worked with Council member Microsoft and technology partner CGI to extend its existing data warehouse system to collect and analyse data generated by sensors installed on all buses in the HelB fleet. These sensors generate more than four million lines of data each day, so it was important to have a highly scalable solution. A careful analysis of the bus sensor data has brought HelB numerous benefits:

- **Overall fuel consumption** across the bus fleet is down by 5%, reducing the city's carbon footprint
- **Customer satisfaction** among HelB riders has increased by 7%, based on biannual surveys conducted by the city
- **HelB monitors bus driver performance**, to improve their driving efficiency and safety
- **Sensor data about fuel consumption** and engine temperature helps HelB identify vehicles developing mechanical problems to proactively address issues

Further, HelB began a pilot project using Power Map for Excel to analyse and visualise sensor data in areas where emergency braking is most common. HelB can physically examine and find effective solutions.

### Improving transportation budgets:

*Sensor data about fuel consumption and engine temperature helps HelB identify vehicles developing mechanical problems to proactively address issues .*



### **Formulate citizen reporting framework:**

*Citizen participation helps in creating most needed data for transportation planning and route optimisation.*

## Transportation targets

We examined various technologies and best practices, and along with the universal targets, we have identified four transportation specific goals that allow cities to achieve these benefits highlighted earlier.

## Inclusivity

It is evident that those cities that actively and directly engage their residents by systematically addressing challenges deliver successful outcomes and create more resilient solutions for all.

**Achieve accessibility optimisation, both physical and Web accessibility.** Transparency and ease of accessibility is paramount to achieve smart transportation. For example, citizens of smart cities who had received a clear picture of their repeated carbon footprint reduction have been encouraged to implement more smart solutions, accruing mileage points to be redeemed for benefits including transport vouchers.

Smart mobility is user-friendly both in terms of infrastructure and web accessibility, allowing a 5-year-old and an 80-year-old to ride safely and conveniently. Informative and barrier-free environment helps all, senior citizens, families with kids, women, and children, apart from those with disabilities. Low-deck vehicle construction and aligned transit platforms not only allow easy street level boarding for passengers of all ages and abilities but also easy ensure optimal passenger flow. Taxibus, the Brussels-based STIB transport service providing on-demand door-to-door service, now offers online service via a dedicated

website — within a few days, the number of online bookings reached almost 30%.

**Formulate citizen reporting framework for outcome thinking.** Almost all smart cities have creatively developed proposals with involvement and inspiration from its citizens. Citizen participation helps in creating most needed data for transportation planning and route optimisation. Adopting an outward thinking approach, easy access to data, status reports, conscious communication enables more citizen-centric transportation solutions.

For instance, the interim infrastructure development plan for NAINA (the smart city being developed in Navi Mumbai) included 360 degree of public consultation. It received around 4,000 suggestion/objections from the local residents, which were discussed by the committee of national and international experts to formulate the projected transport infrastructure development plan.

**Achieve citizen engagement.** Cities that derive insights from both structured and unstructured data that is collected via different channels of engagements develop solutions that are resilient and provide accessibility to all. Citizen engagement of common citizens as well as transport planners and urban development experts assists in envisioning the smart city mobility vision and helps in co-creating smart cities initiatives.



Achieve accessibility optimisation:

## ISTANBUL PEDESTRIANISING STREETS TO IMPROVE PUBLIC MOBILITY

**T**he city of Istanbul is not only surrounded by water, it is also twice divided by it. Istanbul's car-dominated roads were dangerous for pedestrians and detrimental to the city's air quality. The centralised location and very narrow streets of the Historic Peninsula made the daily commuters travel across the city through constant traffic jams — the endless congestion making the city less accessible.

In 2010, Istanbul's Faith Municipality embraced people-oriented mobility and engaged in a robust public-private partnership to facilitate the 'pedestrianisation' project to improve and expand mobility options and create a more accessible and sustainable future to the Istanbul's Historic Peninsula.

Since 2011, Istanbul has pedestrianised 295 streets — through numerous infrastructure upgrades such as

subways, tramways and bus-only lanes, tunnels at bottleneck locations, and by making it easier for people to use trains, ferries, buses, and bicycles rather than cars.

The pedestrianised streets led to a strong perception that the initiative increased the accessibility by foot to other transport modes, and streets are safer from traffic crashes.

A survey of local students, residents, and business owners found that 80% of the local community feels safer and approves of the changes. Residents surveyed noted the changes improved the ease of commuting, made neighbourhoods quieter, improved air quality, as well as strengthened the attractiveness of historic buildings over 50%.



Achieve accessibility optimisation:

*The pedestrianised streets led to a strong perception that the initiative increased the accessibility by foot to other transport modes, and streets are safer from traffic crashes.*

## Collaborativity

Collaboration and creativity together help realise the vision of multimodal transportation. Smart cities initiate multilateral collaboration among various stakeholders, both in physical as well as in the Web domain, to achieve smart mobility.

**Create an institutional framework.** To achieve integrated transit hubs, smart cities initiate and incentivise development of inclusive mobility vision and collaboration among multiple agencies, jurisdictions, and transport systems, such as bus system, railways, metro system, etc. Many smart cities have great success in developing integrated multimodal transit by creating Comprehensive Mobility Plans (CMP) and strong institutional frameworks, such as a Unified Metropolitan Transportation Authority (UMDA), which can plan, coordinate, execute and monitor the implementation of physical connectors, linked 'feeder' modes and cross-system information integration.

**Pursue multilateral collaboration.** Smart cities often witness public and private sectors collaborating together to formulate creative solutions and achieve smarter mobility.

For example, car-free Thursday is a successful example of locals groups coming together

and collaborating with corporate companies to formulate a solution to reduce traffic congestion. Successful smart cities analyse such efforts and then collaboratively scale the successful and viable efforts on the city-level or even share with the state and nation.

## Governance

**Achieve existing infrastructure optimisation.** Technologies and innovation together can improve efficiency and resilience of transportation systems, while minimising the need for physical infrastructure expansion. The city government of Chennai launched the Chennai Street Design Project, in close collaboration with the Institute for Transportation and Development Policy (ITDP), to address the safety challenges related to transport in the city. The solution rests on one, simple pledge — that at least 60% of the city's transport budget to be allocated to constructing and maintaining infrastructure for non-motorised transit. This includes: expanded

**Instigate 'soft mobility'.** Smart cities implement focused, creative solutions, and annually expand 'non-vehicular' infrastructure. Continuously developing infrastructure such as footpaths, walkways, well-integrated skybridges, dedicated bicycle lanes, public

bicycle storage and bicycle-sharing facilities and maximising people's access to public transport by promoting the mixed use of land for both residential and commercial purposes, provides convenience and reduces incentives to travel by private car.

The city of Graz — 'Bicycle Capital of Austria' — boasts many activities in the areas of mobility management, mobility education and information. The city signed integrated mobility agreements with investors for safe, protected and sufficient bicycle parking and attractive thoroughfares. The city also provided a free Bike Citizen app and carried out city-financed mobility projects at the school and business-levels. With the annual 'Tour de Graz', the transportation department organised the 'CityRadeIn' five times a year, to provide inspiration and create a strong rider community.

**Facilitate revenue generation for the city using demand-based road users charging.** Smart cities have systems in place to use dynamic, demand-based pricing as a tool to influence customer behaviour. Road user charges are direct charges levied for the use of roads, including road tolls, distance or time-based fees, congestion charges and charges designed to discourage use of certain classes of vehicle, fuel sources or more polluting vehicles.



Facilitate revenue generation:

## LONDON SOLVES TRAFFIC PROBLEM WITH CONGESTION PRICING

Facilitate revenue generation:

*Transport for London (TfL) reported in 2013 that the congestion charging scheme resulted in significant reduction in traffic volumes from baseline conditions, and an overall reduction in vehicle kilometres in London between 2000 and 2012, and raised hundreds of millions in fees.*

Traffic jams had been a substantial problem for many years for the central part of London. In February 2003, to reduce traffic congestion and raise revenues to establish public transport improvements in the city, a new city congestion charge scheme was introduced. Under it, all vehicles (with some exemptions) operating within the Congestion Charge Zone in central London between 07:00 and 18:00 during weekdays were made liable to a charge. To assist drivers in recognising the congestion charge zone, relevant signs were set up and congestion symbols were painted in the charge zones.

To enforce the scheme, a number of fixed and mobile Council member 3M Automatic License Plate Recognition (ALPR) cameras were installed in the Congestion Charge Zone.

These ALPR cameras record all vehicles entering and exiting the zone using infra-red technology to identify the license plates. The recorded license plates are then checked against a database of those who have already paid or are exempt from the charge. Those vehicles that have entered the Charge Zone but not paid the fee are identified and fined with the help of the 3M ALPR camera and the charge database.

In 2013, 10 years after its implementation in 2003, it remains one of the largest congestion charge zones in the world that is showing significant improvements. Transport for London (TfL) reported in 2013 that the congestion charging scheme resulted in significant reduction in traffic volumes from baseline conditions, and an overall reduction in vehicle kilometres in London between 2000 and 2012, and raised hundreds of millions in fees.

It can be leveraged in certain busy areas or selected cities to discourage private transport usage. As cities better understand people's transportation behavior through instrumentation and analytics, they can influence that behavior by changing prices throughout the day to accomplish their transportation goals.

For example, a city with crippling morning smog can analyse vehicle use at that time and tailor parking prices for vehicles based on distance traveled. Or a city with high road congestion can toll the road with variable pricing and/or alter its bus and subway pricing in targeted areas to reduce traffic. Cities have different transportation circumstances and priorities, and different political operating environments, so the use of dynamic pricing to influence behaviour is likely to differ from city to city. This also generates revenue for further improvement projects.

## Instrumentation and control

Smart devices including on-street traffic equipment such as roadway sensors, smart streetlights and GPS devices help cities monitor, manage and control traffic.

**Implement optimal devices and other instrumentation for all transportation modes.** Deploying the right devices in the right place — covering all modes of transport — provides the data smart cities use to analyse traffic in real time. In some cases, optimal instrumentation may mean a smart device for every vehicle, for instance, and a GPS tracker for every bus. In other cases it may mean a smart device “every so often.” For example, a roadway sensor placed every so often as needed to provide a picture of traffic on city highways and byways. Gathering and analysing data from all modes of transportation within a city enables multimodal optimisation.

**Achieve integrated control system.** Various optimal design devices produce essential data for traffic pattern analysis. However, creating a single, coherent system, with common interface among multiple subsystems where the various technologies communicate with each other, generates far more effective data and optimises performance.

For instance, an integrated traffic control system achieves optimum signal control based on traffic volume and other information from various devices to effectively deal with ever-changing traffic flow patterns and provides real-time traffic information and implements each subsystem of traffic management.

## Connectivity

The data collected from a city's smart transportation network often impacts more than just transportation operators. The first responder needs to know about traffic conditions so that they can take an alternate route.

Likewise, long waits at a city ferry terminal may be something the communications office needs to know in real time so they can alert the traveling public.

**Connect devices with citywide, multi-service communications.** It's not enough to embed smart devices throughout a transportation network. The data the devices gather needs to be channeled through a citywide communications system so that it can be analysed and acted upon. Geospatial-enabled services provide periodic traffic forecast, journey planning mobile applications based on real-time data, etc.



Pursue multilateral collaboration:

## FRENCH CITIES CUT DRIVERS' COSTS BY 90% WITH INTELLIGENT CAR-SHARING

**S**yndicat Mixte Auto lib is an electric car-sharing program established by the city of Paris and 46 surrounding municipalities to relieve traffic congestion, reduce noise and air pollution, and provide people with more flexible transit options.

Implemented by logistics company IER, the intelligent system based on Council member Microsoft's Windows Embedded provides connectivity between the in-car system, registration and rental kiosks, charging stations and a central management system.

Available around the clock, the solution has reduced carbon dioxide emissions by 1.5 metric tonnes annually and replaced 25,000 privately owned gas vehicles. By using Auto lib, former car owners have cut their transportation costs by approximately 90% annually. Auto lib subscribers also enjoy an enhanced driving experience with GPS navigation, free parking and personalised settings.

The flexible solution also simplifies implementation and minimises deployment risk, which makes it easier for Auto lib to implement new features and services.

 Pursue multilateral collaboration:

*Microsoft Windows Embedded provides connectivity between the Auto lib in-car system, registration and rental kiosks, charging stations and a central management system.*

## Interoperability

Cities can rarely afford an out-with-the-old, in-with-the-new overhaul of their transportation systems, much as they might want to. The targets in this section highlight some of the ways cities can make sure they're making decisions today that will bode well into the future.

**Adhere to open standards.** Insisting on open standards will increase choice and decrease costs, as products can be mixed and matched from different vendors. Cities may also want to work with standards organisations to ensure their particular needs are addressed.

**Use open integration architectures and loosely coupled interfaces.** Cities that adopt open integration architectures make it much easier and simpler to share data between applications.

**Prioritise the use of legacy investments.** As you well know, transportation systems can be a huge investment and most cities can ill-afford to scrap equipment that still has lifetime value. So as cities add intelligence to their transportation network, it makes sense to use existing equipment and systems whenever possible to avoid unnecessary spending and stranding assets.

**Enable multi-channel access to an integrated transportation account.** One goal of a smart transportation system is to encourage people to use it — so making it incredibly convenient will be a big factor. A couple of ways smart cities can do that is to enable people to (1) pay for all city transportation services with a single account and (2) enable access to this account through multiple channels — integrated fare cards, cell phones, websites, on-vehicle transponders, etc. A single account covering multiple modes of transportation and offering multiple channels of access lowers barriers to mass use. Increased usage boosts efficiency and revenue and decreases road congestion. Although it is unlikely a city can integrate all modes of transport at once, it's a goal worth working toward.

## Security and privacy

The security and privacy concerns that apply to other city infrastructures are equally important in the realm of public transportation.

**Publish privacy rules.** As we mentioned in the last section, transit authorities are moving to single account payment systems, which will generate data that can track where an individual has been and when. Some transit

systems also use video surveillance for security purposes. Those are just two reasons why publishing privacy rules will help cities get in front of a potential consumer backlash.

**Create a security framework.** One of the realities of life today is that a driver never knows who's hopping on a bus or what's in the backpack he's carrying. And what about the package left behind on a subway seat? A security framework mitigates risk by taking a proactive approach and using ICT technologies to identify and address threats before they can cause damage.

**Implement cyber security.** Smart transportation systems collect all manner of data that could make them vulnerable to cyber-attacks: from smart card payment information to ridership details. Having strong cyber-security measures in place will help ward off trouble.



Pursue predictive analytics :

## CONNECTED BOULEVARD: THE WORLD'S SMARTEST STREET

Council member Cisco has teamed with the city of Nice, France, to pilot a next-generation smart street they are calling “Connected Boulevard.” Boulevard Victor Hugo, located in the centre of Nice, is host of the proof-of-concept zone and almost 200 different sensors and detecting devices. In addition to these, it also plays host to “guest” devices such as mobile phones and tablets used in the streets that get connected onto its wireless mesh network.

Data captured through these “things” is being processed and analysed to offer the city and its residents invaluable context-aware information on parking, traffic, street lighting, waste disposal, as well as environmental quality as experienced in real time.

Early projections from pilot tests of smart parking services have shown a potential for up to 30% decrease in traffic congestion, significant air pollution reductions, combined with an increase in parking revenues.

Further benefits are also being realised from estimates in synchronising street lighting on a need-basis. For example, by calibrating street light intensity with pedestrian and traffic peaks and real-time environmental conditions such as fog and rain, the city could potentially save 20 to 80% in electricity bills. On the environmental aspect, more accurate data of humidity and temperature levels, in addition to air particles are being processed for understanding context-critical patterns.



### Pursue predictive analytics:

*Boulevard Victor Hugo in Nice, France is host to a Connected Boulevard proof-of-concept zone that includes almost 200 different sensors and detecting devices.*

This is possible because Connected Boulevard is made up of more than just sensors and devices. Connected Boulevard equips the city with the capacity to capture data from daily life through the hybrid network infrastructure of the city that includes the Cisco Wi-Fi network. The data is processed into real-time information and converted into Intelligence with the help of context-aware location analytics, before being disseminated to serve multiple services in city operations and for city dwellers. It is an Internet-centric “always-on” platform designed to be resilient, extensible, highly secure and agile, through four interoperable layers:

Layer 1: Sensors and networked devices with mesh technologies

Layer 2: Data capture, processing, storage and analytics at distributed points across the city

Layer 3: Central data collection, including computing, storage and analytics, combined with integrated and open standard application programming interfaces

Layer 4: New and innovative applications and services

As Nice Mayor Christian Estrosi said, “For Nice to continue welcoming millions more visitors and companies while ensuring a high quality of life, using Internet intelligence is key. Many more things are going to get connected between people, with and between objects, creating valuable interactions and processes including that of public administration. Our ability as a city to harness this data is crucial to understanding what’s going on in real time and to enhance a multitude of services for city-dwellers.”

## Data management

With smart sensors, smart payments, GPS and other intelligent devices that are gathering data as part of a smart transportation system, the city and its residents are all better off when there’s a plan for managing it.

**Create and adhere to a citywide data management, transparency and sharing policy.** Citywide data management plans make it easier to enforce privacy and security best practices discussed in the last section. But they also can help improve data accuracy and lower costs by eliminating unnecessary duplication.

## Computing resources

Transportation systems involve a lot of data, a lot of logistics, and a lot of details coming from various sources that ICT can help cities get under control. The targets below illustrate some of the ways they can do that.

**Consider a cloud computing framework.** A cloud computing framework enables scalability, reduces costs and improves reliability.

**Use an open innovation platform.** A lot of cities are seeing amazing results with open

innovation platforms that empower developers to create apps that city residents can use. Smart parking apps, for instance, are very popular. Apps that people can use to synch up with bus and train schedules are too.

**Have access to a central GIS.** City decision-making capabilities are greatly improved with a central GIS. A transit system, for instance, can see efficiency gains through more intelligent scheduling and routing.

**Have access to comprehensive network and device management.** To manage the large, scattered deployments of smart devices across the transportation infrastructure, smart cities rely on comprehensive device management programs that improve security and resiliency, deliver cost savings and enforce compliance with city data management, security and privacy policies.

## Analytics

It's no surprise that analytics can have a major impact in a transportation network. This section includes some new targets that reveal how.

**Achieve full situational awareness.** Using the smart devices deployed across various transportation modes, smart cities use analytics to provide their transportation managers with a complete operating picture. Incident detection and notification systems can analyse information from cameras and vehicles to detect traffic problems, alert drivers and suggest alternative routes. This increases the reliability and resiliency of the infrastructure, and allows for the quickest possible incident response time. Full situational awareness also enables dynamic, multi-modal disaster and recovery plans.

**Achieve multi-modal operational optimisation for transportation.** When it comes to optimising transportation operations, the goal is to make sure the optimisation takes place across all modes, in or near real time depending on circumstances. Cities that optimise transport modes individually limit the returns on their technology investments, since a change or incident impacts one another. For example, shutting down a railway line can create a big influx of riders to the closest bus. Many ways that multimodal optimisation improves transit operations, including:

- **Improved mobility.** Travel is as fast, efficient and safe as possible. Traffic lights are optimised to eliminate structural traffic problems, or to find the best compromise to allow streetcars to pass with minimum delays for automobile traffic. Data analysis might suggest a new bus route along a particularly crowded transit corridor. Or a smartphone app could alert drivers to the best route, sending them around congestion and accidents. Improved mobility is important to residents, of course, but is also critical for businesses that move people or goods around a city.



### Use open innovation platform:

*Many cities are having great success with open innovation platforms that encourage developers to create apps. Parking apps like SFpark pictured here are very popular.*



## Flexibility.

*If pollution is a major problem, then a city can effectively optimise its transport system to promote bus use over private car use, and metro use over bus use.*

**Achieve asset optimisation.** The goal is to ensure a city can extract maximum value from its transport infrastructure and instrumentation investments. This includes calculating precisely which transportation assets should be replaced or repaired and when, to achieve maximum return on investment.

**Pursue predictive analytics.** The importance of using analytics to predict when elements of a transportation infrastructure are close to failure can't be overstated. Consider the value of predictive maintenance, for example, in relation to the critical infrastructure like bridges and highways. Not only can predictive analysis save money, it can also save lives.

- **Cost savings.** In addition to the cost benefits of reduced congestion, multimodal transport optimisation brings cost benefits to cities through more efficient energy usage and improved customer experience. (As noted earlier, the better the experience, the more willing people are to use public transportation). In some scenarios system optimisation can reduce costs through shared infrastructure — especially ICT resources — and by getting more out of existing infrastructure. It can also defer or delay the need for new roadways or buses by optimising the use of what the city has in place already.
- **Flexibility.** Multimodal transport optimisation can be a tool that smart cities use to accomplish specific transportation goals. If pollution is a major problem, then a city can effectively optimise its transport system to promote bus use over private cars, and metro use over bus use. Or if a city suffers from rush-hour bus congestion, it can optimise its transport system to increase subway use during that time.



Achieve asset optimisation:

## KOBE RAILWAY MAKES IT SAFE AND RELIABLE FOR RIDERS

With the new company vision aiming to enhance safety and functionality, Kobe Electric Railway, serving 46 stations in and around Kobe, Japan, needed a highly available network that provided uninterrupted service, yet simple to use and maintain. Inter-Station Remote System was facing problems due to increasing demand for high-speed network and need for a stringent stations surveillance systems.

Among other issues, the long failure identification time and temporary power turned off almost every night for maintenance, without affecting other stations, made it more complex to create uninterrupted operations round the clock.

Smart cities Council India member Allied Telesis provided new 'mission-critical' inter-station remote system achieved by EPSR and VCStack and x900 Series Advanced Gigabit Switches. This high-speed next-generation network brought numerous benefits, helping Kobe Electric Railway meet their objectives, which were

- **Uninterrupted network** service 24 hours a day, 365 days a year provided the must-needed reliability.
- **High capacity network** with Quality of Service and non-blocking architecture allowed ISRS to connect all stations in a high-speed, large-capacity network and instantly complete data transmission.
- **Easy to use**, simple and robust network structure facilitated easy maintenance procedures.
- **Future-proof infrastructure** with sample planned bandwidth for projected image and sound applications and provision of easy bandwidth amplification.
- **Cost-effective solution reduced overall cost** with reuse of some existing infrastructure and easy operations reducing IT support and associated costs.
- **Advanced security features** of Allied Telesis switches gave unprecedented control over the network.



Achieve asset optimisation:

*Future-proof infrastructure with ample planned bandwidth for projected image and sound applications and provision of easy bandwidth amplification.*

# ISO 37120: A yardstick for measuring city performance



In 2014, the International Organisation for Standards announced an ISO standard that applies strictly to city performance. The document -- known as ISO 37120:2014

-- establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecom- munications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right we have indicated how the standard related to Transportation correspond to the Council’s Transportation targets identified on the next page. The ISO 37120 transportation indicator has cities reporting on the extent of their mass transit and non-car infrastructure, overall transportation safety and direct flight interconnectedness.

## Transportation Indicators

		Implement optimal instrumentation for all modes	Citywide, multi-service communications	Multi-channel access to integrated accounts	Integrate all transport modes for optimisation	Enable dynamic, demand-based pricing	Achieve full situational analysis	Achieve operational optimisation	Pursue predictive analysis
<b>Core</b>	18.1	Kilometers of high capacity public transport system per 100,000	●	●		●	●		
	18.2	Kilometers of light passenger public transport system per 100,000 population	●	●		●	●		
	18.3	Annual number of public transport trips per capita	●	●	●	●	●		
	18.4	Number of personal automobiles per capita	●	●	●	●	●	●	●
<b>Supporting</b>	18.5	Percentage of commuters using a travel mode to work other than a personal vehicle	●	●	●	●	●		
	18.6	Number of two-wheel motorised vehicles per capita				●			
	18.7	Kilometers of bicycle paths and lanes per 100,000 population				●			
	18.8	Transportation fatalities per 100,000 population	●	●		●		●	●
	18.9	Commercial air connectivity (number of non-stop commercial air destinations)				●			

# TRANSPORTATION TARGETS

In the checklist below, targets specifically pertaining to the transportation responsibility are in **bold**, universal targets are not

	Enabler	Transportation Targets How smart cities deploy and use ICT to enhance their transportation networks	Implementation Progress			
			None	Partial	Over 50%	Complete
Human	Inclusivity	Achieve accessibility optimisation <b>(Supplement: including physical and web accessibility)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate citizen reporting framework for outcome thinking Achieve citizen engagement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	Collaborativity	Create institutional framework <b>(Supplement: across multiple transit systems)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Pursue multilateral collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Governance	Achieve existing infrastructure optimisation <b>Instigate 'soft mobility'</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Facilitate revenue generation for the city <b>(Supplement: using demand-based road user charging)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# TRANSPORTATION TARGETS

In the checklist below, targets specifically pertaining to the transportation responsibility are in **bold**, universal targets are not

Technology	Enabler	Transportation Targets	Implementation Progress			
		How smart cities deploy and use ICT to enhance their transportation networks	None	Partial	Over 50%	Complete
	<b>Instrumentation and Control</b>	Implement optimal instrumentation <b>Supplement: for all transportation modes</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Connectivity</b>	Connect devices with citywide, multi-service communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Interoperability</b>	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritise use of legacy investments <b>Enable multi-channel access to an integrated transportation</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Security and Privacy</b>	Publish privacy rules Create a security framework Implement cyber security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Data Management</b>	Create a citywide data management, transparency and sharing policy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Computing Resources</b>	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Analytics</b>	Achieve full situational awareness Achieve operational optimisation Pursue predictive analytics <b>Supplement: integrate all transport modes for multi-modal transportation optimisation</b> Achieve asset optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Few people need to be reminded of water's importance. Along with energy, it is essential for everyday life. Water provides sustenance, supports industry and irrigates fields. But city administrations are struggling to meet rising demand from growing populations while contending with issues such as water quality, flooding, drought and aging infrastructure.

# 9

## Water And Wastewater



According to the United Nations, about two-thirds of the world's population — 4.6 billion people — will face water-stressed conditions in the next decade.

In India, an agro-driven nation with a population over 1.2 billion, water scarcity has begun early, and uncertainty over the availability of and access to water may be soon reaching crisis levels. We need water for human consumption and to produce food and other consumer products. Escalating growth in population, dramatic shifts in industrial production and growing agriculture needs are putting tremendous strain on this limited resource.

Also, being the second largest grain producer and exporter, significant amount of water supply is consumed for food production. Water supply is expected to fall 50% below demand by 2030.

Another major concern for an agro-driven economy is lack of long-term availability of replenishable water supply. Lacking innovative water storage and reuse methods, India already is consuming significant amount of surface water — on an average 40% of available surface water, while extremely high-stressed northwestern regions — India's agricultural hub — are using as much as 80%.

### **Complex issues leading to water scarcity:**

*In India, an agro-driven nation with a population over 1.2 billion, water scarcity has begun early, and uncertainty over the availability of and access to water may be soon reaching crisis levels.*

**T**he ability to deliver adequate clean, potable water and effective sanitation disposal are two important responsibilities of cities today. However, most countries around the world are already facing the issue of water scarcity, and the situation is only going to get worse. According to the United Nations, about two-thirds of the world's population — 4.6 billion people — will face water-stressed conditions in the next decade.



Regardless of improvements to drinking water, many other water sources are contaminated with sewage and agricultural runoff — both bio and chemical pollutants. As a result, about 21% of communicable diseases in India are water-borne, related to unsafe water, according to a recent World Bank report.

Sanitation disposal is a huge issue in India. More than 38 billion litres of sewage is generated in urban India annually. Most of the untreated sewage is discharged into rivers, ponds or lakes, which is the main source of municipal water. Open defecation is huge problem, and now the government is taking great measures to address this issue.

This chapter will give cities tools to apply smart technology for an economical and sustainable water supply. It begins by outlining urban water realities. Next it demonstrates key frameworks and tools deployed by smart cities, and further explains the benefits cities can achieve by increasing the intelligence of their water systems. Finally, it talks about the technology targets cities should aim for to gain those benefits. But first we need to look at the global water scenario to understand the full extent of the water crisis, as global water scarcity is expected to become a leading cause of national political conflict.

### **The energy-water nexus:**

*In the U.S. in 2005, power plants withdrew four times as much water as all U.S. residences, accounting for 41% of total water use.*

But not everyone realises that we need large volumes of water to produce energy. The so-called “energy-water nexus” works in both directions. It takes a lot of water to generate electricity. It takes a lot of electricity to pump and treat water. Worldwide, we use an average of 7% of total electricity to pump and treat water and wastewater, but the percentage can be much higher.

Though India has taken significant efforts to improve availability and quality of municipal drinking water, there is still a gross disparity in coverage. It’s estimated that over 97 million Indians lack access to safe water, according to the World Health Organization.



## Risks to urban water supplies

Think you don't really need to worry about water in your area? Think again. Here is a partial list of the issues confronting urban water supplies.

**Sea levels on the rise.** For coastal cities, water quality will be further eroded by rising sea levels, which can increase salt concentrations in groundwater and estuarine rivers.

**Flooding on the rise.** Increased flooding will affect hundreds of millions of people who live close to coastlines, flood plains and deltas. Even inland cities face the problem of flooding as a result of more intense rainfall or snowmelt.

**Storms on the rise.** Hurricanes, tornadoes and other extreme weather events will become more frequent and rainfall more intense in many areas.

**Droughts on the rise.** Some regions will receive less rainfall than usual, leading to droughts more severe than in the past.

**Fresh water on the decline.** Higher temperatures reduce the amount of water

stored in mountain snowfields. They also dry out the soil, which then soaks up more water, reducing the recharge of underground aquifers. The result could be reductions in available water for drinking, household use and industry.

**Water quality on the decline.** Water quality will become a concern for some cities. Changes in rainfall patterns may change the watershed, affecting quality. Contamination of water wells due to industrial and agricultural pollutants will also have an adverse effect.

**Aging infrastructure.** Water and wastewater infrastructure in cities around the world is aging and must be replaced to protect its efficiency and the quality of its product.

**Competition from agriculture.** According to the World Economic Forum, to meet demand from growing populations, we will need to grow and process 70% more food by 2050. Yet as early as 2030, we will be confronting a water shortage of approximately 40% due to a toxic combination of rising demand and climate change-driven shifts.

**Competition from recreation.** In some parts of the world, boaters, skiers, fishermen, campers and other outdoor enthusiasts have mounted strong protests when cities attempt to get more water from popular lakes and rivers.

## Why make water systems smart?

Smart cities use information and communications technology (ICT) to achieve a sustainable, efficient and clean water supply. Most people refer to an ICT-enabled water system as a “smart water system” or a “smart water network.” Smart water is driven by four urgent realities:

1. **Water is insufficient.** Currently, per person usable water available in India is about 1,000 cubic meters, much below the universal water-stressed level of 1,700. In addition, population growth and extreme weather patterns that create droughts and floods are expected to increase in the coming decades, making water an even more precious resource.
2. **Water quality is poor.** Water is most of the rivers is unfit for human consumption. More than 100 million people in India do not have access to safe, unpolluted water, which results in severe health and socioeconomic problems.
3. **Water is at risk.** Drought, flooding and other factors can wreak havoc on water supply. (See list on previous page.)

4. **Water is becoming inaccessible.** Sustainable water supply is going to be a critical problem in the future due to lack of long-term availability of replenishable water supply. Surface water exhaustion is leading to groundwater extraction. Recorded falling groundwater levels indicate that water is going to be more and more inaccessible in the future.
5. **Water extraction is energy-intensive.** Indian agriculture industry heavily depends on groundwater and rains. About 65% of cultivable land in the country doesn't have irrigation facilities. To make matters worse, the government subsidises electrical pumps for farmers which they use to pump water, putting a lot of strain on the electrical grids in India, a power-starved country.
6. **Water is underpriced.** Water today is often priced far below the level that would accurately reflect its scarcity. This price/value imbalance will rectify as water scarcity becomes more apparent. As a result, the price of water will rise significantly in the future.
7. **Water infrastructure is expensive.** Lack of real-time information about the water network status will lead to costly system break-ups and sub-optimal maintenance.



8. **Water is illegally obtained.** The illegal connections sprung over time not only reduce revenues of the city, but also are the major cause of contaminations with sewage and water lost due to leakage.

Already we see regions where water periodically becomes scarce, where water is prohibitively expensive, and where water is of extremely poor quality. For these reasons and many others, every city must use smart technology to preserve and enhance its water supply while keeping the cost of water as low as possible. ICT can contribute in at least seven ways:

**1. Map and monitor the physical infrastructure.** Most water utilities do not know with great precision where their pipes and valves are located. In particular, they don't know the actual condition of that infrastructure. ICT gives a highly accurate picture of location and "health."

"Possessing a clear and comprehensive picture of the entire infrastructure can save a water company tens or hundreds of thousands in repairs each year," explains the Smart Water Network Forum, an industry forum that acts as an advisor to the smart cities Council. "Survey-quality GPS, sometimes combined with electromagnetic or ground-penetrating radar, can map pipe infrastructure, creating three-dimensional maps that show exactly where the pipe is, correcting the widespread errors in existing maps, and ensuring that repair crews will find the pipe when they dig." Acoustic technology can continuously monitor pipe conditions and pinpoint leak locations.

**2. Accurately measure what is consumed.** Smart water meters can give customers highly accurate records of their consumption while also helping utilities spot "non-revenue water" (NRW) that is being lost to defective equipment, leaks and theft.

**3. Monitor drinking water quality.** A smart water system can have sensors placed strategically throughout the network to detect contaminants. Those sensors can monitor the acidity and alkalinity, watch for biological indicators, measure chlorine and other chemicals and watch for heavy metals, then alert human operators when problems arise so they can intervene quickly to mitigate threats.

**4. Present, perfect and predict conditions.** Using data from the first two examples above, a smart water system can present current conditions to give operators full situational awareness, perfect the system by optimising it, and predict leaks, floods and equipment failures. "Utilities can achieve better operations through better knowledge and tighter control of the network's extensive and complex assets," explains the Smart Water Network Forum. Modern dashboards and tools can improve the efficiency, longevity and reliability of the underlying physical water network by better measuring, collecting, analysing and acting upon a wide range of events.

**5. Make better use of diffuse and distributed non-traditional water resources.** through recapture, recycling and reuse and through better planning. Water is so much broader than pipes and treatment plants. Rain falls everywhere

— on rooftops, soil, gardens, roads. This run-off water can all be captured and put to use with the help of ICT. Instrumentation diffused into these "green water systems" can store water, while advanced analytics are critical to managing this distributed resource. You can have the insight to understand where your green water systems are, how they are performing and how the water they capture can be best deployed.

**6. Better prepare for storms.** Some parts of the world — North America for instance — must confront challenging water quality and storm water regulations. And many parts of the world are faced with flooding that is reaching new extremes. Smart water systems not only monitor flooding, they can predict events in time to prepare for flood control and management.

**7. Harness the energy and nutrient resources in water and wastewater.** ICT helps us capture the full potential of water. Beyond its own value as a scarce resource, water systems house nutrients and even energy. Technology enables us to reduce and recapture excess kinetic energy in water supply piping, utilising it to power sensors, recover energy and nutrients in wastewater, and avoid the damaging dumping of nutrients into carefully balanced ecosystems.



Map and monitor the physical infrastructure:

## WATERMIND MANAGES COMPLEX WATER DISTRIBUTION SYSTEM

The massive population growth of one of the top three fastest growing cities in the world, Bengaluru, from 5.4 million in 2000 to 10 million and counting today, has put tremendous strain on the city's water distribution systems. Bangalore Water Supply and Sewerage Board (BWSSB), the only water supplier of the city had to ensure equitable water supply and a solution for the city's significant water loss mainly due to physical and unauthorised connections. The utility was billing water usage of 15,500 when actual usage was 28,900 ML/Day, led to annual loss of more than \$8 million.

Though BWSSB replaced old pipelines, installed new bulk flow meters and domestic water meters to reduce non-revenue water loss, it was still faced with challenges like identifying water meter tampering and distributing water as per the needs of consumers.

Council member Itron introduced WaterMind Analyzer as a solution to all of BWSSB's water loss challenges, and helped improve service to customers. Under the UFW contract, over 135,000 Itron meters were installed to replace the existing domestic meters by L&T and Suez, where Itron installed over 200 WaterMind devices and L&T is installing 124 WaterMind devices.

Earlier, around 45% of the water supplied by the BWSSB used to go unaccounted. Implementing this solution helped minimise this water loss by detecting large changes in water flow, through real-time monitoring. Now, BWSSB is able to monitor faulty meters efficiently. Revenue loss is reduced and BWSSB plans to install WaterMind in many more locations across Bengaluru.



Map and monitor the physical infrastructure:

*Earlier, around 45% of the water supplied by the BWSSB used to go unaccounted. Implementing this solution helped minimise this water loss by detecting large changes in water flow, through real-time monitoring.*

For example, when water officials see spikes or other any changes in usage, the system alerts the engineers so that it may be rectified immediately. Smart sensors working in conjunction with the IBM Intelligent Operations Water software enable workers to receive alerts through their mobile or smart devices so they can respond in near real time. As a result, KWA is able to respond immediately to irregularities in water supply and react to repairs that are needed in a much shorter timeframe.

Instead of manual sampling methods, KWA can measure water turbidity, salinity, conductivity, pH, and chlorine levels in real time using installed sensors. Using the IBM Intelligent Water Software, workers can instantly visualise operations and receive alerts and notifications when readings stray from norms or when analysis indicates that water quality has changed.



## Water realities

Before we look at specific targets for water responsibility, let's quickly consider four realities that affect when, where and how a city should approach the transformation of its water system.

- 1. Smart cities “close the loop” around local watersheds.** A watershed is the land area that drains into a particular river, lake or ocean. “Closing the loop” refers to reducing (or even ending) the import of water from other watersheds while taking full advantage of the water available within the loop. Giving preference to locally available water allows a city to be more confident in the sustainability of its water program.

ICT helps cities close the loop by maximising the potential of non-traditional sources. The idea is to supplement traditional water sources such as reservoirs and aquifers by capturing storm water runoff, gray water and purple water and by tapping natural systems like wetlands, rivers and lakes. ICT can oversee and optimise the capture of water from these sources. Closed-loop systems also use different grades of water for different needs.



### Smart cities “close the loop” around local watersheds:

*“Closing the loop” means giving preference to water from the local watershed, which allows a city to be more confident in the sustainability of its water program.*



**Better prepare for storms of runoff, storm, and flood:**

## THE NETHERLANDS TAKING BETTER CARE OF FLOOD WATER

**T**he Netherlands is working with Council member IBM to transform flood control and the entire Dutch water system. The need is high. Of the total Dutch population, 66% live in flood-prone areas. More than 4,000 square miles (26% of the country) is below sea level.

The financial stakes are high as well. The ongoing cost to manage water, including anticipating flooding, droughts and low water levels is up to €7 billion each year and expected to increase to €1-2 billion by 2020. The project with IBM is expected to reduce costs by up to 15%.

The Rijkswaterstaat (the Dutch Ministry for Water), the local Water Authority Delfland, Deltares Science Institute and the University of Delft are working with IBM on the “Digital Delta” program. They will investigate how to integrate and analyse water data from a wide range of data sources, including precipitation measurements, water level and water

quality monitors, levee sensors, radar data, model predictions as well as current and historic maintenance data from sluices, pumping stations, locks and dams. The initiative will provide water experts with a real-time intelligent dashboard. That dashboard will combine, process, and visualise data from multiple organisations’ data that today is kept in separate silos.

The new management system will address concerns ranging from the quality of drinking water, to the increasing frequency and impact of extreme weather-related events, to the risk of floods and droughts. By modelling weather events, the Netherlands will be able to determine the best course of action.

Digital Delta is a cloud-based system. “As flooding is an increasing problem in many regions of the world, we hope that the Digital Delta project can serve as a replicable solution for better water management anywhere in the world,” said Jan Hendrik Dronkers, director general of the Dutch water ministry.

 **Better prepare for storms runoff, storm, and flood:**

*This Dutch storm surge barrier is just one piece of Holland’s vast flood control system. The country is working with Council member IBM to use ICT to transform flood control management.*

**2. Smart water requires collaboration. Perhaps more than any other city responsibility.** Water is a regional issue. The water source that city residents use to quench their thirst may be the same that a factory uses for its operations or a farmer to water his crops 100 miles away. Water is tied into vast watersheds that link many population centres. Because of that, a smart water vision requires a collaborative approach between cities and a lengthy list of stakeholders. The list includes other cities in the watershed, regional or national government entities that may have regulatory authority, utilities, the private sector, agricultural organizations, citizen and community groups, etc. In some cases, international collaboration may be necessary.

**3. Smart water requires smart policy.** There are many ways that local, regional and national governments can enhance the prospects for smart water. One instance: policy improvements that clear the way for public-private partnerships to help with the financing. Another is mandates for efficiency, conservation, leak reduction or water quality. Yet another is working with suppliers to craft a careful business case that demonstrates the return on investment. Whatever steps a city takes; it should NOT mandate a specific technology.

Rather, it should mandate the results it wants, and then work with advisors and suppliers to determine the best way to achieve that result.

**4. Smart water may need creative financing and staffing.** Many city budgets are under great pressure. Even if a city can make a strong business case for rapid payback, it may not have the funds to finance the project. Fortunately, several alternative mechanisms have arisen to lighten that load. For instance, some suppliers will sell software-as-a-service (SaaS) on a monthly fee basis. This eliminates the need for the city to make a big capital purchase and install, maintain and update all the hardware and software on its own. Instead, the supplier handles all that in the cloud and the city simply pays a monthly charge. In many ways, this is similar to leasing a car instead of buying it.

Another option is a risk-sharing contract. The city pays a reduced fee to the supplier, and then shares a portion of the saved costs or additional revenue back to the supplier.

It is worth noting that some developing countries have funding available for infrastructure projects, often thanks to grants and programs from development

banks. Utilities in those regions have the chance to leapfrog the developed world by jumping straight to a state-of-the-art smart water system.

## Interconnectedness assessment

Water and wastewater infrastructure improvements are related with multiple services, and can't be planned without understanding of the interdependencies with other city systems and services. Looking at just a few of these dependencies, it is easy to see how smart water services are heavily influenced by local government policies and how closely they are aligned with communications and energy systems in a smart city context.

Contaminant warning systems rely on communications and energy systems. And pumps that move water throughout a city infrastructure require power. Flood control systems (e.g., pumps or gates) require resilient energy systems to operate.



Lowering operational costs:

## BREDA OPTIMIZES WATER - ENERGY NEXUS

**B**ecause the city of Breda in the Netherlands is located at the junction of two rivers and experiences a lot of heavy rainfall, the city needed to find a way to use and monitor water efficiently, which would also help future generations and help prevent flooding. Breda needed to optimise the water-energy nexus by developing an IoT solution that provides a comprehensive water management system.

Breda analysed Waterkokers — a large reservoir surrounded by housing development and undertook the 'Smart Data Management' Waterkokers project running on Council member Microsoft Azure. Microsoft partner iReckon developed a software solution on Microsoft Azure — a data cloud environment that connects and captures all the data from physical sensors in water and sewage plants to provide real-time data about water flow levels.

Microsoft Analytics Server now analyses and visualises massive data collected by sensors and pumps around the city. Working with iReckon, the city of Breda is able to adjust pumping levels more efficiently, and can even predict pump maintenance and failure to fix them in a timely manner — to decrease wasted power consumption, as well as to help prevent flooding.

The Waterkokers project provides transparent data that lets citizens stay updated on the water levels, allowing them to make conscious decisions on water use in the city. Citizens participate by sending water observations through social media. A scalable platform offers the city the ability to continue adding sensors as needed while still keeping the maintenance costs low for the city. The solution has enabled the city of Breda to optimize its asset management, reduce energy and maintenance costs, and prevent flooding.

 **Lowering operational costs:**

*A scalable platform offers the city the ability to continue adding sensors as needed while still keeping the maintenance costs low for the city. The solution has enabled the city of Breda to optimize its asset management, reduce energy and maintenance costs, and prevent flooding.*

# Benefits of a smart water system

In this section we highlight benefits that smart water systems can deliver and their impact on livability, workability and sustainability.

## Livability

Promoting water quality and reliability. Smart cities use ICT to protect the safety and reliability of their water supply. Remote sensors can detect impurities, protecting water supply from the intentional or unintentional introduction of contaminants. The affected areas can often be isolated automatically, preventing the spread. Meanwhile, the system alerts human operators so that they can deploy repair crews to fix the problem.

**Increasing resilience.** Smart security measures help protect water infrastructure from external cyber threats. Video cameras and access cards can provide physical security. Automated fault management can ensure problems are found and dealt with before they affect a wide area. In a disaster scenario, analytics can immediately tell cities

what equipment needs replacing, and can prioritise tasks for maintenance crews so that water delivery is restored as quickly as possible.

### **Increasing customer choice and control.**

ICT can empower customers with information about when and where they are using water, plus tools to help them control that use. This allows them to change behaviour and make trade-offs to lower their bills.

### **Reducing damaging floods and overflows.**

Full situational awareness informed by weather data helps cities see exactly where floods and overflows are occurring. Some systems can even predict floods in advance, so emergency crews can be dispatched in advance. Technology also allows cities to more effectively plan flood prevention efforts.

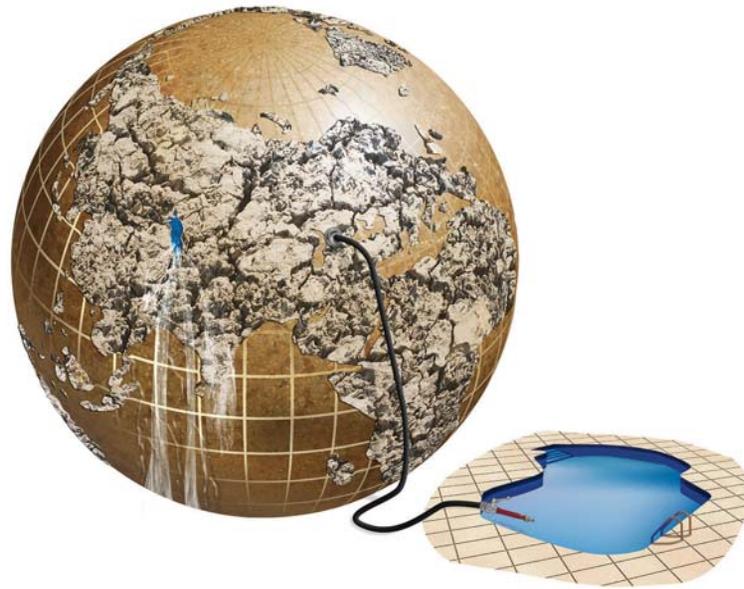
**Saving energy on building cooling.** Green roofs and other green water systems not only capture water for use before it enters a crowded sewer, they also serve to cool the buildings and streets and other infrastructure in which they are housed. This can save energy on building cooling while simultaneously reducing the dangerous urban heat island effect.

## Workability

### **Increasing economic development.**

Smart water can differentiate a city in the competition for business and investment. Smart water is financially attractive to industrial consumers in particular, since they are often the largest users of a city water supply. Water-intensive businesses often decide whether to expand and where to relocate by looking first at a region's water availability.

**Lowering operational costs.** ICT solutions can dramatically reduce costs for both water providers and customers. Cities can optimise their water infrastructure for efficiency, saving the cost of wasted resources and optimise maintenance. Advanced analytics, using data from smart water meters in homes and businesses can identify ways customers can reduce consumption and save on water bills.



The compelling case for smarter water:

## THE COMPELLING CASE FOR SMARTER WATER

**N**on-revenue water (NRW) – water that is produced but lost before it reaches the customer – is a major challenge for water utilities around the world. NRW has a significant financial impact on utilities and their customers. It also represents the loss of a precious resource.

NRW occurs for a variety of reasons:

- Unmetered consumption (where water meters do not exist so usage can't be accurately measured)
- Authorized but unbilled consumption (fire fighting, for instance)
- Apparent losses (water theft and metering inaccuracies)

- Real losses (leaks and bursts)

A 2011 study by the Smart Water Networks Forum (SWAN), a Council advisor, compiled NRW losses in urban centre around the world. The findings were staggering. The NRW in Guayaquil, Ecuador topped the list at 73%, but Adana, Turkey wasn't far behind at 69%. NRW ranging from 30% to 50% were not uncommon. Conversely Singapore, which is recognized as a leader and innovator in smart water, reported NRW losses of just 4%.

As Navigant Research analyst Neil Strother states: "Losses from NRW represent \$14 billion in missed revenue opportunity each year, according to the World Bank. The economic case for better water metering is compelling."

### The compelling case for smarter water:

*Losses from non-revenue water – which can include everything from water theft to leaks and billing irregularities – represent an estimated \$14 billion in missed revenue opportunity each year, according to the World Bank.*

Navigant has forecast that the global installed base of smart water meters will reach 29.9 million by 2017, up from just 10.3 million meters in 2011. By the end of the forecast period, Navigant anticipates that 3.3 million smart water meters will be shipped each year, representing an annual market value of \$476 million.

And smart water meters are only part of the larger market. In 2011, Lux Research said that the market for technologies to inspect and repair the world's aging water infrastructure was approaching \$20 billion world-wide and growing at a healthy 10%. It reported that many municipalities were desperately seeking cost-effective new ways to maintain their pipe networks. Lux claimed that the most successful solutions would be those that can monitor the entire water infrastructure

and reveal the sections in most urgent need of repair.

"Out-dated water infrastructure and record deficits are both fuelling demand for low-cost inspection and repair solutions – namely software and sensor technologies that can provide a snapshot of a utility's entire infrastructure," said Brent Giles, a Lux Research senior analyst. "Without this holistic view, utilities cannot prioritize the most critical repairs – and may end up throwing money down the drain to address the leaks that are visible today rather than the ones that could prove catastrophic tomorrow."



## Sustainability

**Eliminating wasteful leaks.** Smart water meters and sensors reduce water loss. Through situational awareness and automated fault management, water utilities can immediately identify and repair leaks and problems. Most cities that install smart water networks discover they have been losing at least 10% to leaks and percentages as high as 50% are not unusual.

**Conserving the water resource.** Treating and reusing the water helps in conserving the precious water resource.

**Getting the maximum value from existing infrastructure.** Building entirely new water systems is not an option for most cities. With ICT, cities can make their existing systems far more productive.

**Harnessing the kinetic energy of water.** Achieving an energy efficient water system to power and use ICT.



Conversing the water resource:

## WASTEWATER REUSE HELPS PALAVA ACHIEVE WATER SUSTAINABILITY

**P**alava is one of the first smart city projects under development on 4,000 acres area by the Lodha Group near Mumbai. To ensure water sustainability in this township, Lodha developers have partnered with Council member GE Power, Water & Process Technologies.

By using GE's state-of-the-art ZeeWeed Membrane Bioreactor (MBR) technology, for sewage/wastewater treatment and reuse, the Developers shall provide Palava township residents the ability to recover and reuse a significant quantity of water for applications such as gardening, flushing, floor and car washing, water landscapes and HVAC.

GE's MBR technology not only ensures regulatory compliance but also provides other benefits such as safe, automated, odor-free operations, the best quality of treated water, space savings and lowest lifecycle costs. Combined with rainwater harvesting, wastewater reuse would reduce dependency on external sources and make the townships self-sustainable for water needs.

GE has designed and constructed two Sewage Treatment Plants (STPs) based on MBR technology, at: Casa Bella Gold (3 MLD or 3 Million Liters per Day) and Casa Rio (6.1 MLD). These plants are designed with modular capability such that the capacity can be increased in a phased manner.

 **Conversing the water resource:**

*MBR technology not only ensures regulatory compliance but also provides other benefits such as safe, automated, odor-free operations, the best quality of treated water, space savings and lowest lifecycle costs reducing dependency on external sources and make the townships self-sustainable for water needs.*



## Optimise water use:

*Many technologies and best practices can help cities develop a smart water system, including advanced, automated water treatment facilities.*

## Water targets

Many technologies and best practices can help cities develop a smart water system. Five targets specifically relate to water and wastewater and will be discussed in detail below. We'll also talk about several of the universal targets as they apply to smart water.

**Implement optimal instrumentation and control across the watershed.** We've added on to this universal target to remind you that most cities will need information that extends beyond their city boundaries. A smart water network uses sensors to capture data on the condition of the water and the equipment. These devices are installed in both traditional

and non-traditional segments of the watershed — from the pipes and pumps to green water systems in gardens or rooftops that collect storm runoff or grey water. As noted above (and as illustrated in the case study from the Netherlands), cities will want to collaborate to gather data not just within city limits, but from the larger watershed as well.

Smart water networks also utilise sensors that monitor water quality. This may include tracking different grades of water to ensure they are properly routed for the appropriate end use.

In addition to sensors for the physical infrastructure, some cities will want to consider smart water meters. In regions with

conservation mandates, smart meters can give customers the detailed information they need to curb consumption. Smart meters can also reduce the need for additional sensors on pipes, pumps and switches.

**Connect devices with citywide, multi-service communications.** This universal target applies equally to water. It is worth reminding, however, that most cities should NOT build a communications network just for smart water purposes. Instead, they should seek to piggyback on an existing network. Or share costs with other departments to build a system they all can use. For instance, in Tianjin China, a single communications network carries the signals for smart meters of several different kinds.



Connect devices with  
citywide, multi-service  
communications:

## BISMARCK UTILITIES COLLABORATION IMPROVES CAPABILITIES

**B**ismarck, North Dakota's state capital, sources its municipal water from the Missouri River and disperses its treated water through an elaborate distribution network. Even though advanced metering infrastructure (AMI) is being installed at an increasing rate every year and over 50% meters installed in the US are now smart meters, overall, the effort to modernise water infrastructure has made slow progress in North America.

The city of Bismarck faced challenges to control its budgets while aiming to modernise water management technologies, especially in attaining a return on investment on the most expensive aspect of implementing AMI networks: the communications infrastructure needed to route the meter and network sensor data to the utility back office.

The city of Bismarck partnered with Council member Itron to deploy multi-utility meter reading concept with the help of two progressive utilities, Bismarck's water department and Montana-Dakota Utilities (MDU). These entities work together to improve water infrastructure operations – the first example of public-private partnership to manage an entire city's water meters.

Montana-Dakota Utilities (MDU) already uses Itron's network system to collect, measure, and analyse meter data from over 300,000 meters installed for electric and natural gas service. With the help of Itron, the water department modernised its water distribution system with 21,000 advanced water communication modules and managed the smart water system using MDU's existing network in its service territory, as per an agreement that MDU provides water meter readings to Bismarck using its existing network.



Connect devices  
with citywide,  
multi-service  
communications:

*Bismarck's water department and Montana-Dakota Utilities (MDU) work together to improve water infrastructure operations – the first example of public-private partnership to manage an entire city's water meters.*

## Inclusivity

Providing 24x7 supply of drinking water for all and adequate and hygienic sanitation are one of the most important and high priority goals for smart cities around the world.

**Achieve accessibility optimisation.** Smart water has to be clean, accessible, affordable and inclusive — it not only provides water to all citizens, it also prevents water theft and illegal connections, mitigating risk of backward contamination of clean water supply. With the effort of the state and the World Bank, Punjab today leads its way to bring safer water to its citizens — more than 1 million homes receive safe water supply.

**Formulate citizen reporting framework for outcome thinking.** The city municipalities should empower local groups with knowledge, understanding, and real-time information for water conservation and sustainable usage, such as to manage extraction in a cooperative way. This problem can only be managed by a cooperative agreement among the users of the aquifer, who should know how much can be extracted without depleting the resource. The state can monitor and provide this information. Mexico's efforts at cooperative management of groundwater suggest that this practice can work.

## Collaborativity

**Create an institutional framework.** Water is a local issue; however, it is a state-level subject in the federal constitution, and collaboration with state governments is extremely critical to devise a holistic strategy. The smart city municipalities create a platform, to share ideas and take into account the strengths of the water resources throughout the state, and formulate a comprehensive framework. This leads to avoiding conflicts as well as sustainable use of this finite natural resource. When appropriate, smart cities privatise the water-distribution systems to improve its efficiency.

**Pursue multilateral collaboration.** At the same time, many active NGOs are now able to enforce compliance with environmental obligations through the Right to Information Act, active and competitive media, and growing awareness on water issues. Furthermore, international agencies like Habitat for Humanity and World Bank offer collaborative and financial assistance to the cities.

## Governance

**Achieve existing infrastructure optimisation.** Rain harvesting could be one solution for water collection. Collected water can be immediately used for agriculture and landscaping, and with improved and advanced technology filtration practices to reduce water-borne pathogens, also quickly available for human consumption.

**Develop systems to enforce regulations.** The city should work with state pollution control boards to formulate, strengthen and enforce effluent standards. The capital, technical and human resources currently available to the boards are inadequate to effectively monitor activities, enforce regulations, and convict violators.



# TOWN of CARY

The Technology Town of North Carolina

Achieve existing  
infrastructure optimisation:

## AQUASTAR PROJECT HELPS TOWN OF CARY TO SAVE MONEY

**T**own of Cary had manual meter reading system, conducted by meter readers walking routes with handheld devices interfaced to the billing system, would be over-burdened with the growth projections for the town, while the demands for accurate readings would exceed. Non-revenue water was a growing concern along with growing metering inaccuracies and theft or unmetered consumption.

In addition, holidays, unplanned staff absences, and inclement weather disrupted meter reading schedules, which led to inconsistent billing periods. When customers called to express dissatisfaction with high bills, the town was unable to provide information about when high usage occurred.

Cary replaced 60000 Residential and Commercial water meters which required monthly manual readings with a Aquastar wireless system that collects hourly meter data, allowing the town to operate more efficiently and provide citizens with in-depth water usage reports, powered by SAS® Analytics from Council member SAS.

SAS® Analytics platform is used to analyse millions of rows of metered data. The town's daily reports reveal anomalies, and prioritise and identify customers with possible leaks or unplanned water usage. Cary uses the reports to proactively reach out to customers to alert them of high and/or continuous water use.

### **Reducing carbon footprint and cost of service operations.**

Aquastar helped Cary reduce carbon emissions by taking meter readers off the road, as previously, 10 meter readers drove 71,000 miles and used 7,000 gallons of fuel in one year.

**Increasing billable revenues and higher operational savings.** Through operational savings, Aquastar will save the utility more than \$10 million.

### **Increasing business effectiveness & reduces**

**amount of unaccounted water.** The town can quickly detect and stop leaks, and give customers valuable information so that they can use water more wisely and future rate setting more predictable.



Achieve existing  
infrastructure  
optimisation:

*The town can quickly detect and stop leaks, and give customers valuable information so that they can use water more wisely and future rate setting more predictable. Through operational savings, Aquastar will save the utility more than \$10 million.*

## Interoperability

**Adhere to open standards.** Hydrologic data collections and sensor feeds are notoriously non-interoperable. By using open standards such as the new OGC Water ML 2.0 Encoding Standard, diverse data collections can be quickly discovered, assessed, accessed, aggregated, compared, used with other spatial data (weather, geology, elevation etc.), and flowed between computer models.

## Data management

**Create and adhere to a citywide data management, transparency and sharing policy, including water usage data.** In the Universal chapter, we discussed the merits of a citywide data management policy. In this chapter, we want to recommend additional rules that apply specifically to water.

Cities may not own their own municipal water utility, but they will want to have access to overall usage data provided by the local utility. It's important to ensure that the data conforms to the citywide data management policy, even if it originated elsewhere. Cities will also want to encourage utilities to grant water customers access to their own

consumption data so they can see hour-by-hour how, when and where they use water. Armed with this type of information, they can make choices and trade-offs that can reduce their water usage and their utility bills.

From a smart city perspective, water usage data is invaluable for long-range planning, for making zoning decisions, for water efficiency programs, for low-income assistance programs – and for setting an example by reducing water consumption in city facilities.

## Computing resources

**Consider a cloud computing framework.**

With the cost of cloud services declining, this universal target can make sense for cities large and small. It is particularly germane to the water sector in North America. In that part of the world there are few large water companies. Instead, water is managed by more than 18,000 small- to medium-sized organisations. Few of them have the budget for a large ICT staff and powerful server farms. Yet they can get the same power and benefits as larger organisations by turning to software-as-a-service running in the cloud.

**Have access to a central GIS.** A central geographic information system (GIS)

improves decision-making capabilities citywide. Two reminders germane to water: 1) In many parts of the world the water system is well over 100 years old and many water utilities don't know exactly where all the pipes and valves are located. 2) A city water department should seek to share costs with other departments if it needs to build a GIS system from scratch. A central GIS enables efficiency gains through more intelligent scheduling and routing, provides improved accuracy of essential records and boosts resiliency of key assets.

## Analytics

**Achieve full situational awareness across the watershed, informed by weather data.**

Situational awareness is a universal target. When it comes to water responsibility, it means getting a complete view of what's happening across a watershed. Such insight is essential for cities that want to 'close the loop' and promote sustainability by relying on their local watershed rather than importing water from elsewhere. That situational awareness should be further expanded by including local and regional weather data. Weather data can help give an accurate view of current conditions and can help predict future problems.



Smart water requires smart collaboration:

## WATER AGENCY BUILDS "BORDERLESS" INFRASTRUCTURE

**T**he California Natural Resources Agency manages the state's natural resources, including water. One of its largest departments is the Department of Water Resources (DWR), with around 3,500 employees. DWR supplies and manages the water-delivery systems, provides flood protection through improvement of levees, inspects 1,200 dams and helps coordinate the state's integrated water management.

To accomplish those tasks, department personnel need to access and manipulate large data sets to model the effects of the environment on the water system. "Many of our missions require close collaboration with other federal, state, and local government organisations, subject matter experts, and the people of California," says CEO Tim Garza.

But DWR had limited ability to share data outside the

department, which made it difficult to make timely decisions.

The agency wanted a new data centre infrastructure that could adapt easily to support changing business needs. The immediate need was for borderless collaboration with all stakeholders, including local, state and federal government and private sector entities.

The solution the agency chose was a borderless infrastructure based on Council member Cisco's Data Centre Business Advantage solutions and Cisco's planning, design and implementation services.

The results enabled secure collaboration by creating 20 distinct security zones, reduced total cost of ownership for the network by 30% and accelerated network performance by 40%.



**Smart water requires smart collaboration:**

*California Department of Water Resources required a secure way to share data with other water management agencies. New "borderless infrastructure" from Cisco created 20 distinct security zones, making it easy for multiple departments to collaborate safely.*



### Pursue predictive analytics:

*By analyzing the data from a smart water infrastructure and combining it with weather data, cities can predict problems, such as areas prone to flooding.*

- **Optimise water use.** Smart devices can monitor conditions and assign different water grades. Some grades might be acceptable for your garden, but not for your cooking.
- **Automate fault and leak management.** A smart water network can automate many parts of the leak management process. Leak management systems automate both the prioritization of repair work and the dispatch of crews. They make water systems more resilient to natural disasters and intentional damage.
- **Pursue predictive analytics.** This universal target applies to water in powerful ways. By analysing the data from smart water infrastructure and combining it with weather data, cities can predict problems, such as areas prone to flooding. In some cities — including Rio de Janeiro — smart systems can monitor incoming storms and predict where floods will occur later that day, so emergency steps can be taken in advance.
- **Optimise energy use.** Hydro-powered generators can allow real-time sensor operations and significantly cut down on operating expenditures.

**Achieve operational optimisation for sustainability, efficiency, cleanliness and safety.** Operational optimisation is a universal target. We have extended it to emphasise its value in a smart water network. Here are examples.

- **Optimise water capture.** A city might discover it is overdrawing from one source, and under drawing from another. Correcting the situation creates a more optimised operation and a more sustainable water supply.
- **Optimise water distribution.** Analytics can ensure water goes where it is needed, when it is needed. Demand and supply can be balanced, so that water is distributed, consumed and reported with maximum efficiency. With smart meters providing data on consumption at customer premises, water pricing can move to a variable model to acknowledge that water is more expensive to procure in certain seasons and certain times of the day.



Optimise water distribution:

## BIG DATA ANALYTICS ASSISTS IN 100% EQUITABLE WATER

With a population of more than 33 lakh, providing connections with equitable water supply to 2.1 lakh households in Thiruvananthapuram was a challenging task for the Kerala Water Authority (KWA), Government of Kerala, India, due to aging pipes, leaking infrastructure and unauthorised use of water. KWA was facing challenges in two areas — loss of close to 45% of the current water supply and lack of proper water management in the city, and revenue collection, as the billing system was unable to accurately track water consumption by consumers.

KWA wanted to put in place the necessary infrastructure, monitoring systems and analytics to help proactively identify potential issues, dramatically reduce water waste, improve customer satisfaction and increase the efficiency of maintenance and business operations.

KWA deployed council member IBM's Big Data analytics solutions to analyse, monitor and manage water distribution in the city of Thiruvananthapuram. With the solutions, KWA aimed to achieve 100% success in equitable water supply with the ability to monitor and flag irregularities in water usage using sensors and intelligent meters.

IBM worked closely with KWA to establish a Water Management Centre using the IBM Intelligent Operations Water Software containing GIS information to bring all the distribution and consumption data from meters across the city to a central dashboard. The unified and real time information of water usage now can be effectively and predicatively monitored and managed, thereby reducing billing anomalies and improving revenue collection by more than 10%.



**Optimise water  
distribution:**

*The unified and real time information of water usage now can be effectively and predicatively monitored and managed, thereby reducing billing anomalies and improving revenue collection by more than 10%.*

# ISO 37120: A yardstick for measuring city performance



In 2014, the International Organisation for Standards announced an ISO standard that applies strictly to city performance. The document -- known as ISO 37120:2014

-- establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, planning, wastewater, water, and sanitation.

In the table, we have indicated how the standard related to Water and Sanitation and Wasterwater correspond with the Council's Water and Wastewater targets identified on the next page. The ISO smart city wastewater standard attempts to capture all the risk to the water supply with five core indicators designed to measure the availability of wastewater treatment, accessibility and the quality of the treatment.

## Water and Sanitation Indicators

			Optimal instrumentation across water shed	Citywide, multi-service communications	Create water data management policy	Achieve operational optimization	Achieve asset optimization	Automate fault and leak management	Full situational awareness across watershed	Pursue predictive analysis
<b>Core</b>	21.1	Percentage of city population with potable water supply service	●	●	●					
	21.2	Percentage of city population with sustainable access to an improved water source	●	●	●					
	21.3	Percentage of population with access to improved sanitation	●	●	●					
	21.4	Total domestic water consumption per capita (liters/day)	●	●	●	●	●	●		
<b>Support</b>	21.5	Total water consumption per capita (liters/day)	●	●	●	●	●	●		
	21.6	Average annual hours of water service interruption per household	●	●	●			●	●	●
	21.7	Percentage of water loss (unaccounted for water)	●	●	●			●	●	●

## Wastewater Indicators

<b>Core</b>	20.1	Percentage of city population served by wastewater collection	●	●	●	●	●	●		●
	20.2	Percentage of the city's wastewater that has received no treatment	●	●	●	●	●	●		●
	20.3	Percentage of the city's wastewater receiving primary treatment	●	●	●	●	●	●		●
	20.4	Percentage of the city's wastewater receiving secondary treatment	●	●	●	●	●	●		●
	20.5	Percentage of the city's wastewater receiving tertiary treatment	●	●	●	●	●	●		●

# WATER AND WASTEWATER TARGETS

In the checklist below, targets specifically pertaining to the water and wastewater responsibility are in **bold**, universal targets are not.

	Enabler	Water and Wastewater Targets: How smart cities deploy and use ICT to enhance their water infrastructures	Implementation Progress			
			None	Partial	Over 50%	Complete
Human	Inclusivity	Achieve accessibility optimization <b>(Supplement: including physical and web accessibility)</b> Formulate citizen reporting framework for outcome thinking Achieve citizen engagement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Collaborativity	Create institutional framework <b>(Supplement: across multiple transit systems)</b> Pursue multilateral collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	Governance		Achieve existing infrastructure optimization <b>Instigate 'soft mobility'</b> Facilitate revenue generation for the city <b>(Supplement: using demand-based road user charging)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# WATER AND WASTEWATER TARGETS

In the checklist below, targets specifically pertaining to the water and wastewater responsibility are in **bold**, universal targets are not.

Technology	Enabler	Water and Wastewater Targets: How smart cities deploy and use ICT to enhance their water infrastructures	Implementation Progress			
			None	Partial	Over 50%	Complete
	<b>Instrumentation and Control</b>	Implement optimal instrumentation <b>(Supplement: across the watershed)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Connectivity</b>	Connect devices with citywide, multi-service communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Interoperability</b>	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Security and Privacy</b>	Publish privacy rules Create a security framework Implement cyber security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Data Management</b>	Create a citywide data management, transparency and sharing policy <b>(Supplement: including water usage data)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Computing Resources</b>	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Analytics</b>	Achieve full situational awareness <b>(Supplement: across the watershed, and informed by weather data)</b> Achieve operational optimization <b>(Supplement: for sustainability, efficiency, cleanliness and safety)</b> Achieve asset optimization <b>Automate fault and leak management</b> Pursue predictive analytics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Rapid, dynamic population growth, increasing disposable income and changing consumer behavior have put tremendous pressure on basic amenities and municipal services, and dealing with the chronic problem of unmanageable urban waste is one of the most pressing civic issues city leaders are facing today. Hence, smart and innovative concepts for effective and sustainable solid waste management to reduce or eliminate adverse impacts on environment and human health becomes of utmost importance.

# 10

## Waste Management



clothing, bottles, newspapers, appliances, paint and electronic items.

In the past century, as the world's population has grown and living standards continued to escalate, waste production has risen tenfold. Moreover, the solid waste generation rate is outpacing urbanisation. In a landmark report released in 2012, the World Bank estimated that urban residents worldwide generated 1.3 billion tonnes (or metric tonnes) of municipal waste per year. By 2025, cities are expected to nearly double that amount, producing 2.2 billion tonnes.

The waste management problem is acute in emerging economies. Laogang in Shanghai, China; Sudokwon in Seoul; the now-full Jardim Gramacho in Rio de Janeiro, Brazil; and Bordo Poniente in Mexico City are some of the largest landfills in the world — each typically receiving over 10,000 tonnes of waste per day.



### The rising ride of waste:

By 2025, India will be the world's fastest growing region for waste, according to World Bank projections. Hence, managing the waste is going to be a major environmental and economic challenge for India

## Mounting problem of garbage

Solid waste is inextricably linked to urbanisation and economic development — the most striking and noxious by-product of resource-intensive, consumer-based economic lifestyles. Municipal Solid Waste (MSW) refers to the commercial and residential garbage generated in municipal or notified areas — household and industrial waste, construction and demolition debris, waste from streets and so forth. MSW consists of everyday items such as product packaging, food scraps, vegetable waste, discarded furniture,

In urban India, around 60 million tonnes of municipal solid waste (MSW) is generated annually. Though the number looks relatively low compared to some of the global cities, most of the Indian cities does not have scientific waste disposal and sewage treatment facilities. Rapidly growing population, increasing disposal income and changing lifestyle, food habits and consumer behaviour in India has considerably changed the composition of municipal solid waste and going forward, will significantly increase the amount of waste generated.

By 2025, India will be the world's fastest growing region for waste, according to World Bank projections. Hence, managing the waste is going to be a major environmental and economic challenge for India.

In India, a fraction of the solid waste is recycled or composted, and most of the waste is landfilled or incinerated, and still a lot is unmanaged — leading to open dumping. Landfills are increasingly becoming a major problem — due to space limitation — while existing landfills in metropolitan areas are becoming full, finding new ones is even more difficult.

In this chapter we examine how smart technologies are enabling cities to manage MSW in an efficient and sustainable manner. As in other city responsibility areas,



information and communications technologies (ICT) are driving many of these new solutions, particularly in the area of garbage collection. But scaled-up applications in the realm of biological and industrial engineering are also involved.

### **The rising ride of waste:**

ICT driving many of the new solutions, particularly in the area of garbage collection. But scaled-up applications in the realm of biological and industrial engineering are also involved.

## Why managing solid waste matters

As the municipal solid waste is piling up at an alarming rate in India, the SWM efforts are becoming inadequate and the effects of poorly managed waste disposal are becoming increasingly threatening.

**Public health.** First and foremost, cities manage waste to mitigate its public health impact. As a breeding ground for bacteria, insects and vermin, accumulated trash has long been linked to the spread of air- and water-borne diseases. Industrial Revolution and mass movement of workers to cities spurred the first rigorous efforts to address and improve urban sanitation. These efforts included systematic waste collection with disposal via incineration plants and landfills.

Solid waste landfills are becoming a chronic problem — leading to significant health concerns, direct and indirect. Lack of enforced regulations enables potentially infectious medical and increasingly expanding level of hazardous industrial waste to be mixed with MSW, which is harmful to public health, waste pickers and the environment. E-Waste — obsolete, discarded, broken and surplus electrical and electronic devices — are of immediate and long-term concern as the industry is unregulated and recycling can lead

to major environmental degradation which presents imminent threat to human health. Additionally, it may result in safety hazards from fire or explosions.

**Environment protection.** The environmental impacts of poor collection and improper waste disposal methods — and their effects on public health — came under closer scrutiny after World War II. In India, solid waste is predominantly disposed of in landfills — most are not properly lined and protected, resulting in landfill debris leaching out and contaminating groundwater, or open dumping grounds, contaminating surface water.

The problem of landfill greenhouse gas (GHG) emissions is even worse. Landfill gases are produced by the breakdown of organic material. They contain carbon dioxide, methane, volatile organic compounds, hazardous air pollutants and odorous compounds that can adversely affect public health and the environment. Methane is of particular concern. It is 25 times more effective at trapping heat in the atmosphere than carbon dioxide. Methane from landfills represents about 12% of total global methane emissions. Also open burning and landfill fires add a significant amount of pollution in the air.

There are also significant carbon emissions released from the transportation of municipal solid waste.

**Cost control.** Managing solid waste is one of the major responsibilities of the local government, and constitutes the single greatest cost in the municipal budget. Moreover, the global cost of managing garbage is going up, most severely for rapidly developing countries. The World Bank predicts the annual global garbage bill will jump from the current \$205 billion to \$375 billion by 2025. Even today, there is trash dumped at street corners and in open street-side drainage facilities, creating extreme health and environmental issues, requiring additional labor- and capital-intensive clearing efforts to prevent water blockages and flooding.

**Promoting sustainability.** Waste management practices have become increasingly linked to the goal of sustainability. Programs that promote waste prevention, recycling and material recovery directly support emerging sustainability goals by reducing demands on the resources and energy as well as landfills.

Hence, there is a severe need to sort out recyclable and biodegradable waste. More importantly, there is a need to see waste more than a waste, but as a resource. Before we think of waste prevention — we need to take a closer look prior to a material or product becomes solid waste. The linear — take, make, dispose — economy is becoming increasingly unsustainable and even expensive for the businesses and the economy.



have access to SMW systems; effective - to safely remove waste; efficient - to maximise benefits, minimise costs, and optimise the use of resources; and sustainable - technically, environmentally, economically and socially.

## Waste is not a waste till it is wasted

Smart cities have a complete different take on waste. Waste is considered more than just garbage, and develop approaches to tackle the problem at its source is the way forward toward smart waste management.

### Need a shift in thinking

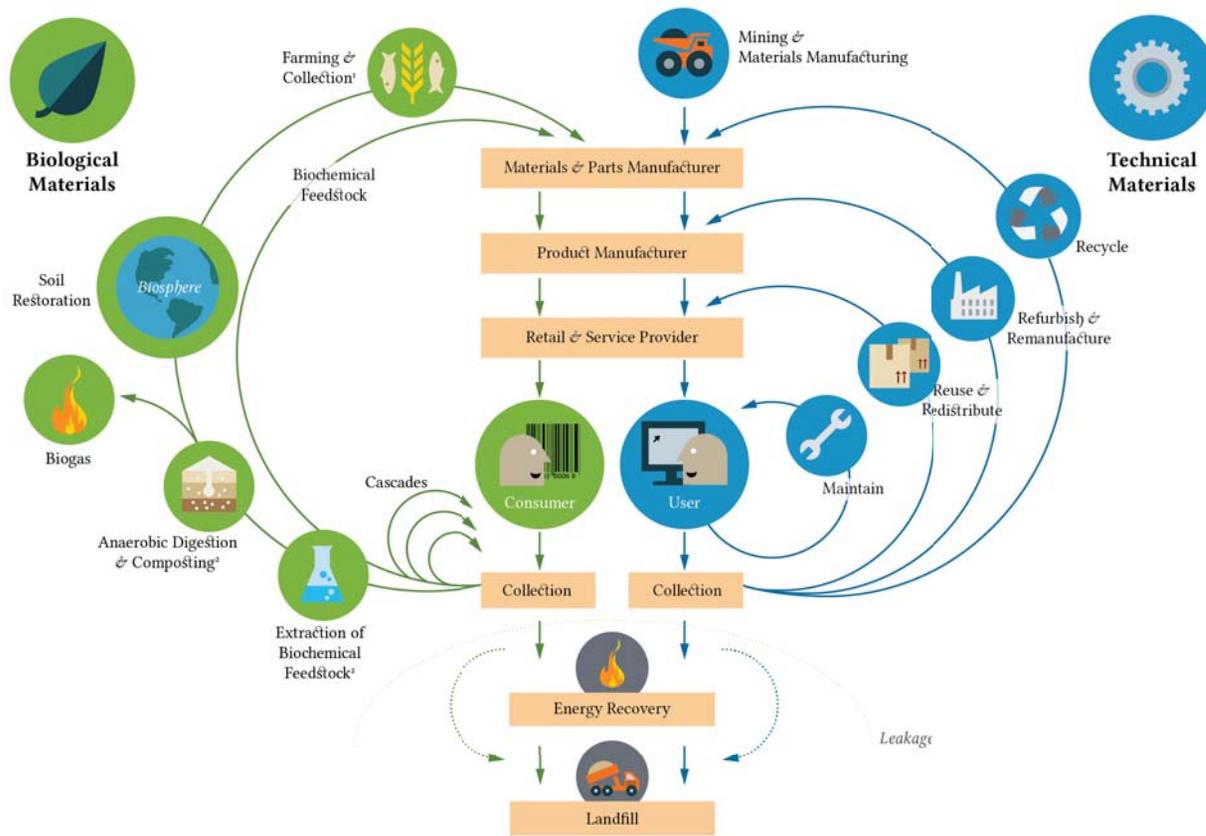
The pursuit of sustainability represents one shift in the thinking around modern waste management practices. The other more essential shift in mindset is from waste management to resource management. As landfills are phasing out, incineration is increasingly becoming the chosen solution; there needs to be a closer look at this approach. Even though waste-to-energy is diversion of materials that comes from petroleum products, it creates emission Hazardous ash that contains toxic substance and heavy metals that must be dealt with.

### Need a shift in thinking:

*The pursuit of sustainability represents one shift in the thinking around modern waste management practices. The other more essential shift in mindset is from waste management to resource management.*

## Integrated solid waste management

Solid waste management encompasses the entire life-cycle of material, from extraction of raw materials to ultimate transformation. ISWM reflects the need to approach solid waste in a comprehensive manner — waste prevention, recycling, and disposal program — with careful selection and sustained application of appropriate technology, working conditions, and 'social license' between the community and local government waste management authorities. ISWM in smart cities are driven by four objectives: inclusive - all citizens to



A circular economy is a closed-loop system which acts like nature to rebuild capital and minimise risks of managing finite resources — where ‘biological nutrients’ that reenter the ecosystem safely and ‘technical components’ that are designed to circulate at high utility value in the production system without entering the biosphere — without creating any garbage or pollution. A circular economy is a continuous development cycle of a restorative economy — to regenerate manufactured, financial or natural capital.

Urban metabolism, material and energy flows in cities, needed to be analysed to develop widespread application of this ‘industrial ecology’ — to re-thinking and re-designing the manufacturing and urban systems to make and reuse or remake products over and over again, ultimately minimising or eliminating waste.

There are multiple innovative ideas currently incubating that will allow to recover and reuse existing materials, such as Council member IBM Research and some European companies who have successfully developed technology to create infinitely recyclable plastic — using biorecycling or chemical recycling processes, considerably reducing the waste itself.

### Circular economy:

The lifecycle analysis of product or material instigated an innovative concept, waste = food. Depiction of the Circular Economy by the Ellen MacArthur Foundation.

### Circular economy

As material or product goes through a long life cycle — extracting and processing raw materials, manufacturing, transporting materials and products, and operations — all mostly use finite resources — raw materials and energy from fossil fuels. The analysis of lifecycle instigated the idea of cradle-to-cradle product innovation, which was developed into an innovative concept, waste = food.

## Seeing waste as an asset

Waste represents a source of assets from which to recover both materials and energy in a cost effective and environmental-friendly manner. This emphasis on recovery departs from the traditional 'reduce, reuse, recycle and dispose' mantra chanted by waste management pundits.

"The first message for municipalities considering best practices for waste management is to transition from seeing discarded materials as a waste, a liability, towards recognising each scrap as a potential asset to be recovered and returned to the marketplace," says Michael Theroux, a resource recovery consultant and Council Advisor who advocates clean conversion for recovery of energy and raw materials at his 'Thru Talk' website.

This focus on broad recovery of waste stream components strives to shrink the volume of garbage that goes into problematic landfills and incinerators. But it's also introducing the view that waste represents a revenue-generating resource. Cities now have the opportunity to sell their waste streams to companies that sort, divert and process refuse into products that have genuine market value.

## Seeing waste as an asset:

*Waste represents a source of assets from which to recover both materials and energy in a cost effective and environmental-friendly manner.*



## Understanding the character of waste

For cities embarking on new waste management initiatives, experts advise that they should first get to know their garbage. Municipalities must understand the nature of waste generation in their particular community, including what's in it, where it's coming from and how much of each type is present. An agro-based country like India creates a lot of agricultural, wet waste. Annually, India generates approximately 60 million tonnes of garbage, mostly wet, where metropolitan cities contribute a

significantly large amount. However, there is not enough, accurate data. With more prosperity comes more packaging, imports, electronic waste and broken appliances — changing the mix of waste generated.

"You cannot manage what you do not measure," says waste consultant Theroux. He advises that waste characterisation studies include city demographics, land use and business data. The use of geographic information (GIS) system data can help plot physical location of waste generators, while useful analytical tools such as cluster analysis help city management understand where there are concentrations of large-volume generators of certain waste types.



In the hierarchy of waste management, the waste diversion options of reduce, reuse, recycle — a fourth 'R' for recovery will prove to be a value-added solution in the near future. These options are then followed by incineration and landfill, or other disposal options.

Smart integrated solid waste management falls in five phases:

- Reduce – Smart waste prevention
- Reuse – Smart waste dispersion
- Recycle – Smart waste collection
- Recover – Smart material and energy recovery
- Disposal – Smart waste disposal

However, smart cities around the world devise and encourage smart waste management solutions that with actively participate in the critical dimension — reduce — to manage the amount and type of waste generated Let's look at each of these areas a bit closer.

### The hierarchy of waste management:

The waste diversion options of reduce, reuse, recycle — a fourth 'R' for recovery will prove to be a value-added solution in the near future. These options are then followed by incineration and landfill, or other disposal options.

## Getting smart about waste management

Municipal corporations are charged with an immense task of managing municipal solid waste — to dispose the waste in the most economically, socially, and environmentally optimal manner possible. Smart solutions are already working their way into the waste management arena. Navigant Research reports that smart waste management technologies now touch 43% of the global solid waste stream. And more convergence is on the way. The research firm estimates that 644 million tonnes of waste was managed by smart waste technologies in 2014. This volume is expected to increase to 938.4 million tonnes by 2023.

Reducing resource use through optimisation:

## SMART SENSORS PROVIDE COST SAVING SOLUTIONS IN FINLAND



Located 50 kilometers east of Helsinki, the Finnish capital, is Porvoo, an old medieval town situated in the picturesque scenery of the Finnish archipelago. In the summer of 2011, the scenery at the local recycling stations was less picturesque; overflowing waste containers and angry customers. The local waste management authority, Itä-Uudenmaan Jätehuolto, was having considerable challenges handling the increasing amount of waste that the many guests were generating during the summer season.

Overfilling at the local recycling stations was becoming more common, causing increased littering and cleaning costs. Customers were demanding increased collection intervals, while the service was getting too expensive to maintain.

To tackle the problem the authority decided to pursue

a smart city solution, installing wireless fill-level sensors at recycling. The sensor system provided by Finland-based logistics solution company Enevo, a Council member, measures and forecasts when waste containers will be full. By combining the forecasts with traffic and vehicle information, Enevo's system can generate millions of different route options and suggest the most cost-efficient to the user.

By utilising Enevo's smart sensor service ONE, Itä-Uudenmaan Jätehuolto was able to:

- Reduce the amount of collections by 51%
- Reduce unnecessary driving and emissions
- Reduce the overfilling problem at recycling stations
- Achieve a net savings rate of 47%



Reducing resource use through optimisation:

*By installing Enevo smart sensors the local waste management authority was able to cut the amount of collections by 51% and achieve a net savings rate of 47%. The image above shows a typical recycling station in the Porvoo region.*



## Reduce – smart waste prevention

Most of the material impact is through production and use. Much can be done locally to reduce waste. Public education, outreach, and training are critical components for efficient waste reduction and reuse program.

Resource reduction seeks to prevent waste from being generated in the first place. Minimising or avoiding production of new products or packaging, and thereby preventing waste generation most often is the best strategy to significantly reduce pollution and greenhouse gas emission. Substituting electronic phone directories over print, New York City eliminated approximately 1.3 tonnes of paper each year and reduced estimated greenhouse gas impacts by 2.8 metric tonnes of carbon annually.

The Japanese city of Kawasaki has improved its industrial processes and diverted 565,000 tonnes of potential waste per year — more than all the MSW the city now handles.

### Smart collaboration

The zero waste movement represents an even broader push for sustainability. It not only advocates eliminating waste through waste prevention and recycling, it works toward restructuring production and distribution systems to make everything reusable — in theory completely eliminating the need for landfills and incineration. Smart cities are following the circular economy approach to intentionally designing products in a way that their materials can be continually returned, in high quality state, to the production process.

A number of cities – San Francisco, Austin, Texas and Ljubljana, Slovenia among them — have developed collaboration among various city agencies to officially adopt zero waste as a goal. So has Scotland.

### Trash container sensors

Time and fuel is wasted when garbage trucks include mostly empty trash containers in their collection schedule. To help better determine when trash containers really do need to be emptied, the waste companies are installing micro-sensors in them that communicate

their fill- level status to a central data centre. Only when the sensors indicate the container is almost full is the container added to a collection route.

Trash bin sensors can also be installed in conjunction with an integrated solar-power compactor that pushes down the contents of the container. This adds capacity to the container and further reduces the number of collection trips required.

## Reuse – smart waste dispersion

Following the footsteps of the reduce approach, reuse strategy not only helps in reducing waste but also provides alternatives to finite resources and additionally creates a revenue stream. Reuse of solid waste can be done within the industry, but more effectively, it can span multiple industries. The exchange and reuse of materials connects steel, cement, chemical and paper firms into an industrial ecosystem.

### Deconstruction programs

The construction industry in India is growing at the rate of 10% annually for the last 10 years. Construction and demolition waste (C&D) constitutes a large fraction by mass of the waste stream; total C&D waste generated in India in 2013 amounted for an enormous 530 metric tonnes.



**Reuse – smart waste dispersion:**

## **RECYCLING PLANT SMART REUSE DELHI (MCD)**

**W**ith continuously increasing construction activity across the capital city of New Delhi, more than 5,000 tonnes of waste is produced by construction, demolition and land-clearing activities every day. Most of this construction and demolition (C&D) waste ends up being mostly illegally dumped along the Yamuna or in the Ridge area, making recycling difficult; it is also usually mixed with municipal solid waste.

The Municipal Corporation of Delhi (MCD) has taken an integrated approach of collection, transportation and processing. MCD has started a recycling plant on PPP model with waste collection contract with IL&FS at Burari in North Delhi. The Corporation collects and delivers mixed C&D waste from 28 designated points to the plant through GPS fitted trucks, using the sanctioned Rs 23 crore conveyance budget. The civic body covers the remaining areas.

Though the plant was set up with 500 tonnes per

day (TPD) capacity, it processes 1,200 TPD of waste currently.

Over the last five years, India's first and only recycling plant for C&D waste has saved the already-polluted Yamuna and the overflowing landfills of Delhi from 15.4 lakh tonnes of debris.

The plant is a 'zero-discharge facility' not only does the plant keep the C&D waste from ending up in landfills, it also uses 10 to 12 tankers of treated effluents every day, supplied by the Delhi Jal Board, for washing process and later, the water is recycled and used.

The treated recycled C&D is used to make ready-mix concrete for road sub-base and kerb stones, cement bricks, pavement blocks, hollow bricks and manufactured sand and soil. This processed material is currently only sold to private individuals and builders. The government departments also ready to buy these products once standards and BIS regulations are in.



**Reuse – smart waste dispersion:**

*The plant is a 'zero-discharge facility' not only does the plant keep the C&D waste from ending up in landfills, it also uses 10 to 12 tankers of treated effluents every day, supplied by the Delhi Jal Board, for washing process and later, the water is recycled and used.*

However, C&D waste can be an invaluable source of building materials. Hence, smart cities deploy building strategies that maximise the use of existing materials in new construction. Deconstruction programs reuse construction and demolition debris and help in diverting the debris from waste disposal and landfills. Preparing and marketing the salvaged materials create additional jobs.

Buffalo Reuse, a nonprofit organisation, was established in response to the City of Buffalo's plan to develop deconstruction as a competitive alternative to the demolition of abandoned houses. Habitat for Humanity ReStore and deconstruction program handle demolition debris and surplus materials, which prevented more than 600,000 pounds of waste from entering landfills since 2004. The program also provides training and green jobs within the community.

## Recycle – smart waste collection

Municipal solid waste collection is comprised of three stages: segregation, collection and transportation. With effective mechanisms in place, segregating and deploying recycling strategies at the source is most effective.

In past two decades, the global market for recyclables has increased significantly. The

world market for post-consumer scrap metal is estimated at 400 million tonnes annually and around 175 million tonnes annually for paper and cardboard (UN-Habitat 2009). This represents a global value of at least \$30 billion per year.

Collecting municipal solid waste is an expensive and sometimes polluting proposition. It requires an army of drivers who operate fleets of trucks that typically get poor gas mileage and spew emissions. This holds true for India too, where there are local, informal mechanism and systems in place for paper and scarp metals that considerably reduce the load on municipalities.

Smart waste collection solutions offer relief in several ways. They can eliminate unnecessary pick-ups on collection routes, along with the associated operating and maintenance costs for collection vehicles. They can also monitor participation rates for waste reduction programs such as recycling.

### Composting

Organic matter constitutes 35%–40% of the municipal solid waste generated in India. This waste can be recycled by the method of composting, one of the oldest forms of disposal. It is the natural process of decomposition of organic waste that yields nutrient-rich manure or compost — high

in carbon and nitrogen and is an excellent medium for growing plants. Composting ensures the kitchens and agro waste is not carelessly thrown and left to rot. This is an integrated part of a circular economy, where it recycles the nutrients and returns them to the soil as nutrients. Apart from being clean, cheap, and safe, composting can significantly reduce the amount of solid waste. The organic fertiliser can be used instead of chemical fertilisers, and is better for vegetables and community gardens. It improves the soil's ability to hold water and makes the soil easier to cultivate.

### RFID tags on trash and recycling bins

Some cities have started to embed radio frequency identification (RFID) tags in trash and recycling bins. In the UK, they're sometimes called "bin bugs."

The tags are associated with a specific resident or address and, similar to a barcode, can be read by equipment on collection trucks. Collected RFID information is sent to a city database where it can be analysed to help cities in several ways. For instance, RFID enables collection trucks to record the weight and filling level of bins. Historical analysis of this data lets waste managers optimise collection routes and schedules. The result is fewer trucks running fewer routes resulting in reduced truck emissions and air pollution.

A European Commission technical study on the use of RFID in the recycling industry indicates that use of these systems can reduce waste collection costs by up to 40% due to the decrease in fuel consumption and air pollution.

In Cleveland, the city's solid waste department used RFID container tagging to link trash and recycling bins to homeowners. After analysing its trash stream data, the city determined that 42% of the 220,000 tonnes of trash collected by the city every year is recyclable. Calculating the resale value of the recyclables along with the savings in dump fees by removing these recyclables from the waste stream, the city expects to generate \$5.5 million in total savings.

Another use for RFID data is to help track which residents set out their trash and recycling bins. Cities might then target educational programs toward those who don't participate in recycling.

Finally, waste collectors are looking to incorporate RFID technology into pay-as-you-throw (PAYT) programs, where residents are charged for trash collection based on the amount they throw away. The city of Grand Rapids, Michigan, has successfully deployed such a system.



### GPS truck tracking

The use of global positioning systems (GPS) has proved helpful to optimise waste collection routes, improve driver behavior and cut operating expenses. These systems help waste managers ensure that truck drivers are adhering to routes and schedules and that there's no excessive idling or speeding, which can consume additional fuel. A study published by the Aberdeen Group noted a 13.2% reduction in fuel costs with adoption of GPS vehicle tracking. There was also a 13.4% reduction in overtime costs.

### GIS-based route planning

A geographic information system (GIS) is used to construct, record, analyse, manipulate and display geographic information.



### GPS truck tracking:

*GPS has proved helpful to optimise waste collection routes, improve driver behavior and cut operating expenses.*

Many cities have had GIS systems in place for a number of years. GIS technology is now starting to play a significant role in modern solid waste management operations. It can help with planning waste collection routes, as well as prudently developing sites for recycling centers, material recovery facilities, yard waste depots and landfill locations.



waste stream. Magnets pull out ferrous metal. Air jets are used to suspend lighter plastics and paper so that heavier products, such as glass and non-ferrous metals, fall out of the stream. To identify and sort non-ferrous metals, infrared and even x-ray scanning are sometimes used. Plastics are typically sorted by hand, a practice that adds considerably to the expense of operating an MRF.

Material recovery plants generally fall into two categories. Clean MRFs only accept recyclables already separated at the collection point. Dirty MRFs accept comingled trash that includes recyclables, organic waste and everything else that goes into a residential garbage can. A dirty MRF can actually recover more material than a clean MRF because it processes the entire waste stream and targets a greater number of materials for recovery.

## Mechanical biological treatment

In addition to clean and dirty MRFs, a third type of recovery system has entered the picture. Mechanical biological treatment (MBT) — also known as a wet MRF — treats solid waste both mechanically and biologically. A mixed waste stream enters these facilities and magnets, shredders and other types of separators mechanically remove metals, plastics, glass and paper.

## Recover – smart material recovery

After collecting refuse and recyclables, the recovery of valuable waste stream material can begin. Let's now look at some of the smart processing solutions that extract waste stream assets.

### Advanced material recovery facilities

An advanced material recovery facility is commonly referred to as an MRF (pronounced "murf"). It is typically a large building where collected waste enters on a conveyor belt and, as it moves forward, is separated into various piles for recycling markets.

A variety of mechanical systems are used to sort and separate the good stuff from the

### Smart materials recovery:

*Automated systems are used to separate various recyclables at MRFs, but hand sorting is sometimes required, too.*

Some MBT facilities will also separate combustible elements from the waste stream, such as plastics and organics, and convert them to refuse-derived fuel (RDF). RDF is typically used as a fuel in power plants.

After mechanically recovering recyclables from the waste, the remaining organic material is processed using biological methods. These include anaerobic digestion, in which microorganisms break down the waste to produce biogas, soil amendments and materials suitable for composting.

Because MRF technologies and systems can vary depending on each community's waste stream profile and management goals, no two MRFs look exactly alike.

However, the main objectives generally overlap:

- Reduce the volume of waste to be landfilled
- Improve resource recovery through recycling and production of a degradable or combustible residue
- Stabilise all waste residuals that end up in landfills

## Recover – smart energy recovery

Because municipal solid waste contains plastics, organics and other carbon-rich material, waste managers are increasingly viewing their garbage as a potential source of renewable energy. Methods of converting waste to energy — WTE in waste industry parlance — are the focus of this section.

WTE conversion occurs in two basic ways. One is incineration. This typically implies burning solid waste to heat steam-powered generators that produce electricity. The other way is to process waste in a manner that produces gases and liquid fuels that are used for commercial heat and power.

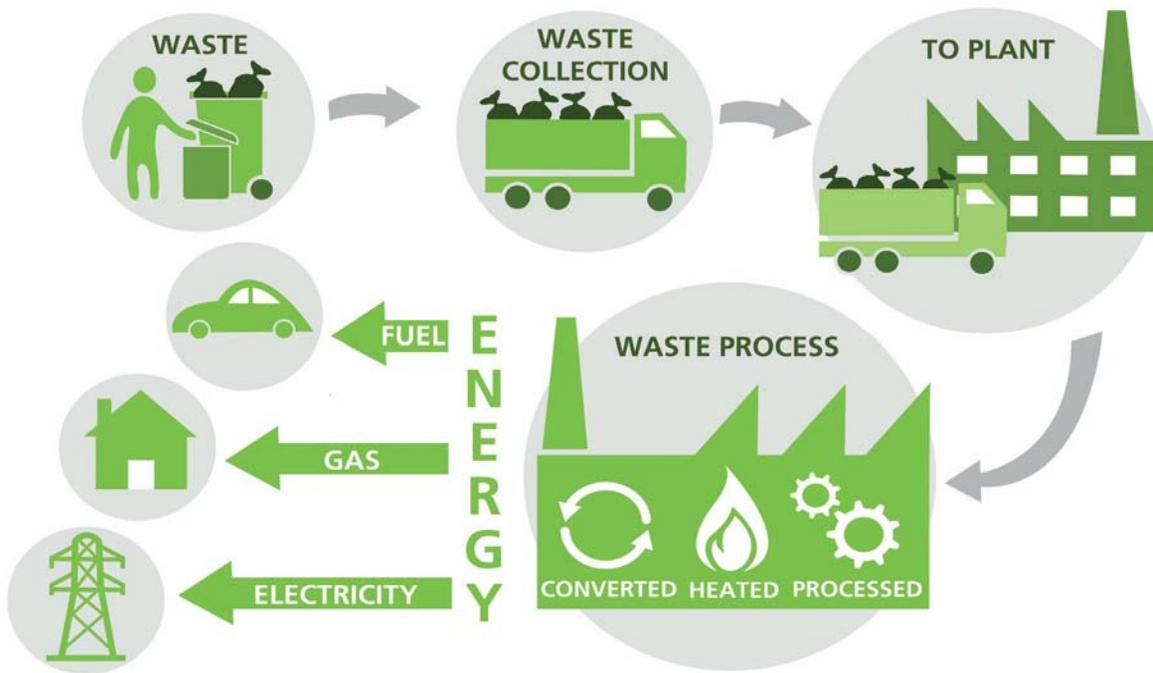
Some argue that because incineration generates emissions, residue — every tonne of waste incinerated results in considerable amount of (about 20%) hazardous ash containing toxic substance and heavy metals that must be dealt with. It is a relatively low-value use for previously manufactured materials, it falls outside the smart cities sustainability emphasis. However, in India, in the interest of both hygienic waste treatment and power generation, with sorting-recycling prerequisite and advanced technologies WTE might be used as a stepping stone towards more sustainable options.



### Modern incineration plants:

*Waste to energy conversion occurs in two basic ways. One is incineration which takes places in plants like that one above.*

Moreover, it should be considered as a last resort and needs to be carefully planned and monitored. With these caveats in mind, let's briefly take a look at where WTE is headed as a waste management tactic.



Authority of Palm Beach County is completing the first WTE plant built in the U.S. since 1995. It will burn 99% of the municipal waste it receives and generate enough electricity for 85,000 homes.

Today's WTE advocates argue that modern incineration facilities work differently from old-fashioned municipal incinerators. Modern WTE facilities combust post-recycled waste in highly controlled and efficient combustion systems that are equipped with proven air emissions control components (such as fabric filters, electrostatic precipitators and scrubbers) that minimise potential emissions. Moreover, the process in modern facilities is closely monitored via control equipment, remote sensors and computers to ensure optimal combustion of the waste.

### Bio-Waste Energy:



Moreover, Solid Recovered Fuel (Refuse Derived Fuel - RDF) offers significant environmental and market opportunities, is relatively clean and can be traded in the market for numerous energy applications, replacing fossil fuels.

### Incineration

Incineration has been, and still is, the most common way to recover energy from waste. It also reduces the volume of disposal waste by about 90%.

More than 800 WTE incinerators now operate in 40 countries, with the vast majority in Europe and Asia. The story is far different in the US, where public concern over emissions from incinerators remains entrenched, even with ever-tightening air quality regulations imposed by federal and state authorities. But that's starting to change. In Florida, the Solid Waste

### Other WTE technologies

While incineration dominates the WTE arena, other technologies are emerging that may appeal to cities where residents object to burning garbage. There are several state-of-the-art technologies for converting MSW to energy. Moreover, Solid Recovered Fuel (Refuse Derived Fuel - RDF) offers significant environmental and market opportunities, is relatively clean and can be traded in the market for numerous energy applications, replacing fossil fuels.



Reducing greenhouse gas emission from landfills:

## JABALPUR BRIDGES ENERGY GAP WITH WASTE-TO-ENERGY GENERATION

Jabalpur, the third largest city in Madhya Pradesh, has experienced steep population growth in last two decades. However, there was no system in place for hygienic disposal of solid waste. Most of the waste collected was dumped in a crude manner in the disposal site — a trenching ground, located within the city boundaries. The trash piles caught fire often, which released harmful pollutants into the air.

The Municipality of Jabalpur Municipal Corporation chose Council member Essel Infraprojects to develop solid waste management. Essel Infra projects collaborated with a consortium of leading environmental systems providers to develop scientific integrated multi-product Municipal Solid Waste processing facility leading to energy recovery instead of Bio Methanation.

Essel and Hitachi joined forces to engineer, construct and operate an Energy-from-Waste plant, which is entrusted with the long-term concession of municipal waste treatment in a public-private partnership contract with the urban local body Jabalpur Municipal Corporation, without using a grant under any schemes.

The Jabalpur project comprise of one stoker-type waste combustor for converting MSW to Energy /Compost/ Refuse Derived Fuel/Useful Products with a processing capacity of 450 tonnes/day and a power output of approximately 11 MW for the city of Jabalpur. The Energy-from-Waste plant constructed in 18 months and started operating in December 2015 will provide safe, reliable waste disposal, Greenhouse gas reduction and clean renewable electricity to the city of Jabalpur.

 **Reducing greenhouse gas emission from landfills:**

*The WTE plant comprise of one stoker-type waste combustor for converting MSW to Energy /Compost/ Refuse Derived Fuel/ Useful Products with a processing capacity of 450 tonnes/day and a power output of approximately 11 MW for the city of Jabalpur.*

**Anaerobic digestion for biogas.** Anaerobic digestion (AD) technology is gaining traction in Europe, spurred on by European and national legislation aimed at reducing municipal waste going to landfills. The technology relies on anaerobic digesters that, with the help of bacteria, break down organic waste in an oxygen-free environment. Once confined to use on farms to break down manure waste, that's no longer the case today for AD. One natural product of AD is biogas, which typically contains between 60% to 70% methane.

**Gasification and pyrolysis.** Some cities are using a process called gasification to extract biogas, a fuel that contains hydrogen and methane and can be used in various applications. Gasification involves heating of mixed waste or derived fuels at high temperatures. Oxygen is introduced to allow partial oxidation, but not enough for full combustion. In Australia, the city of Sydney is pushing forward with gasification, with the goal of producing syngas that can be fed back into a natural gas grid.

Another advanced thermal WTE process is pyrolysis. It involves energy-assisted heating of waste at controlled temperatures but with no oxygen introduced. Byproducts include volatile liquids and syngas — with relative proportions determined by process temperature.

Because gasification and pyrolysis technologies have limited operating history of processing solid waste, it is difficult at this time for cities to draw conclusions about their viability.

## Dispose – smart waste disposal

Solid waste is predominantly an urban phenomenon — generating about four-fold as much waste as rural areas. However, most of the rural areas in India do not have any organised waste disposal system.

Waste disposal sits at the bottom of the waste management hierarchy as the least preferred option. Yet for many developing countries, which now practice open dumping of trash, trucking waste to managed landfills represents a cost-effective step in advanced waste management. In this section, we look at smart waste disposal alternatives.

### Sanitary landfills

Today's sanitary landfills are engineered sites where waste is managed to prevent environmental contamination. These landfills isolate waste from the environment while degrading it biologically, chemically and physically.

A primary technology challenge at landfills is managing the release of methane-rich landfill gas caused by the natural breakdown of organic material. These gases can make a significant contribution to GHG emissions.

Smart waste disposal solutions start with removal and conversion of organics from the waste stream before they get to the landfill.

In addition, waste managers can implement systems to collect and use the landfill-generated gas for heat or electricity production. Methane captured at San Diego's Miramar Landfill provides 90% of the fuel to power electrical generators at the local Metropolitan Biosolids Center and North City Water Reclamation Plant.

### Bioreactor landfills

Unlike a traditional sanitary landfill, a bioreactor landfill accelerates the decomposition of organic waste by intentionally adding liquid and air to enhance microbial processes.

Where decomposition in a dry landfill can take 30 to 50 years, the process takes only 5 to 10 years at a bioreactor landfill. By stepping up the rate of decomposition, the volume of material in the landfill rapidly shrinks and creates space for more material. As a result, fewer new landfills are needed.

Managing the biological, chemical and physical processes occurring in a bioreactor landfill requires the use of remote monitoring networks, sensors and other sophisticated technologies.

While not yet widely adopted, bioreactor landfills are gaining attention due to the potential they have to extract landfill gases and convert them to fuels. The bioreactor landfill near Asheville, North Carolina recently added a gas-to-energy operation. It's now producing enough fuel to run a generator that powers 1,110 homes a year.

### **Solar-capped landfills**

When a landfill closes, the site is typically sealed with a polyethylene cap and then covered with several feet of compacted soil on which grass is planted.

One alternative capping system is to cover the buried garbage not with dirt and grass, but with solar panels. This not only eliminates the

need to mow grass and replace eroding soil, but brings underutilised acreage into renewable energy production.

Landfill solar farms are already in place in several states in the US, including the Hickory Ridge landfill near Atlanta, Georgia with 7,000 panels installed. The EPA and the US Department of Energy are offering guidance to landfill operators and solar energy developers looking to integrate solar projects with retired landfills.



### **Solar-capped landfill:**

*The 48-acre Hickory Ridge Landfill was transformed into the largest solar energy generating facility in Georgia. It is the world's largest solar energy cap and the first use of the technology as a fully permitted landfill final closure system.*



## Interconnectedness assessment

Improvements to a city's solid waste management system in part depend on other city systems. Transportation systems, computing resources and data analytics capabilities can all play a role in waste management.

Efficient transportation networks, for example, are necessary for collection and transport of debris to material and energy recovery facilities, as well as landfills. Computing resources such as GIS systems are valuable for planning collection routes, siting processing facilities, as well as choosing locations for landfills.

Cities with data analytics tools available can also better support smart waste management

initiatives. Data analytics are often required to process and gain insights from data derived from sensors and RFID tags on trash and recycling containers.

Efficient and safe solid waste management system improves public health, safety and water as well as enhances built environment.

## Benefits of realising solid waste targets

Smart solid waste management enhances a city's livability, workability and sustainability in a variety of ways.

### Livability

**Lowering costs for citizens.** Use of technologies that yield more efficient waste management — such as sensors, RFID tags and GPS to optimise collection routes — can reduce operational costs and thereby lower or help control garbage bills for residents and businesses. Waste recovery companies that pay municipalities to recover energy and materials from their solid waste stream also help offset waste management costs for cities

and citizens.

**Protecting water and public health.** Open dumping and garbage burning are still widely practiced in India. These activities continue to adversely impact urban air and water quality.

Uncollected garbage also takes a toll on public health. Refuse on the streets collects water where insects breed and potentially spread disease. Plastic bottles and packaging left in the open leach chemicals and toxins into the soil and water. Litter clogs and interferes with the function of sewer systems. Modern waste management solutions will assure citizens that air and water resources are neither contaminated nor a threat to public health.

**Increasing civic pride and property values.** Smart waste management can visually and aesthetically improve communities by ensuring that garbage is removed and processed in an efficient, timely and responsible manner. Uncollected waste and litter is not only an eyesore, but also encourages people to act less responsibly about how they handle waste. Clean streets and minimised litter, on the other hand, promote civic pride and higher property values.

## Workability

**Establishing an appealing business environment.** Timely and efficient collection and removal of urban waste contributes to an attractive environment for a company's workers and clients. Businesses that want to maintain a strong corporate image utilise advanced waste management practices — such as zero waste initiatives — and look to locate in cities that have strong waste management practices.

**Creating new jobs.** Cities that promote waste management solutions such as material recovery facilities and waste-to-energy plants open the door to new industries and jobs.

## Sustainability

**Recovering and reusing waste material.** Basic sustainability practices of recycling and reusing by extracting metals, glass, plastics and paper from the municipal waste stream reduces the resources required to create such materials anew.

**Reducing greenhouse gas emissions from landfills.** Converting organic waste to compost and fuels reduces the amount of organic material going to a landfill. That in turn lowers



the production and release of methane and other landfill gases into the atmosphere.

**Creating more fuel-efficient waste collection systems.** New technologies that involve sensors and RFID tags are enabling waste managers to better analyse and optimise collection routes for garbage trucks.

**Enabling alternative energy deployments.** Communities are beginning to use dormant acreage covering retired landfills as locations for solar panel installations.



### Enhancing sustainability:

*Extracting metals, glass, plastics and paper from the municipal waste stream reduces the resource required to create such materials anew.*

## Solide waste targets

The technology targets described in this section can help cities develop a smart solid waste management system that uses intelligence to efficiently and responsibly handle refuse.

## Inclusivity

Smart cities strive to achieve an inclusive waste management, where all citizens have access to efficient, effective and environmentally-safe SMW systems. Selective household waste collection with recycling cooperatives creates unique opportunities to build more inclusive and cleaner cities.

**Formulate citizen reporting framework for outcome thinking.** There is a need to bridge the gap between a municipality and its citizens to achieve inclusive and sustainable solid waste management. Crowd-sourcing is an effective method, where citizens are encouraged to report waste-related activities which need urgent attention from the authorities, using via mobile, Web or social media channels. Accurate information reported by a proper waste collection methodology encourages people to adopt a better attitude towards waste prevention and source separation. For example, the city of Kota has developed a GIS-

based citizen reporting and waste management system. This GIS-integrated Web and Android-based application can do analytics, report generation and SMS alert delivery.

**Achieve citizen engagement.** People's participation is essential, and education and training are critical to tackle many challenges towards awareness building about waste avoidance and diversion as well as inclusive resource recovery. Social capitalisation, involving communities and institutions in the city is better way towards sustainable waste management. Entire community will be involved in the neighbourhood-specific projects. NGOs like Green Energy Foundation, Pune and Exnora, Chennai help formulating networks involving entire communities and creating tools to educate them, share expertise and help reduce energy consumption. Training can be individuals at communities and schools, or commercial venture — waste reduction, segregation, composting, and growing organic vegetables. The model has been successful in South India and able to solve the garbage problem to a great extent.

## Collaborativity

Public-private partnerships are essential for effective SMW, and so does the comprehensive

need among various city responsibilities for improved dematerialisation efforts.

**Create institutional framework.** As being at the end of the life-cycle chain, smart waste management should encourage circular economy, by promoting use of fewer natural resources with innovative and technology-driven ideas — designing, manufacturing, purchasing, or using materials to reduce the amount or the toxicity of waste produced. Stopping waste at the source, may it be household or industrial, significantly reduces the burden on waste disposal.

Another tactic is to steer people to buy less with their increased wealth, and to spend more on experiential activities that require fewer resources. Encouraging and collaborating with a city planning department, private developers or NGOs will help to create such opportunities.

**Pursue multilateral collaboration.** Municipalities can collaborate with businesses and non-profit organisations to initiate and implement effective and sustainable waste management.

Some countries and cities are leading the way. San Francisco in California has a goal of 'zero waste' (100% waste diversion by reduction and recycling) by 2020; already more than 55% of its waste is recycled or reused.

Waste Management World says the report found plastic bottle recycling in the US grew by 3.3% or 97 million pounds (44,000 metric tonnes) in 2014, with the new total surpassing 3 billion pounds (1.36 million metric tonnes).

Education and involvement at an early age is also extremely beneficial. A city can collaboratively organise various events and internships, where students can participate and will receive certificates and green star awards for their project work. Incorporating such programs within the school system can even have a wider effect.

## Governance

Though there are some advanced examples of SWM in India, most of the waste is landfilled or incinerated, and still lot is unmanaged — leading to open dumping. Solid waste landfills are becoming a mounting problem — leading to significant health concerns, and space limitation — though scientific, green technologies have been implemented in creating landfills, most of them are still unlined or undermanaged. What is needed is stringent governance and policy reforms.

### **Create and mandate effective regulation.**

Stricter government regulations result in higher waste management costs for non-sustainable

waste disposal methods. In the 1990s, the US Environmental Protection Agency required that authorities in charge of existing municipal waste landfills to either install groundwater and gas monitoring programs, plus adhere to other operating standards or close down their landfills. For many communities the price tag to meet the new requirements was too high. In Texas, the number of landfills dropped from more than 1,000 to the 100 in operation today. Similar restrictions are in effect in Europe. In Germany, untreated municipal solid waste has been effectively banned from landfills since June 2005.

### **Devise price instruments to reduce waste.**

Mandated and enforced regulatory policies and imposing frameworks can directly restrict or modify consumption and disposal decisions by the businesses as well as individual consumers. Price instruments such as disposal fees and taxes can change consumption and disposal decisions indirectly by altering incentives that govern behavior which change relative costs and benefits.

Regulatory rules as well as public fee and subsidy programs can be implemented at various stages of the lifecycle of material and waste dispossession decision points. North America, Europe and New Zealand have implemented such price instruments, especially disposal fees, and the results show that as fees increases, waste generation decreases. The

effectiveness of specific regulatory and price instruments depend on the specific, effective structure of these instruments which can be implemented either in the production upstream or downstream end:

1. **Regulatory tax or incentive for waste reduction.** Regulatory policy instruments that encourage 'source reduction' by increasing the relative costs of waste production during the extraction, production and operation processes will result in decreased waste production. Mandates that limit the amount of waste production or taxes that increase the cost of production may result in less waste to manage. For example, mandating recycled products from construction and demolition (C&D) waste, making developers responsible and accountable for good construction practices, and on-site segregation of waste, reuse and disposal considerably reduce sourcing of new material. Singapore, a land-constrained country, recycles 98 per cent of its C&D waste.
2. **Incentives for reuse. In the long term,** governments will continue imposing tax on the materials, which have environmental influence during exploitation and landfill, just like what they did for tyres. And these regulatory taxes or incentives will make recycling profitable.

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2. **Incentives for reuse. In the long term,** governments will continue imposing tax on the materials, which have environmental influence during exploitation and landfill, just like what they did for tyres. And these regulatory taxes or incentives will make recycling profitable.
3. **Regulatory tax or incentive for recycling and reuse.** In the short-term future, recycling of some materials is profitable, while some are not. Regulatory policy instruments that mandate recycling requirements or assist in lowering the relative cost of recycling and reuse will

result in diversion of waste away from landfill or other disposal methods. The recycling cost includes actual cost as well as the time cost. But in the long term — with governments continuing to impose tax on the materials and supporting policies and infrastructure in place — the recycling opportunities will increase and encourage establishment of more recycling firms due to reduced variable cost, and in turn will lower overall cost for the consumer.

4. **Facilitate revenue generation for the city.** The regulatory policy instruments not only assist in reducing the waste management costs, they also form sources of revenue for the city. Publicly imposed taxes and fees towards waste prevention or recycling and reuse become a substantial revenue source in the near future. As cities become more sustainable, these sources decline, but so does the solid waste management cost for the city.
5. **Create waste management models that integrates informal elements.** Some cities fully understand waste-pickers and scrap-dealers potential and view them as valuable resources and actively integrate them in urban waste management models, as it creates a more efficient system of waste collection and recycling. Waste-pickers who are excluded from the formal system are forced to salvage

waste from landfills and other unhygienic environments, causing a threat to public health. An inclusive approach allows them to access waste directly from the source.

This could be achieved in multiple ways — encouraging waste-pickers to organise themselves into cooperatives, or even integrating them into the system through a formal contract or the formation of public-private partnership models.

Since total integration has multiple challenges, many municipalities deploy different innovative solutions, creating a parallel system within which waste-picker cooperatives can function, and are given much better access to waste. They are also provided with a more professional framework within which to work and are equipped with uniforms and ID cards. In Chennai, the NGO Consumer Action Group (CAG) has also been working at better incorporating the city's waste-pickers into a formal system.

## Instrumentation and control

Waste collection, processing and disposal practices now include electronic devices and controls to make waste management smarter and more efficient.



Create waste management models that integrates informal elements:

## THREE STORIES, THREE RESULTS, BUT ONE GOAL

**P**une has managed to leverage the potential of its informal networks. The Pune municipality has outsourced the responsibility of front-end door-to-door collection of waste to SWaCH, a waste-picker cooperative in Pune, which has around 2,300 members.

These members service 4,00,000 households in the city. They are also provided with a more professional framework within which to work and are equipped with uniforms and ID cards.

A Noida-based private business, operates as an 'umbrella model' — focusing on the entire value-chain from door-to-door collection, transportation, segregation, treatment and disposal. Under a PPP model, the city of Noida contracted the company for segregation and disposal of MSW, that formed a major part of the company revenue, while others are collection fees, and sale of recyclables to industry. As a result, the company was not only able to incorporate rag-pickers formally but also able to treat them as employees, offering rent of the living units equipped with water and electricity, and health cost.

Though the city of Bogota started implementing inclusive programs only in 2013, they have executed some progressive policies towards waste-pickers.

Today, waste-pickers in the city are treated at par with commercial collectors and are compensated for their services (apart from what they earn from selling recyclables).

**Create waste management models that integrates informal elements:**

*The waste-pickers are also provided with a more professional framework within which to work and are equipped with uniforms and ID cards. The company was not only able to incorporate rag-pickers formally but also able to treat them as employees.*

**Implement optimal instrumentation.** New types of instrumentation are gaining traction in the waste management world. RFID tags embedded in recycling bins help identify the types of refuse generated by citizens and help track customer participation in sorting programs. Attaching RFID tags to specific types of items aids waste sorting at municipal recycling facilities. Evidence from Europe suggests that these improvements can lower collection costs by up to 40%.

Smart wireless sensors embedded in public waste bins inform waste collectors when the container needs emptying, enabling development of efficient pick-up schedules and routes based on the actual fill levels and historic fill level patterns.

Sensors are also becoming key components in waste processing. Scanners and optical sensors at material recovery facilities enable efficient recyclables sorting. Sensors are also used to monitor landfill conditions.

## Connectivity

Data collected by waste technology sensors requires transmission to servers or Web services for storage, viewing, monitoring and analysis.

**Connect devices with citywide, multi-service communications.** Communications systems are an essential component in new waste technologies — RFID, GPS and GIS.

Data transmitted from waste collection sensors and RFID tags typically relies on the presence of wireless and cellular (GPRS) network services. Depending on the vendor implementation, these connectivity resources may be part of a citywide, multi-service communications platform, or they may be included in the vendor's service subscription.

## Computing resources

Smart SWM solutions may require that cities expand their in-house computing capabilities. However, solution vendors may enable waste authorities to connect to their applications via web services or APIs, eliminating the necessity of onsite IT deployments.

**Have access to a central GIS.** A GIS useful in waste management. Using GIS software, waste collectors can, for example, plot neighbourhood population density and income data against household addresses to estimate volumes of garbage for various city sectors. That, in turn, enables waste managers to develop efficient collection routes that save time and

fuel. GIS systems can also assist with siting waste processing facilities and choosing better locations for landfills.

## Analytics

With the expanded use of RFID tags, sensors and GPS data in more developed global economies, cities now have the opportunity to apply data analytics for optimising waste collection, recycling and waste processing.

**Achieve full situational awareness.** As mentioned earlier, waste characterisation studies should serve as the starting point for smart waste management initiatives. Cities and municipalities need to understand the types and volumes of waste being generated from their communities and where it's coming from. Statistical analysis of data from waste collection operations, recovery facilities, city demographics and GIS can help cities see the big picture of their community's waste stream.

**Achieve operational optimisation.**

Application of data analytics to GPS information and RFID data lets haulers optimise operations in several respects. The primary benefit is that waste fleet managers can determine in real-time the most efficient routing for collecting trash and recyclables.



Achieve asset optimisation:

## HOUSTON LOOKS TO 'ONE BIN' TO DIVERT WASTE

Despite decades of promoting recycling, the city of Houston remains well below the national average. The city's landfill diversion rate is a mere 17%, with just 6% resulting from recycling and the remainder from the recovery of yard waste.

Looking to remedy the situation, Houston Mayor Annise Parker has led a city charge to adopt a "one bin" approach to waste diversion. It would allow residents to mix trash, recyclables, yard clippings and other waste in one container and let a resource recovery facility separate and process the refuse.

Under the plan, the city expects the Houston recycling rate to climb to as high as 75% in two years. It would also reduce pollution from garbage trucks, as there would be fewer trips required to collect waste.

Using the one-bin model in conjunction with advanced material recovery facilities can "completely transform the global solid waste industry," says George Gitschel,

chairman and CEO of Organic Energy Corporation, a Council member. Organic Energy, which builds and operates advanced material recovery facilities (MRFs), is one of the companies interested in working with Houston to manage its one-bin waste stream. Gitschel explains that Organic Energy's recovery separates items by density, size, optical characteristics, magnetism and other means into 20 different types of materials, which can be marketed and turned into new manufactured goods.

The city of Montgomery, Alabama, recently adopted a one-bin waste collection system in conjunction with the opening of a \$35-million materials recovery facility. The city has seen the recycling rate jump from 1% to about 70% in less than a month. When composting and methane production is added to the facility, the material recovery rate is expected to climb to 90%.



### Achieve operational optimisation:

*Advocates believe using the one-bin model in conjunction with advanced material recovery facilities can transform the solid waste industry.*

# ISO 37120: A yardstick for measuring city performance



In 2014, the International Organisation for Standards announced an ISO standard that applies strictly to city performance. The document -- known as ISO 37120:2014

-- establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, planning, wastewater, water and sanitation

In the table at right we have indicated how the standard related to Transportation correspond to the Council's Transportation targets identified on the next page.

The ISO 37120 transportation indicator has cities reporting on the extent of their mass transit and non-car infrastructure, overall transportation safety and direct flight interconnectedness.

## Solid Waste Indicators

			Implement optimal instrumentation	Citywide, multi-service communications	Create citywide data management policy	Have access to a central GIS	Achieve full situational awareness	Achieve operational optimization	Achieve asset optimization
<b>Core</b>	16.1	Percentage of city population with regular solid waste collection (residential)	●	●	●	●			
	16.2	Total collected municipal solid waste per capita	●	●	●	●			
	16.3	Percentage of the city's solid waste that is recycled	●	●	●	●	●	●	●
<b>Supporting</b>	16.4	Percentage of the city's solid waste that is disposed of in a sanitary landfill	●	●	●	●	●	●	●
	16.5	Percentage of the city's solid waste that is disposed of in an incinerator	●	●	●	●	●	●	●
	16.6	Percentage of the city's solid waste that is burned openly	●	●	●	●	●	●	●
	16.7	Percentage of the city's solid waste that is disposed of in an open dump	●	●	●	●	●	●	●
	16.8	Percentage of the city's solid waste that is disposed of by other means	●	●	●	●	●	●	●
	16.9	Hazardous waste generation per capita (tons)	●	●	●	●			
	16.10	Percentage of the city's hazardous waste that is recycled	●	●	●	●	●	●	●

# WASTE MANAGEMENT TARGETS

In the checklist below, targets specifically pertaining to the waste management responsibility are in bold, universal targets are not.

	Enabler	Waste Management Targets How smart cities deploy and use ICT to enhance their waste management	Implementation Progress			
			None	Partial	Over 50%	Complete
Human	Inclusivity	Achieve accessibility optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate citizen reporting framework for outcome thinking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	Collaborativity	Achieve citizen engagement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Create institutional framework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Pursue multilateral collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	Governance	Achieve existing infrastructure optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate new supporting policy frameworks and regulatory mandates	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<b>Devise price instruments to reduce waste</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# WASTE MANAGEMENT TARGETS

In the checklist below, targets specifically pertaining to the waste management responsibility are in bold, universal targets are not.

TECHNOLOGY	Enabler	Waste Management Targets How smart cities deploy and use ICT to enhance their waste management	Implementation Progress			
			None	Partial	Over 50%	Complete
	<b>Instrumentation and Control</b>	Implement optimal instrumentation Embed RFID tags in recycling bins and smart wireless sensors in waste bins	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Connectivity</b>	Connect devices with citywide, multi-service communications <b>Ensure wireless and cellular network services for waste data transmission</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Interoperability</b>	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Security and Privacy</b>	Publish privacy rules Create a security framework Implement cyber security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Data Management</b>	Create a citywide data management, transparency and sharing policy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Computing Resources</b>	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Analytics</b>	Achieve full situational awareness Achieve operational optimization Achieve asset optimization Pursue predictive analytics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# 11 Health and Human Services



**Advances in information and communications technologies (ICT) will transform the delivery of essential health, education and other human services in powerful ways – and smart cities will ride the wave to ensure a better life for their residents.**



India's poor health outcomes and innovation-lacking education are two major development challenges in India. While multidimensional problems such as poverty and corruption are most critical and giant barriers to development, they cannot be removed without solving the problem of literacy.

## Why make health and human services smart?

Epidemiology, air quality, UV radiation, health research and development, population health management, food safety, health literacy and other large-scale issues are the concern of city public health agencies.

**B**efore we dive too far into this chapter, let's deal with some definitions. In the India Readiness Guide we consider human services — those that cities provide to support the wellbeing of residents, their health and welfare, their education, the clean air they breathe and even the food they eat. Whereas in previous chapters we showed how ICT makes infrastructure smarter, in this chapter we explore how ICT empowers people to be smarter and healthier. The importance of smart human services can't be overstated — after all, an educated and healthy city is a wealthy and successful city.

**Access to healthcare services.** India has significantly higher diseases burden not only more than the global average but also considerably higher than other emerging economies like China, Brazil, Mexico and even Nepal and Bangladesh. Diagnosis and treatment is just not accessible to millions of Indians. Low awareness and poor accessibility of medical infrastructure contributes to high rate of preventable diseases. Urban populations continue to swell in India; over 30% of citizens now live in cities and the trend is expected to escalate rapidly. Unavailability of doctors and nurses is going to be even further scarce.

**Out-of-pocket expenditure.** Low insurance coverage and weak public health systems drive up average health costs. High healthcare costs often lead people to delay treatment, aggravating health problems.

**Public health and human services expenditure.** Public health expenditure moved up over the past decade. However, it is not just the lowest in the world, but also regressive — poorest income class benefiting least from public health care.

**Education supply and demand gap.** According to a joint survey by aspiring minds and Nasscom in 2013, each year only 19% students enrol into higher education, either due to lack of school infrastructure or low-quality institutions.

**Public investment.** Low level of investment in India in public facilities and preventive health facilities such as sanitation and waste management, as well as public care facilities such as primary health centres and medical professionals, leads to poor health conditions.

**Non-communicable diseases.** Lifestyle diseases such as heart disease, diabetes, obesity, stress and mental health problems have grown significantly in the last decade due to changing working/living habits coupled with processed products, and are often concentrated in urban areas.



**Project-based learning and industry relevant experience.** Poor emphasis on analytical and creative learning, along with lack of hands-on project-based and industry-relevant experience deprive students of the knowledge that they need to succeed and make a difference.



### **Public health and human services expenditure:**

*Public health expenditure moved up over the past decade. However, it is not just the lowest in the world, but also regressive — poorest income class benefiting least from public health care.*

# Making health and human services delivery smarter

There are four interrelated areas in health and human services where ICT can substantially improve services for city residents. Because some elements of those services are not owned by cities, the effort will require participation with public and private organisations.

**1. Public health is the macro, citywide view of health.** Smart public health uses ICT to improve outcomes for citizens and cities alike. City agencies can use sensors to collect data on air quality, noise pollution, UV radiation, diseases and a host of other factors that impact public wellbeing. They can also proactively receive health information directly from citizens, by encouraging them to share their health feedback and experiences through mobile apps. This data can then be analysed to detect trends and potential problems — and to inform city decision-making — which might include anything from zoning laws to emission standards to mobilising health providers to respond to an outbreak.

**2. Health services are how cities support the mental and physical wellbeing of residents.** Traditional approaches to healthcare are being challenged by

several factors that seriously strain tight city budgets. The emerging discipline of smarter healthcare sometimes referred to as e-health or e-Care uses technology to overcome these challenges (and greatly improve outcomes) in these ways:

- It broadens and deepens access to health services.
- It addresses health factors holistically, across a broader range of city services and departments, and by focusing on prevention and healthier living.
- It supports better cooperation, collaboration and productivity between multidisciplinary and often geo-dispersed teams of health professionals.

Remote delivery of health services makes it possible for a patient to receive advice and treatment from a doctor without having to leave home or work. And the doctor can assess and treat conditions in real time and with maximum efficiency. This is one example of how smart cities use ICT to improve health — reaching more people in less time and using fewer resources without compromising the quality of health outcomes.

Here's another: Healthcare providers are rapidly ditching paper-based patient medical records for electronic health records (EHRs). A

doctor enters the exam room, chats with the patient and conducts an exam. The doctor then turns to a keyboard to enter data into fields on a computer screen. The patient's health profile gets electronically updated right then and there.

There's a big upside to having this digital version of a person's medical history. It makes their diagnoses, lab tests, allergies, current prescriptions and other bits of health information easy to share and manage. It allows for coordination of their care between clinicians. It helps control the administrative cost of delivering care. All of these are essentials in smart healthcare and certainly in smart cities that are proactive about enhancing livability for their residents.

Additionally, natural user interfaces and analytics can "learn" about a patient's health history and suggest tailored and specific medical interventions.

There's also the convenience factor. A mother gets a text on her smartphone that it's time for her child's vaccination; she can make the appointment on her phone or on a Web portal. In so many ways, information can be a powerful tool in healthcare — and ICT can help get it to the people who need it, when they need it.

**3. Human services refer to a broad spectrum of easily accessed services that help people live better lives.** These include services to help people deal with substance abuse, domestic violence, HIV/AIDS, disabilities, nutrition challenges and physical fitness. It includes helping the homeless find beds to sleep in and dysfunctional families find counselling.

While it is common for cities to treat health and human services separately, smart cities integrate clients' human services history into their health portfolio for better outcomes and greater efficiency.

**4. Education and skill development are a priority in a smart city.** They provide opportunities for all ages and all levels, ranging from hours at the public library to computer classes at the senior centre. K-12 education, workforce training programs and higher education are all essential. But today education is mostly stuck in the physical world. With the right deployment of ICT, cities can revolutionise the connection between student and teacher, school and learning.



## Dependencies in health and human services

When planning improvements in the public health arena, it's important for cities to recognise dependencies between healthcare services and other city systems and services.

Clearly, public healthcare services rely heavily on a city's public safety, communications and water systems. One example: The health of a city's population is at risk if municipal water supplies are contaminated.



**Traditional approaches to healthcare are being challenged:**

*As urban populations swell and people live longer, demand for health services will increase, requiring new efficiencies in service delivery.*

On the human services front, consider the dependencies between education and communications, energy systems and government administrative services. For instance, enhancing communications technologies and access to them can help conquer the “digital divide” that challenges low-income students. The same communications technologies can improve access to remote education services.

## Benefits of health and human services

Before we examine this chapter’s targets in detail, consider how smart health and human services enhance livability, workability and sustainability.

### Livability

**Providing more access to healthcare and better disease prevention.** Cities are growing larger. And as they grow, existing medical resources are not always keeping pace, which means access to them becomes more difficult. How can ICT help cities bridge the gap between growing demand and available resources? By

creating targeted prevention campaigns that reach residents and encourage them to act. It can also help the medical community care for more patients with better results.

**Improving accessibility and patient satisfaction.** One of the primary benefits of remote delivery of healthcare services — or telemedicine — is increased accessibility and patient satisfaction, especially for the elderly and mobility-challenged, but others too.

Imagine if instead of taking time off work, making a trip to the doctor’s office and then sitting in a waiting room, you could transmit your health data on your own time, and your physician could review it with you via a video feed.

Telemedicine eliminates much of the hassle associated with healthcare. A prime example of how well telemedicine can work is the field of telepsychiatry. A psychiatrist is able, through video technology, to examine a patient in much the same way an office examination would take place. The psychiatrist can interview the patient, examine his or her overall appearance and check for symptoms of problems.

As beneficial as telemedicine can be, it must be noted that there remain barriers to its adoption — regulatory and insurance roadblocks among them.

**Improving the delivery of health, education and other human services.** City services are often underutilised because those most in need of them may not know they are available, aren’t sure they qualify, or don’t know how to access them. An integrated, personalised citizen portal ensures easy, on-demand access to information people need.

**Ensuring better, faster response to public health emergencies.** The combination of smart devices, advanced and predictive analytics — even social media — empower public health officials like never before. They can monitor the outbreak of a disease or a hazardous fuel spill in real time, predict how it will spread and alert the public instantly through a wide range of communications channels.

### Workability

**Improved public health means fewer work hours missed.** A 2012 study estimated that illness cost the United States economy around \$576 billion a year. Cities that use ICT to bolster awareness of public health issues and promote remedies optimise their citizens’ wellbeing, which translates into a more productive workforce and a stronger economy as a result.



**Smart healthcare and social services make a city more attractive to business and talent too.** Cities that offer access to state-of-the-art healthcare and social service programs have a competitive advantage in attracting the creative class of tomorrow. Put simply, if you're a top talent, you're not going to locate your family somewhere they'd have to leave when they needed quality health and human services.

## Sustainability

**Telemedicine is cost effective.** Because of its capabilities, telemedicine can help cities provide quality care with fewer resources.

**Long-term healthcare costs drop.** Intelligent devices that measure and track health conditions can help public health officials prepare targeted prevention campaigns where they are most needed throughout a city. Successful campaigns can result in lower overall healthcare costs.

**Smart learning means less travel.** Improved service delivery of educational opportunities utilising ICT cuts down on travel, which promotes energy conservation and reduces pollution.



### Smart learning means less travel:

*Improved service delivery of educational opportunities utilising ICT cuts down on travel, which promotes energy conservation and reduces pollution.*

**Smart education makes a city more attractive to business and talent.** Cities that make education a priority and use technology to empower current and future workers with a superior education and continuing online education and training — particularly in high-demand fields such as math, science and technology — can capitalise on this demand to draw new businesses and investment that bolsters the local economy.



responsibility areas is the objective here. Given the new types of services involved, different kinds of instrumentation will be required.

For instance in a smart city, instrumentation can include smartphones and apps that allow people to directly participate in city public health and human services monitoring by providing feedback about conditions and experiences. For example, Council Partner IBM has created the Accessible Way app that allows users to report on accessibility of their cities, and help construct a crowd-sourced knowledge base about urban mobility challenges.

In the healthcare, social services and education arenas, devices collect data from people for the most part. These include devices that may monitor how patients in a study are responding to a new medication or ones that record academic progress in a new teacher's classroom. The purpose is to provide actionable data that can be analysed for trends.

Data-capturing devices are critical for the telemedicine systems mentioned earlier. Patients use devices to acquire data on their health status in the comfort of their homes and then transmit it to remote care providers. This greater efficiency can save time, money and resources. Similar savings can occur when health professionals remotely monitor patients with chronic conditions like diabetes or heart disease.

### **Implement optimal devices:**

*Given the new and different types of services involved, different kinds of instrumentation will be required.*

## Instrumentation and control

Health and human services use instrumentation and control in two slightly different ways, but the primary mission remains the same as in other city responsibility areas. It's all about data collection.

### **Implement optimal devices and other instrumentation for each human service.**

Implementing the right data-capturing devices across all of a city's health and human services



Smart learning means less travel:

## UOH ENABLES E-LEARNING WITH NETWORK UPDATES

The University of Hyderabad, located near the IT hub of Hyderabad is a premier institution of post graduate teaching and research in India, with more than 5,000 students. It had a piecemeal, network that had been put together over time, unprepared to meet with the rising digital demand.

Lack of equipment standardisation or centralised management was a huge challenge for network administrators. Slow network access, no endpoint security and multiple points of failure created a lack of reliability. With modern digital online library resources, e-learning, virtual desktops and private cloud-based computing, the university needed a highly reliable network that could provide various user groups with easy and secure access to online resources. Scalability was an important criterion for future growth.

The university deployed Network Management System (NMS) and AlliedWare Plus from Council member Allied Telesis, which simplified the network administration and management.

The SwitchBlade and High-density 10 GB connectivity provided high availability, which ensured uninterrupted access to online information, and scalability — flexibility in expansion to add other IP-based services, such as security surveillance, e-learning in near future.

The AlliedWare Plus operating system combines superior networking functionality, strong management capabilities and exceptional performance that today's networks demand. Allied Telesis technologies with features like high efficiency power supplies, low-power chipsets and ECO- Switch button minimised the total cost and ensured an environment-friendly network.

Deploying a comprehensive end-to-end, standards-based solution, total network access control for different users with powerful edge security features, full interoperability with other major network equipment, and improved usability created a superior customer experience and made the University of Hyderabad confident in its new network infrastructure and potential of easy move to IPv6 networking.



Smart learning means less travel:

Deploying a end-to-end, standards-based solution created a superior customer experience and made the UoH confident in its new network infrastructure and potential of easy move to IPv6 networking.



### **Create a security framework:**

*A smart risk mitigation strategy designed to identify and deal with threats will give cities the tools to prevent security breaches.*

And the opportunity to use ICT for real time, interactive check-ups allows physicians to deliver emergency medical help that can save lives where more time-consuming traditional medicine may be too late.

In education, there are many ways to improve outcomes through ICT. Applying data analytics to test results, attendance and graduation rates can help pinpoint problems and trends. Today's smart devices combined with all manner of Web apps and social media tools connect students to teachers, to other students and to diverse learning opportunities in ways never imagined a few short years ago.

In one example, e-learning with combination of visionary leadership and instrumentation helped public schools reduce the digital divide and improved the creativity and innovative spirits significantly. In another example, school-owned smartphones that allowed a 24/7 wireless connection to teachers improved algebra proficiency results by 30%.

## Privacy and security

While technologies drive the growth of convenient new products and services, those same technologies have raised privacy concerns in many areas. It is critically

important that citizens are able to trust that the information they share with programs and services via smartphones, social media and the like — and particularly potentially sensitive personal information — remains private.

To drive that point home, a trust survey found only 20% of participants believed the benefits of their smart devices were more important to them than their personal privacy. In other words, the great majority thought their privacy was more important than the convenience of their smart devices.

The security recommendations that follow offer a common sense approach to resolving privacy issues.

**Publish privacy rules.** Smart cities should let residents know what they are doing to protect their privacy.

**Create a security framework.** A smart risk mitigation strategy designed to identify and deal with threats will give cities the tools to prevent security breaches.



Implement optimal devices  
and other instrumentation:

## NEW ERA IN HEALTHCARE FOR MAGNOLIA REGIONAL CENTRE

When Magnolia Regional Medical Center, owned by the City of Magnolia in Southwestern Arkansas, replaced a 75-year-old hospital with a brand new facility, it needed an advanced healthcare communications and life safety solution.

The medical center, for being a relative small, rural hospital that offers multitude of medical-surgical specialties, infant care, family medical care needed a single-source solution to help the hospital enhance safety, security, staff responsiveness and efficiency, and patient satisfaction.

The medical centre installed a number of advanced technology systems, including a packaged communications and life-safety solution from Council member Tyco SimplexGrinnell.

The integrated healthcare communications solution combined ease of use with advanced features and options has reduced errors, accelerated response time, and helped improve staff responsiveness. IP video surveillance, access control system and video intercom, internal communications systems that include wireless paging, video Wi-Fi telephoning has provided an advanced fire detection and alarm system well suited for healthcare facilities.

Tyco's quick installation within six months allowed the medical centre to be operational swiftly. All-inclusive support provided by Tyco helped the administration to transition into a new system seamlessly. The single-source solution with end-to-end capabilities is highly valued by the administration, the staff, and community.

 **Implement optimal  
devices and other  
instrumentation:**

*The integrated healthcare communications solution combined ease of use with advanced features and options has reduced errors, accelerated response time, and helped improve staff responsiveness.*

**Combat cyber security threats.** Security professionals have warned of a dramatic rise in the number of cyber attacks against critical infrastructure — ranging from electric grids and the transportation system to hospitals and other providers of key services. Implementing a cyber security network as soon as possible will enhance the safety of personal information — and reduce its cost.

**Take precautions to protect patient and student data.** Remove personally identifying information from data that is to be stored in the cloud to protect their privacy if the data is stolen or compromised.

These steps will not only provide protection for sensitive personal information, they will also go a long way toward minimising privacy concerns residents may have about using relatively new services such as telemedicine and other advanced ICT-based technologies that may not be new, but are unfamiliar to residents asked to use them.

By taking these steps, cities will do much to assuage potential privacy concerns that could become a barrier to telemedicine or other advances in health and human services technologies designed to help them.

## Connectivity

We talked earlier about how public health agencies use smart devices and other instrumentation to collect data about air quality, disease outbreaks and the like. Collecting it is only a starting place.

**Connect devices with citywide, multi-service communications.** Connecting the smart devices deployed around cities for public health data-capture to a citywide communications system is important for realising improved public health outcomes in the same way that smart gas or water meters must be connected to optimise those infrastructures. Water quality monitors that detect a chemical leak that could contaminate a popular swimming beach aren't useful unless the information is communicated in real time to all of the city departments that might need to get involved.

## Data management

To reinforce the privacy and security strategies highlighted in the previous section, smart cities will want to make sure all departments are following the same rules.

**Create and adhere to a citywide data management, transparency and sharing policy.** Again, due to the sensitive nature of data involving health and human services, it goes without saying that a policy needs to be very explicit about who owns which data sets, who has access, how it can be shared and when it should not be shared.

When cities adopt an open data policy for non-sensitive information, they unleash enormous possibilities. In conjunction with a strong and clear privacy policy, city health and human services data can be used to create new health, social services and education apps for cities and residents.

**Architect a single health history for citizens.** As we mentioned earlier, smart cities integrate personal health data from their different agencies and departments so that patients can enjoy the benefits of a single health history.

This repository can be more than passive storage — it can be an online, security-enhanced storage, sharing and services platform that citizens can access.



Create a security framework:

## WORKFORCE OPTIMIZATION BRINGS POSITIVE IMPACTS TO ELLIS MEDICINE

Located in upstate New York, Ellis Medicine is one of the largest providers serving the Albany, Troy and Schenectady communities. The product of a state-mandated consolidation of three area hospitals, Ellis Medicine comprises four campuses and 10 service locations. With 438 beds, Ellis supports a workforce of 3,400 plus 600 affiliated physicians.

Ellis Medicine needed a workforce management technology to support the mandated consolidation of three hospitals into a single entity. During the transition, transparency and accountability were priorities.

The solution needed to focus on integration, consolidation and transparency to effectively manage the transition from three distinct organisations to a single entity with a single, strong corporate culture.

The following Workforce Optimization solutions from API Healthcare, Council member GE Healthcare Company, provided Ellis Medicine a centralised view — timely data information about human resources and payroll, staffing and scheduling, and time and attendance.

Newly acquired capability and flexibility of adjusting and redeploying workforce significantly reduced overtime expenses, nearly 50%, which equated to a savings of almost \$2 million. Payroll processing improved substantially, with error rate of only .004%. Ellis Medicine also experienced significant decrease in unscheduled absences.

Ellis Medicine, in collaboration with GE, displayed exemplarily how software, data and analytics can positively impact patient outcomes.



Create a security framework:

*Newly acquired capability and flexibility of adjusting and redeploying workforce significantly reduced overtime expenses, nearly 50%, which equated to a savings of almost \$2 million.*



## Computing resources

There's nowhere in a smart city that computing resources aren't a major player. Below is a quick refresher on four targets to consider in a health and human services context.

### **Consider a cloud computing framework.**

Cloud computing has become more affordable and more prevalent. Smart cities of all sizes may see advantages in the cloud's scalability, reliability and cost. However, as we mentioned earlier, before uploading personally identifiable health and human services data to the cloud, steps must be taken to 'de-identify' it.

**Use an open innovation platform.** An open innovation platform empowers innovators. And the possibilities in the health and human services arena are limitless. In Mumbai, for example, residents can download an app that provides all sorts of useful information about local restaurants — including grade they received in recent health inspections.

**Adhere to open standards (and help develop them).** A number of information technology standards organisations have health working groups, and a few standards groups are dedicated to efficient communication in the health industry. Health-related standards are still emerging, and cities have a stake in their outcome. Groups welcome their participation.

**Have access to a central GIS.** With health and human service agencies spread out in many parts of a city, a GIS will prove useful for smart cities. A central GIS enables efficiency gains through more intelligent scheduling and routing, provides improved accuracy of essential records and boosts resiliency of key assets.

**Have access to comprehensive device management.** It's important to include devices used by health and human services workers in the field — smartphones, laptops, etc., — as part of a city's device management system to ensure they comply with city data management, security and privacy policies.

## Analytics

The four targets highlighted here demonstrate how analytics are particularly important as cities monitor trends and developments in public health.

**Achieve full situational awareness.** Smart cities use monitoring devices to take the pulse of the city and its people. Situational awareness aids that effort by increasing the reliability and resiliency of the public health infrastructure and those monitoring devices, allowing for quick response to incidents that threaten public health and wellbeing.



### **Smart learning enhances sustainability:**

*Improved service delivery that utilizes ICT cuts down on travel, which promotes the conservation of energy resources.*



Use an open innovation platform:

## WIRELESS VIDEO SOLUTION HELPS HOSPITAL PATIENTS COMMUNICATE WITH DOCTORS

**B**radford Royal Infirmary and St Luke's Hospital are teaching hospitals in the United Kingdom that serve the healthcare needs of 500,000 citizens, of which 22% are from black or minority ethnic (BME) origins. Many of them do not speak or understand English, a situation that often resulted in patient communication problems at the hospitals.

With over 900 beds and 5,200 staff collectively, these two busy hospitals deal with over 120,000 accident and emergency (A&E) attendances a year, nearly 50% of who are estimated to be from the BME communities.

Effective communication between doctors, nurses and patients is vital, but interpretation services were inconsistent. For face-to-face consultations, clinicians used in-house interpreters or hired interpreters from their professional register, who specialised in a core

set of languages. However, these interpreters were not always available at short notice, so clinicians were often forced to communicate via patients' relatives and friends.

The alternative was to use a telephone interpreting agency, but this approach was expensive and unpopular with medical staff because it lacked the visual interaction needed in a patient consultation.

In addition to inconsistency and expense, these methods of interpretation had other disadvantages. Using non-professionals increased the risk of misinterpretation, which could create potential risks when delivering medical care. Similarly, using a male interpreter could be embarrassing for women, particularly if their condition was of a sensitive nature.



Use an open innovation platform:

*A wireless video solution allows two UK hospitals to provide much-needed interpretive services to patients on a timely basis, providing a better patient experience with less risk of incorrect treatment or cultural offense due to language issues – and also reducing hospital costs.*

That's when they came up with the idea of video interpreting. They already used wired and wireless networks from Council member Cisco, so they consulted experts from the Cisco Healthcare Team to help design a wireless-based video solution. A proof of-concept was subsequently arranged to thoroughly test the Cisco solution and gather feedback from both clinicians and patients.

The result is a fleet of trolley-based interpreting endpoints, which are powered by battery packs, allowing easy transportation to any hospital location. The trolley offers a simple keyboard and screen with video

communication. Using a mouse, clinicians select the language they require and the preferred gender of the interpreter. The system uses one of the hospital's 350 Cisco wireless access points to connect to a dedicated team of interpreters who constitute, in effect, a small contact centre. To help ensure quality of services, video interpreting services are segregated from other traffic on the wireless network.

The primary focus is to make hospital services more accessible to non-English speakers, but a hospital official estimates the solution will reduce interpretation costs by 30%.

Situational awareness depends on different systems being able to communicate about 'where' and 'when'. Thus, open standards for encoding, discovering, assessing and using spatial and temporal data play a key role in health and human services analytics applications.

**Achieve operational optimisation.** Analytics help cities ensure the best possible public health outcomes. For example, they may reveal a sudden shift in air quality in a particular part of a city that requires corrective action. Or analysis of health records may reveal an abnormally high number of lung cancer cases in a community, prompting an investigation by public health officials.

**Achieve asset optimisation.** The objective here is to ensure maximum value is extracted from a city's investments in health and human services infrastructure — which includes everything from computers in offices to field devices that monitor parameters like water quality at public beaches. Calculating precisely which assets should be replaced or repaired and when helps achieve maximum return on investment.

**Pursue predictive analytics.** Analysing health and human services data to spot patterns and trends and taking action before situations worsen can make a city more livable. By monitoring the path and characteristics of a virus, for instance, public health officials can predict where it will strike next and

alert residents as to how they can protect themselves. As we've said, predictive analytics can also help people understand what their own health might look like in the future, offering incentive for behaviour changes.

In one example, using predictive analysis tools based on Council member Microsoft Technologies, a district is providing comprehensive data snapshots of student success indicators. The combination of visionary leadership and data analytics, based on student grades, attendance, health records, and other data, helped measure the students' performances and identified analytical reasons of students' struggles — this efforts resulted in improving the graduation rates from 55% to 78%.



**Achieve operational optimisation:**

## OSAKA HOSPITAL ACHIEVES HIGH-PERFORMANCE GOAL

**W**ith more than 1,000 beds, Osaka Red Cross Hospital, the largest in the Japanese Red Cross society, is also certified as an emergency care centre, regional cancer centre and is involved in disaster relief. The hospital had experienced ongoing network problems with inconsistent communication, and low performance due to many departmental systems — around 1,300 terminals — sharing the Healthcare Information System (HIS) network.

As well as wanting to improve its network performance, the hospital was also in the process of introducing a comprehensive electronic patient record system, and needed a smooth transition from its old paper record-keeping. Osaka Red Cross Hospital upgraded its network with Council member Allied Telesis solution. The new network features reliability and high performance, and is easy to manage.

New wireless network access using Extricom TM Series wireless technology from Allied Telesis, for seamless roaming between hospital wards and the easy real-time entry of patient data, is proving to be a perfect solution for highly mobile users.

The new electronic patient record system uses new wireless connectivity to update patient records in real-time, right at the bedside. The AlliedView NMS network manager centralises and monitors the entire network, while iBAQS network authentication appliance ensures the security of data held in HIS, by preventing access from unauthorised devices.

Osaka Red Cross Hospital, with its new high performing network, providing stable and reliable access, now lives up to its goal — to perform advanced healthcare for all in a heartfelt manner.

 **Achieve operational optimisation:**

*The new electronic patient record system uses new wireless connectivity to update patient records in real-time, right at the bedside. The AlliedView NMS network manager centralises and monitors the entire network.*

# ISO 37120: A yardstick for measuring city performance



In 2014, the International Organization for Standards announced an ISO standard that applies strictly to city performance. The document -- known as ISO 37120:2014

-- establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right we have indicated how the standard related to Transportation correspond to the Council's Transportation targets identified on the next page. The ISO 37120 transportation indicator has cities reporting on the extent of their mass transit and non-car infrastructure, overall transportation safety and direct flight inter-connectedness.

## Health Indicators

			Implement optimal instrumentation	Citywide, multi-service communications	De-identify patient data for research in cloud	Architect single health history for citizens	De-identify student data for research in cloud	Create citywide data management policy	Have access to central GIS	Pursue predictive analytics	Achieve full situational analysis
<b>Core</b>	12.1	Average life expectancy	●	●	●	●		●		●	
	12.2	Number of in-patient hospital beds per 100,000 population	●	●	●	●		●		●	
	12.3	Number of physicians per 100,000 population	●	●	●	●		●		●	
	12.4	Under age five mortality per 1,000 live births	●	●	●	●		●		●	
<b>Support</b>	12.5	Number of nursing and midwifery personnel per 100,000 population	●	●	●	●		●		●	
	12.6	Number of mental health practitioners per 100,000 population	●	●	●	●		●		●	
	12.7	Suicide rate per 100,000 population	●	●	●	●		●		●	

## Education Indicators

<b>Core</b>	6.1	Percentage of female school-aged population enrolled in schools	●	●			●	●		●	●
	6.2	Percentage of students completing primary education: survival rate	●	●			●	●		●	●
	6.3	Percentage of students completing secondary education: survival rate	●	●			●	●		●	●
	6.4	Primary education student/teacher ratio	●	●			●	●		●	●
<b>Support</b>	6.5	Percentage of male school-aged population enrolled in schools	●	●			●	●		●	●
	6.6	Percentage of school-aged population enrolled in schools	●	●			●	●		●	●
	6.7	Number of higher education degrees per 100,000 population	●	●			●	●		●	●

# HEALTH AND HUMAN SERVICES TARGETS

In the checklist below, targets specifically pertaining to the health and human services responsibility are in **bold**, universal targets are not.

	Enabler	Health and Human Services Targets: How smart cities deploy and use ICT to enhance health and human services	Implementation Progress			
			None	Partial	Over 50%	Complete
Human	Inclusivity	Achieve accessibility optimization <b>(Supplement: web accessibility)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate citizen reporting framework for outcome thinking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Achieve citizen engagement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	Collaborativity	Create institutional framework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Pursue multilateral collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	Governance	Achieve existing infrastructure optimization	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Improve the governance of services	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Facilitate revenue generation for the city	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# HEALTH AND HUMAN SERVICES TARGETS

In the checklist below, targets specifically pertaining to the health and human services responsibility are in **bold**, universal targets are not.

Technology	Enabler	Health and Human Services Targets: How smart cities deploy and use ICT to enhance health and human services	Implementation Progress			
			None	Partial	Over 50%	Complete
	<b>Instrumentation and Control</b>	Implement optimal instrumentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Connectivity</b>	Connect devices with citywide, multi-service communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Interoperability</b>	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Security and Privacy</b>	Publish privacy rules Create a security framework Implement cyber security <b>De-identify patient and student data for storage and research in the cloud</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Data Management</b>	Create a citywide data management, transparency and sharing policy <b>Architect a single health history for citizens</b>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>
	<b>Computing Resources</b>	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Analytics</b>	Achieve full situational awareness Achieve operational optimization Achieve asset optimization Pursue predictive analytics	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			



# 12

## Public Safety

**Making a city safe by improving safety services and accountability is undoubtedly essential to reinforce personal safety, reduce fear and ensure socio-economic growth. Well-connected and citizen-centric intelligent surveillance mechanisms and safety systems enhance city performance on safety and security for citizens to thrive as a city. Today's advanced technologies are keeping the city's protectors — and their communities — safer. A secured city will bring investment and lead job opportunities and related economic growth.**



**Public safety is a key pillar for a smart city:**

*Road safety is conceivably the most commonly raised concern by citizens in India. Very few Indian cities can boast of roads that offer a safe journey to its inhabitants.*

The accelerating lucrative employment opportunities and innovation in cities is not only increasing urban population in these economic growth centres, but also escalating public crimes — ranging from petty crimes to public crimes against women to lethal terrorist attacks. As the urban population and gross domestic product (GDP) continue to rise, the increasing population and mass migration further the anonymity, and fighting crime will become even more complex.

A safe city/public safety is a key pillar for a smart city. With increasing crime in cities and additional pressure due to rapid urbanization, it has become very important for modernize and take integrated approach towards public safety to provide safe and secure environment for citizens and business in a smart city.

The mega cities in India, which includes the top 53 cities with population more than 1 million, have extremely high crime rate — the average rate of crime in urban agglomeration centres is 345.9 (Crime Incidence per lakh population), which is 60% higher than the national average crime rate of 215.5, according to recent National Crime Records Bureau statistics.

Road safety is conceivably the most commonly raised concern by citizens in India. Very few Indian cities can boast of roads that offer a safe journey to its inhabitants. Though there is a heavy focus on car-driven infrastructure development to accommodate

the burgeoning number of cars, footpaths are getting narrower and dysfunctional due to disregarded repairs and development in most of the cases. The situation is compounded further by informal vendor encroachments, forcing people to walk on roads and resulting in a rise in accidents.

In the Readiness Guide, public safety includes all the infrastructure, agencies and personnel that cities call on to keep their citizens safe — police and fire departments, traffic management and mass transportation systems, disaster prevention personnel, public and private emergency management services, surveillance and monitoring agencies, safety courts, correction facilities, NGOs and other neighbourhood watch groups, fire hydrants and squad cars. It's a lengthy list that may include infrastructure and resources from other city departments and non-city agencies and even private citizens.

Smart cities are making good use of the intelligence generated by all the connected entities for faster and better decision making. Smarter cities around the world empower these agencies and personnel with information and communications technologies (ICT) to create "smart public safety" and greatly improve safety outcomes. The brief scenario at right illustrates the smart public safety concept.

## Why make safety and security smart?

**Multi-agency cooperation.** As we have seen in the earlier section, there are multitudes of public, private and non-governmental agencies — local, state and also national and even international — that are working hard to respond to emergencies. Therefore, there is a pressing need to create a seamless platform for various agencies to collaborate cross-departments and even cross-borders.

**Deciding factor.** Providing a safe and secure environment to live and work for citizens and business is the key responsibility of city government. Safety and security are perhaps the most influencing factors while choosing where to stay or work. However, high crime rates decrease property values and attractiveness of economic and social environment for the citizens, and ultimately losing to attract the investments for the growth of the city.

**Escalating crime rate.** Criminals are becoming more organised and sophisticated, and increasingly function in a boundary-less environment, operating locally, nationally and internationally. According to the National Crime Records Bureau of India report, there has been a tremendous increase — around 300% since 1950 and about 2.5% annually since 2011 — in

cognizable offences. Catching these criminals requires combining and analysing data from a variety of sources, national and international, public and private.

## It's about the data

At its core, smart public safety is all about the use of “intelligence” — information that helps people make better decisions. For example, intelligence might hint at the identity of a criminal. Or it might suggest to emergency personnel that a wildfire is likely to occur on the outskirts of town. This kind of public safety intelligence creates immeasurable value not only to first responders, but to city residents and businesses too. As cities become safer, people are happier and healthier, businesses take note and tax revenue increases.

Let's look at four specific ways ICT-enabled smart cities improve public safety outcomes:

- Generating their own public safety data
- Accessing the universe of relevant data
- Correlating data sources to create intelligence
- Delivering intelligence to decision makers

**Generating public safety data is a first step in realizing intelligence.** Many cities will have much of this data as well as mechanisms for generating it in place already. It's what we call legacy information, or legacy investments. Think of your own criminal database and records that include fingerprints, mug shots, video evidence and so on. Smart cities augment existing sensors with others to obtain all relevant information in their environment. Sensors might include CCTV, other video sensors or audio sensors.

But this data alone isn't enough to create actionable intelligence. Cities must augment it with many other data sources, traditional and non-traditional. In fact, accessing the universe of relevant public safety data is absolutely critical for improving safety outcomes. Public safety requires close cooperation and data sharing across city departments. Police might need access to drivers' licence records from a licensing department. Or fire personnel might need to understand weather data from a meteorological agency housed in an energy department.



**Using ICT to create intelligence:**

*After being held at gunpoint on a city street, Shayan Pahlevani co-founded a company that makes the free CrimePush app that lets smartphone users push a button to report a crime in progress.*

**Accessing the universe of relevant data aids decision making.** Local, states, and national governments and their agencies keep records. Even international organisations like Interpol keep records. And relevant information can come from non-traditional sources as well — the wealth of data that exists in social media. By 2030 every city asset, across much of the world, might be sending data in an Internet of Things. Smart public safety agencies seek access to all of it, for every new piece of data that a city has access to makes their intelligence that much stronger and precise.

Accessing all of this information is both a big task and a critical one. Fortunately, ICT and good interoperability and data management policy can help. Already, standards exist that can ensure that the data cities collect and use is interoperable.

**Smart cities employ ICT to correlate data and create intelligence.** Computing power and analytics transform otherwise useless piles of data into decisions, insight and foresight. For example, armed with this intelligence, smart cities predict crime, so that their law enforcement agencies can better protect citizens and make more efficient use of resources.

Additionally, thanks to the open government movement discussed in the Universal chapter, we're seeing more and more crime data making its way into applications that everyday citizens can use. Buying a house and want to make sure you're in a safe neighbourhood? On vacation in a new city and want to steer clear of crime-infested areas? Chances are there's an app that can help.

**Finally, smart cities deliver this intelligence to decision makers.** Public safety intelligence is about saving lives and property, so it must be accessible "no matter where, no matter what." With ICT, smart public safety agencies can disseminate intelligence to multiple departments and thousands of employees so there is a common operating picture.

On the law enforcement side of public safety, intelligence will often lead to arrests, and the involvement of city courts and corrections systems. ICT plays a role in these systems as well. Proper data management systems can help courts make effective use of the enormity of information that they hold. Public defenders can level the playing field with private lawyers and their large staff strength with the help of ICT.

## Interconnectedness assessment

Planning improvements in public safety, the city will want to take into account public safety's interdependencies, such as communications, transportation systems and energy.

In normal daily operations, police and fire departments rely on communications and energy systems to maintain real-time situational awareness of activities taking place across a city. And in the urgent case of a natural disaster, first responders will rely on the resilience and reliability of communications, electrical power and transportation systems to help them establish command and control, gain situational awareness, coordinate inbound aid resources and potentially outbound evacuations.

Conversely, the safer a city is, the greater is the reliance on public transport and alternative modes of transport such as walkability and bikability.

## Smart solutions for a safer city

Developing and inculcating solutions for a safe city require a collaborative effort that incorporates a multitude of advanced technological sub-systems. Integration and interoperability among these sub-systems is at the core of the solutions in order to obtain better intelligence from various sensors, systems and sources. From monitoring to crisis management centres, technology will enable law enforcement, emergency services and local decision makers. This will help optimise their response to the expected as well as unexpected.

**1. Enable a holistic safety approach.** Cities can better respond to adverse situations and achieve much more effective results when municipalities view and manage all of the various components of the safe city together holistically, rather than looking at them in isolation or focusing on a few specific areas. Such an approach allows to create a seamless connection among the sub-systems and to support each other. By taking a holistic approach, supported by integrated, robust technology, a city can leverage its existing infrastructure and resources to create innovative and effective public safety solutions.

- 2. Build public safety through urban planning and development.** Urban and transport infrastructure play an important role in monitoring and preventing crime by identifying criminal acts, or potential criminal acts, in advance. Planning and installing various systems such as CCTV and IP cameras in airports, transit hubs, public buildings, and scattered throughout a city, creates an advance surveillance network. Local crime prevention and safety strategies are incorporated in urban planning.
- 3. Build emergency contact infrastructure.** To trigger alerts to police and other connected services in case of an emergency situation.
  - **Helpline with supportive control centre.** Dedicated 24x7 emergency helpline to escalate any events, issues or concerns to centralised or localised call centres.

These centres, supported by dedicated manpower are integrated with hospitals, police stations, emergency responders, etc.
  - **Emergency triggers.** Physical panic buttons are provided at key public places, such as Metro or train stations, which initiate immediate contact. Furthermore, a physical button can be used as an easy and convenient way to raise alerts.



### **Build emergency contact infrastructure:**

*A dedicated 24x7 emergency helpline number escalates any events, issues or concerns to centralised or localised call centres.*

A European company offers a button as a signalling device — a very simple yet effective button with user interface and cloud-to-cloud connectivity to effectively raise alerts, which can be used for on-demand utility services to deliver European Platform for Rehabilitation (EPR) to the elderly.

Similarly, an SoS mobile application is an effective system to trigger alerts and incident reporting with geo location, providing effective response during an emergency situation. The alerts are just not routed to the police control room, but

also to certain selected numbers from the phone book.

- 4. Create integrated city command and operations centre.** Video analytics runs on live camera feeds and automatically detects and raises alerts for public safety issues like left behind objects, suspicious behaviour etc., which makes it easier for public safety agencies to monitor a city, as it's practically impossible to monitor thousands of cameras manually. The analytics proactively detect public safety issues and take action to avoid incidents.

To protect rising urban populations, cities such as Surat and Pune have implemented complete command-and-control solutions to progress towards comprehensive situational awareness, gathering intelligence and effectively responding to events.

- 5. Facilitate remote FIR filing.** Like many legal proceedings, First Information Reports (FIRs) and other police complaint registrations are lengthy, time-consuming and tedious processes, leading to avoidance of reporting the matter. Kiosk systems located at convenient locations allow citizens to register FIRs remotely.

Collaborating with Council member Cisco, the Bengaluru city police has launched a Remote FIR registration system kiosk at Mantra Mall, the first of its kind venture in India. The kiosk is equipped with high definition video and audio systems to connect citizens with police officers at the traffic management centre headquarters, offering 24x7 availability. Such systems empower citizens with convenience and ease to remotely file FIRs irrespective of location of case jurisdiction, while relieving the police from shortage of task force by sharing resources.



Create integrated city command and operations centre:

## INTEGRATED SMART SURVEILLANCE SYSTEM BOOSTS KOLKATA SAFETY

The situation in Kolkata is worsening; road crash fatalities, casualties and women safety issues have been increasing over the past twenty years. To provide better security to citizens, the Kolkata Police has formally launched the City Surveillance System (CSS) that covered 160 major traffic intersections with 24x7 CCTV cover. Kolkata police wanted to analyse not only the traffic flow, but also to try and devise ways to reduce the number of accidents and ensure free movement of vehicles.

CSS now have 500 cameras, including infrared and PTZ (pan-tilt-zoom) cameras, enabling the police to monitor the entire city from its headquarters. However, the information is stored offline to be recalled after an incident happens. Kolkata Police used switching infrastructure by Council member Allied Telesis to provide an effective upgrade to the existing system.

On the same infrastructure, Allied Telesis implemented object racking/processing unit with an intelligent inbuilt algorithm of CCTV surveillance which would instantly identify any change in normal behaviour and alert a system in the nearest kiosk which set off an alarm at the local police station and then the headquarters instantly. To make it foolproof, a system is in place that sets off a loud alarm followed by an SMS to the local kiosk or the headquarters with brief details.

Using a resilient network backbone from POP to POP on gigabit speed provided uninterrupted video traffic and ensured no delay in real time video transmission. Standard switches and network management software and heterogeneous Ethernet-based devices with industry standard technologies make it interoperability-supportive. The future-proof solution has enough room to grow both in hardware and application level.



Create integrated city command and operations centre:

*CSS implemented object racking/processing unit with an intelligent inbuilt algorithm of CCTV surveillance which would instantly identify any change in normal behaviour and alert a system in the nearest kiosk which set off an alarm at the local police station and then the headquarters instantly.*



### **Making people 'feel' safer and mitigating pain and suffering:**

*There is an intangible but very real value to the feeling of safety in a community — when people feel safer, their lives seem more liveable.*

## **More to smart public safety than meets the eye**

Public safety may be one of the more visible and best understood of city responsibilities. But many may not realise how the benefits stack up when cities make it smarter. Here are some highlights that align with our livability, workability and sustainability goals.

## **Livability**

**Reducing response times.** Citywide public safety situational awareness provides emergency managers and other public safety personnel with an immediate and real-time understanding of incidents, allowing them to respond more quickly.

**Making more arrests.** Police and investigator outcomes in criminal cases are improved through access to data. Analysis of the universe of relevant public safety data can unearth links between suspects, crimes and other incidents that result in higher case closure rates — fewer criminals on the street.

**Lowering crime rates with more resolution and more prevention.** Smart public safety lowers crime rates in two ways. First, it empowers police to realise better outcomes, with more cases solved and more arrests made. Second, through analytics, it allows law-enforcing agencies identify and prevent threats before they cause harm.

**Making people 'feel' safer and mitigating pain and suffering.** There is an intangible but very real value to the feeling of safety in a community — when people feel safer, their lives seem more liveable. Through improved outcomes, smart public safety also delivers a freedom from the pain and suffering that crime and other incidents cause to citizens.



Reducing response times:

## TECHNOLOGY AND E-APPLICATION SYSTEM IMPROVES SAFETY IN SURAT

**T**he world's fourth-fastest growing city, Surat, with a population of 5.5 million citizens and rapidly growing, was facing a problem of shortage of staffing in its police force. The approximate ratio of 93 policemen/1 lakh citizens in the diamond processing capital was putting pressure on the police force to reduce the crime rate and keep citizens safe. To protect its citizens, the Surat City Police Department needed to find a way to better monitor and manage city activities.

To bridge the gap between policemen and city growth, the Surat City Police Department started the 'Safe City Project', an initiative striving to reduce the city's crime rate. To use technology as a force multiplier, the department collaborated with Council partner Microsoft in developing advanced surveillance connecting over 6,000 CCTV cameras and keeping vigilance on the entire city from a remote command and control centre.

Surat became the first Indian city to engage with Microsoft CityNext, using 60+ digital solutions. The department created a data centre using Microsoft Dynamics, SQL Server and Windows 7, to monitor street activities by tapping into state and national surveillance grids. To improve the existing process of tracking citizen requests, the department created an e-application system that allows the public to view the status of their submissions.

Since the safe city project's inception, Surat has lowered crime rate by 27% in surveillance zones, with enhanced traffic management, improved police response time, and increased transparency on the status of public requests. According to the non-profit Janagraha's survey, Surat is the top-ranked city in citizen satisfaction and the perception of local government.

### Reducing response times:

*Since the safe city project's inception, Surat has lowered crime rate by 27% in surveillance zones, with enhanced traffic management, improved police response time, and increased transparency on the status of public requests.*



**Ensuring fewer business resources go to crime prevention.** Crime forces businesses to spend more money than they otherwise would to pay for security and insurance. When crime rates are lowered through smart public safety, businesses win.

## Sustainability

**Creating operational savings and enabling better resource deployment.** To put it simply, smart public safety agencies cost less. In one estimate, a hypothetical public safety agency with \$350 million in operating costs can save up to \$60 million annually through smart technologies and best practices. Savings rise to \$200 million when society, other agencies and victim costs are considered.

**Avoiding criminal justice and correction costs through crime prevention.** Unleashing analytics on an integrated public safety information database increases cities' crime prevention capabilities. When prevention efforts are empowered, cities spend less on prosecuting and jailing criminals.

**Creating higher property values and increasing tax revenue.** As neighbourhoods across cities become safer, property values rise and increase the prosperity of their residents, and expands the tax base for governments.

## Workability

**Attracting business and talent.** Lower crime rates and resiliency to natural disasters like fires and floods aid cities in the competition for businesses and jobs, and they help ensure that businesses can operate safely.

**Mitigating reduced earnings and lost productivity.** Crime and disaster can result in injuries to employees and damage to business infrastructure. Improved public safety means that not only do smart cities become more attractive to business, but businesses that operate in smart cities are able to do so more securely and with fewer safety-associated costs and risks.

### **Creating higher property values and increasing tax revenue:**

*As neighbourhoods across cities become safer, property values rise and increase the prosperity of their residents, and expands the tax base for governments.*



Ensure better responses to emergencies:

## PREPAID CARDS GIVE DISASTER VICTIMS A SENSE OF SECURITY

Every year, the Red Cross responds to nearly 70,000 disasters around the world from home fires to major hurricanes. Since 2005, Council member MasterCard has enabled the American Red Cross to provide emergency relief through prepaid cards. Along with feeding and sheltering, this service allows many disaster-affected families and individuals to quickly and reliably get the immediate help they need to get back on their feet.

John Ravitz of the Red Cross provides an example of how important the client assistance cards (CACs) are. A major apartment fire affected 66 people, 30 of them children under age 10. It struck at 3 am on a Sunday morning and people lost most everything. By the next morning they would need medications and food and other daily essentials.

Red Cross was able to get those people client assistance cards within two hours of the fire. Having the MasterCard logo on them means the fire victims could use them at stores in their neighbourhood and anywhere MasterCard is accepted. The prepaid cards can also be used to obtain cash at ATMs.

The Red Cross says it prefers to use CACs for a wide range of assistance types because they provide clients with the flexibility as to where they shop as well as greater privacy and dignity while making purchases.

"It gives them a sense of security moments after they lose everything," Ravitz said, and helps them to start their recovery process.

 Ensure better responses to emergencies:

*Red Cross was able to get fire victims prepaid client assistance cards within two hours of a major apartment fire, providing the means to immediately start their recovery.*

## Public safety targets

The technology targets described in this chapter can help cities develop a smart public safety infrastructure that uses intelligence to protect lives and property and save resources. There is one new target specific to public safety we'll introduce in this chapter, and we'll also highlight how public safety intersects with the universal targets discussed earlier.

## Inclusivity

It is evident that those cities that actively and directly engage their citizens and communities in systematically addressing challenges of public safety and security deliver successful outcomes and create more resilient solutions for all.

**Achieve accessibility optimisation.** The smart cities around the world have great emphasis on providing safety for all. The area, groups, or individuals that are or have probability of falling below minimum welfare or affected by disasters or criminal activities, need to be given special attention. Social media and mobile enabled platform for community/ community groups improves accessibility and allows them to collaborate with police for local safety and security issues.

**Formulate citizen reporting framework for outcome thinking.** Active participation from communities and other stakeholders, including the private sector is critical for developing and implementing effective and inclusive policies and laws to enhance safety and security in cities. Evidence based programming and participatory approaches to crime prevention and community safety are important for the co-production of safety for all.

**Achieve citizen engagement.** Cities Urban crime prevention and safety policies and programmes can only be effective when communities are consulted and when interventions are based on evidence and tailored to the specific needs and vulnerabilities of majority of the populations. The role of youth and women in creating safety and security is the key in smart cities.

## Collaborativity

Numerous public safety agencies, from local traffic management to city-wide emergency response carry operational responsibility of public safety. To successfully achieve this goal, it has become very important for modernise and take integrated approach towards public safety – these various agencies need to develop systematic collaboration systems and

cooperative solution mechanisms.

**Create institutional framework.** Addressing the wide range of root causes of crime and violence requires multi-sectorial coordination between national and local level authorities as well as amongst the various sectors of governance, including education, housing and urban planning, economic development, justice etc. Governments of smart cities take up on responsibilities to empower various stakeholders and act as catalysts of pervasive multi-level efforts to provide safe and secure environment for citizens and business in the city. Though dedicated efforts at organisation and sectorial levels help in creating safe environment, taking an integrated approach and employing more comprehensive analytics, the potential benefits multiply tremendously.

**Pursue multilateral collaboration for monitoring and response.** Collaborative monitoring is a key enabler for a safe city, along with prevention measures and response mechanisms it helps ensure safety and security of all citizens, especially vulnerable population, children, and women. In Indian cities, where every government and private establishment, has realised the necessity to secure its infrastructure and establish surveillance, monitoring and incident response systems, it is important that the data gathered by these agencies is shared among them.



**Achieve accessibility optimisation:**

## CITY SIGNAGE PROGRAM

**Achieve accessibility optimisation:**

*With 10,000+ Signage installed, it helped in ensuring safe, orderly and efficient movement of all road users and vehicles, as well as played a pivotal role in helping Delhi cash-in on the special event and successfully creating a positive image for the numerous visitors.*

**A**s cities compete with each other to be the best places for one to live, work and visit, implementing programs that enhance the quality of life for its people becomes imperative. In 2010, Delhi was one such city which had set its eyes upon improving road safety and impressing visitors from across the world as it readied itself to host the XIX Commonwealth Games.

Delhi implemented one such program – installation of safe traffic control and guidance systems, which works towards making life safer on the roads for motorists and pedestrians alike. At a time when thousands of visitors were expected to throng the city, implementing such programs gained even more importance as it was striving to project itself in a positive light and leave an unforgettable impression on first-time visitors. This would help it grow to be a destination that would

encourage visitors to return, recommend or invest in the city. To make this goal a reality, Delhi local municipal bodies, PWD and NMDC worked with Council member 3M to deploy a first-of-its-kind comprehensive city signage program in India.

The program involved the installation of various signs that followed National as well as International norms. The numerous signs included way-finding, regulatory, mandatory and cautionary signs.

With 10,000+ Signage installed, it helped in ensuring safe, orderly and efficient movement of all road users and vehicles. Deployment of it also played a pivotal role in helping Delhi cash-in on the special event and successfully creating a positive image for the numerous visitors.

Government agencies are already deploying on-board surveillance systems by provisioning CCTV-based surveillance on public buses and bus stands, metros, railway stations and airports. These systems under collaborative monitoring can conveniently share their data in real-time with security agencies of the city, along with live feeds from CCTV systems deployed by private establishments such as malls, business parks and entertainment houses, where the security agency can make effective use of the information. Smart cities are using the collaborative framework to receive video feeds from these systems to ensure real-time responses.

The ability to respond to emergencies promptly is another important function of smart cities. Effective emergency preparedness and response depends on collaboration among various response teams. Video analytics enabled integrated city command and operations centre can monitor emergencies and disasters to provide effective collaborative response in case of emergency.

**Develop resilient city.** Resilience concentrates on how individuals, communities and business not only cope in the face of multiple shocks and stresses, but also creates new opportunities for transformational development. Resilience at city level recognises the urban area as a dynamic and complex system that must adapt to various challenges. Creating resilience of

local communities to factors that may lead to engagement in crime and violence is the key in order to reduce vulnerabilities, opportunities and rewards for offending.

## Governance

### **Improve the governance of safety.**

Enhancing urban safety and social cohesion are issues of good urban governance. They intend to create a city where safety is improved for its citizens and neighbourhoods, where there is fearless interaction among people and groups. These are prudent aspects of good governance, which create an enabling environment for the inhabitants of the city, allowing improved quality of life and fostering economic development.

Developing sustainable urbanisation frameworks by emphasising inclusive as well as participatory urban planning and local development practices, incorporates policy making and strategy development. This, in turn, promotes institutional and organisational development, resource planning and management in order to enhance efficiency in governance.

## Instrumentation and control

In a smart city, first responders use and obtain data in the field. Therefore, police, investigators, fire-fighters and EMS technicians must not only input data to a command centre, they also need to interact with the command centre and others in the field. This two-way relationship requires devices that can display information in useful ways, and devices such as video feeds that can transmit data to storage.

**Implement optimal devices and other instrumentation.** In public safety, these devices include those that help agencies and personnel capture data and those that enable first responders to use that data in the field.

Increasingly cities are preferring to adopt a citywide surveillance system to enable more detailed awareness over data captured by surveillance devices deployed in high-risk areas. Importantly, these surveillance networks should produce evidence-quality video. Data-capturing instrumentation is also likely to include audio and pressure sensors in critical areas, or devices purposed for disaster prevention and awareness — weather instrumentation, water sensors and so on. It is likely that some of this instrumentation is the province of other city responsibilities; one of this Guide's universal targets recommends smart cities share infrastructure when possible.



Implement optimal devices and other instrumentation:

## SMART AIRPORTS: DELHI AIRPORT

Opening of Terminal 3 in 2010 to cater to the escalating passenger growth, the Indira Gandhi International Airport became India's and South Asia's busiest and largest aviation hub, spanning 500,000 square metres and over 160 check-in counters. To secure this new addition with a capacity of 34 million passengers per annum, required a proven access control and security solution for employees, passengers and retailers using fully integrated IP technology.

Delhi International Airport Ltd (DIAL) installed a state-of-the-art access control system from Council member Tyco featuring integrated CEM AC2000 Airport Edition system that seamlessly merges with third-party video surveillance systems, creating a central security management system, providing a single user-friendly command and control graphical interface.

This new system fully supports key operational applications such as passenger reconciliation, visitor management, air-bridge monitoring and airport check-ins, thermal cameras for runways — all of which are critical to airport ground operations. In addition, the Tyco IP video surveillance system has the ability to deliver the same high-quality digital video as comparable solutions with savings of between 25% and 50% on bandwidth and storage requirements. The integrated security system also provides surveillance and analytics to the multi-level and surface car parks and the Metro rail system.

The fully integrated Tyco system allowed the new terminal to run more efficiently in terms of both cost and operations, and enabled the airport to handle the operational complexities and security challenges involved in a wide-area deployment.

 Implement optimal devices and other instrumentation:

*The fully integrated central security management system allowed the new terminal to run more efficiently in terms of both cost and operations, and enabled the airport to handle the operational complexities and security challenges involved in a wide-area deployment.*



## Connectivity

Communications are a critical part of a smart city's public safety strategy, as this target explains.

**Connect devices with citywide, multi-service communications.** To be effective — and that's absolutely what a smart city wants in its public safety system — two-way communication is essential. So is a citywide communications system that loops in all the personnel, smart devices, databases and ICT systems that have a role in public safety



### **Connect devices with citywide, multi-service communications:**

*To be effective — and that's absolutely what a smart city wants in its public safety system — two-way communication is essential.*

outcomes. As we mentioned earlier, a city might require multiple networks and share them when appropriate, but the key is to ensure all devices are able to communicate effectively on a citywide network.

## Interoperability

Interoperability is the key in smart public safety because it opens up the world of data and helps generate integrated intelligence, as you'll read in the targets highlighted below.

**Adhere to open standards.** Open standards for data are a major step in creating actionable, life-saving intelligence for public safety decision makers.

Smart cities adhere to data standards that ensure all of the data they collect — not just by public safety instrumentation and personnel, but across their responsibilities and departments — is handled the same way. Standards exist already for the recording, storing, transmission and use of data. Smart cities use the best and most widely adopted standards possible so they have easier access to data from other agencies. They also help promote the use of standards nationally and internationally so that more and more data from across the world can be efficiently shared. Additionally, by requiring open standards in the procurement of public safety systems and equipment, cities increase the choices available to them and decrease costs because open standards mean products can be mixed and matched from different vendors.

**Use open integration architectures and loosely coupled interfaces.** There are a number of reasons for sharing public safety data within city departments. And in some cases public safety applications used by one department can be adapted for use by another. Both scenarios are made much simpler when open integration architectures are used.



Have access to comprehensive device management:

## CLOUD SEAMLESS STORAGE IMPROVES VISIBILITY FOR OAKLAND POLICE

 Have access to comprehensive device management:

*As a result, use of force complaints dropped 70% — from 2,200 to 572 with body-worn cameras. The seamless integration with existing systems, improved visibility, enhanced decision making, and ultimately helped reduce tension between citizens and officers.*

**W**ith increased protests and events around the world calling for video evidence, the Oakland police needed a solution that could archive their video evidence securely. Though the growing push for body-worn cameras that allows officers to record hands-free audio-video with one motion creates a new challenge — managing and storing data.

Law-enforcement agencies often don't have the information technology infrastructure, budget, or staff to handle large amounts of data.

Cloud storage represents a potential solution, but until now, most cloud platforms have not met the FBI's Criminal Justice Information Services (CJIS) policies, which enable police departments to connect to the FBI's systems and securely access data.

The Oakland Police Department is piloting a new CJIS-capable cloud storage platform for a body-worn camera built on Azure that may help officers better manage the deluge of video they now capture and store.

In response, VIEVU and Council partner Microsoft collaborated to make VIEVU's VERIPATROL platform for the Azure Government Cloud. Moving to the cloud-based solution gave the department seamless storage. Physically isolated Azure Government servers provide an additional layer of security, while digital signatures offer further authenticity.

As a result, use of force complaints dropped 70% — from 2,200 to 572 with body-worn cameras. The seamless integration with existing systems, improved visibility, enhanced decision making, and ultimately helped reduce tension between citizens and officers.

**Prioritise the use of legacy investments, including physically stored data.** Earlier we mentioned how cities can avoid redundant and unnecessary investments in data-capturing devices. Police, courts and other agencies involved in public safety gather massive amounts of data, but often critical pieces — mug shots, arrest records, court files, fingerprints and the like are stored physically. Similarly, some CCTV systems produce physical tape. Smart cities digitise these data sources, connecting them to the rest of the universe of relevant public safety data to create more robust intelligence.

## Privacy and security

Even those responsible for safeguarding the public's privacy and security will want to deliver on ICT-related privacy and security targets as they move toward a smarter public safety infrastructure.

**Publish privacy rules.** By its nature, there is the potential for privacy red flags in much of the day-to-day work that public safety is responsible for. That's why it is so important to address the legal, privacy and ownership issues with a comprehensive privacy policy. Different cities will have different strategies for dealing with access to video, phone records, social

network traffic and the like. But all will want to develop rules and governance protocol that are not only transparent but have been vetted by citizens and other stakeholders.

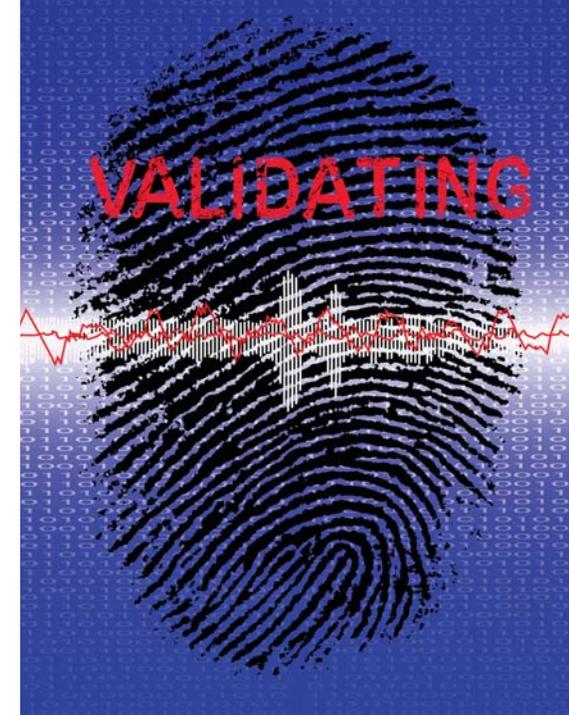
## Data management

We mentioned in the last section the importance of privacy rules in the public safety realm; the targets here are an important follow-on, given the amount of often-sensitive data involved.

**Create and adhere to a citywide data management, transparency and sharing policy.** Data management policies make it clear what city departments can and can't do with the data they collect. This alleviates confusion, improves data accuracy, eliminates unnecessary duplication and reduces the likelihood of privacy or security breaches.

## Computing resources

Advanced computing capabilities have dramatically changed the public safety playing field as these targets reveal.



**Use an open innovation platform.** Here's a prime example of why this target is so important. Like so many other cities today, Glasgow, Scotland holds regular "future hacks" or "hackathons" to encourage software developers to focus their brainpower on apps that can help solve city problems.

According to The Guardian, an event in early 2014 challenged the coders to do something that improved public safety. The winning team presented the idea of helping emergency services find people quicker when they are calling from a mobile phone.



**Achieve operational optimisation:**

## **THAI LAW ENFORCEMENT AGENCY OPTIMISES INVESTIGATIONS USING BIG DATA**

**E**stablished under Thailand's Ministry of Justice, the Department of Special Investigation (DSI) is a national law enforcement agency dedicated to stopping serious criminal activity. DSI needed better tools for mining large sets of structured and unstructured data to improve investigation processes and reduce manual procedures.

The agency's large data sets included more than 1 million records gathered from multiple sources in both structured and unstructured formats, such as images, videos and documents.

"It was very difficult to mine through the data, and the results were too broad with unclear targets," says Police Colonel Yannaphon Youngyuen, Deputy Director of the DSI.

"This often forced us to send personnel to the actual crime scenes, which cost us a lot of time and money."

DSI implemented a big data solution based on Council member Microsoft's platform and Apache Hadoop software to give investigating officers self-service business intelligence tools and data-management capabilities. With them, DSI has improved accuracy and shortened criminal case investigation time from two years to 15 days. DSI plans to implement its own private cloud to manage the security of confidential data.

 **Achieve operational optimisation:**

*DSI needed better tools for mining large sets of structured and unstructured data to improve investigation processes. The Microsoft Big Data solution it implemented has dramatically shortened time spent on criminal investigations.*



**Have access to a central GIS.** Public safety focuses on location and on being able to act decisively in time-sensitive situations make GIS critically important. It improves decision-making capabilities, enables efficiency gains through more intelligent scheduling and routing, provides improved accuracy of essential records and boosts resiliency of key assets.

Keep in mind, however, that in public safety and disaster management, users of many different geospatial systems need to communicate, often in an ad hoc fashion.

Thus a central GIS and countless other GISs and miscellaneous devices and resources need to implement open standards that make it possible for them to communicate complex geospatial information.

**Have access to comprehensive device management.** This target is also extremely relevant in public safety, given the number of devices dispatched in the field and the serious problems that could occur if they end up in the wrong hands. A comprehensive device management system helps enforce compliance with city data management, security and privacy policies.



**Have access to comprehensive device management:**

*A comprehensive device management system helps enforce compliance with city data management, security and privacy policies.*

“At the moment, if someone calls 999 their location can be determined using the nearest mobile phone masts,” said Joshua McGhee, a computing science student who worked on the winning design. “But that doesn’t give very detailed information. Instead we’re providing geo-tagged data which lets services see exactly where someone is, even if users aren’t sure where they are themselves.”

# Analytics

There's a big story to tell about the impact analytics can have in the public safety sector, as the targets below explain.

**Achieve full situational awareness.** In smart public safety, full situational awareness (also referred to as a "complete operating picture") is created and maintained through the use of city command centres. Command centres are important because they assimilate a single version of "the truth" so that everyone involved in a situation is working off the same information. When time is a factor and lives are at risk, you want to be sure that the left hand knows what the right hand is doing. You want thousands of employees, and a handful of different agencies and city departments, to have the exact same information.

Command centres deploy analytics capabilities across the universe of relevant public safety data, the discipline often referred to as Big Data. They correlate, in an automated way, these hundreds or thousands of data sources, criminal profiles or social media streams, for instance, to create intelligence.

And they use this intelligence to render a complete operating picture for public safety personnel — actionable intelligence that keeps people safe (themselves included).

This correlation of data is an ongoing and automated process, so new data is always informing the constantly evolving public safety picture across the city.

Command centres also provide unified threat assessment functionality and are responsible for the coordination and control of incident response and management. With this real-time understanding, emergency managers can assess safety needs and prioritise actions and resources. Because it is a central command, there is authority to deploy resources across agencies, departments and service boundaries to achieve desired outcomes without jurisdictional issues. This is critical because often in emergency situations, other city departments must be part of the response — for example, transportation or public health.

**Achieve operational optimisation.** This target offers savings potential for cities' public safety agencies. Along with full situational awareness, analytics can unearth new insights into how cities deploy their public safety resources, thereby generating savings.

Operational optimisation also holds great promise for city court systems. Courts have access to an enormous quantity of data, often so much so that the data can be difficult to make use of. Public defenders often have much smaller staff strengths than the lawyers they are up against, and these larger staffs

can devote much more time and energy to research that wins cases. ICT levels the playing field. With analytics and operational optimisation, city courts can transform the way they access information, improving outcomes for not just the courts, but the cities and the people that they represent and protect.

**Pursue predictive analytics.** The insights these analytics provide can lead to better public safety planning and decision-making by projecting trends and predicting outcomes to the point that they can even prevent some crimes from occurring. Full situational awareness allows cities to allocate their resources more efficiently for incident response and management. And they can simulate, for example, a potential natural disaster and take steps to mitigate some of the likely devastation before the disaster occurs.

All of the applications of analytics discussed in this section deliver tangible operational savings. Better planning, decision-making, predicting and resource allocation all lead to money saved for public safety agency operations budgets.

# ISO 37120: A yardstick for measuring city performance



In 2014, the International Organisation for Standards announced an ISO standard that applies strictly to city

performance. The document -- known as ISO 37120:2014 establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right we have indicated how the standards related to Safety correspond to the Council's Public Safety targets identified on the next page. A visible and engaged police presence is a critical element in deterring crime, as reflected by the ISO 37120 indicators measuring police officers per 100,000 population and response times. However, many cities are finding that it takes more than law enforcement and criminal justice to combat crime.

## Safety Indicators

			Implement optimal instrumentation	Citywide, multi-service communications	Create citywide data management policy	Achieve full situational analysis	Achieve operational optimisation	Pursue predictive analysis
<b>Core</b>	14.1	Number of police officers per 100,000 population						●
	14.2	Number of homicides per 100,000 population	●	●	●			●
<b>Supp.</b>	14.3	Crimes against property per 100,000	●	●	●			●
	14.4	Response time for police department from initial call	●	●	●	●	●	●

## Fire and Emergency Response Indicators

<b>Core</b>	10.1	Number of firefighters per 100,000 population						
	10.2	Number of fire related deaths per 100,000 population	●	●	●	●	●	●
	10.3	Number of natural disaster related deaths per 100,000 population	●	●	●	●	●	●
<b>Supporting</b>	10.4	Number of volunteer and part-time firefighters per 100,000 population						
	10.5	Response time for emergency response services from initial call	●	●	●	●	●	●
	10.6	Response time for fire department from initial call	●	●	●	●	●	●

# PUBLIC SAFETY TARGETS

In the checklist below, targets specifically pertaining to the public safety responsibility are in **bold**, universal targets are not.

	Enabler	Public Safety Targets How smart cities deploy and use ICT to enhance public safety	Implementation Progress			
			None	Partial	Over 50%	Complete
Human	Inclusivity	Achieve accessibility optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate citizen reporting framework for outcome thinking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	Collaborativity	Achieve citizen engagement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Create institutional framework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Governance	Pursue multilateral collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Develop framework for resilient city</b>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Governance	Achieve existing infrastructure optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate new supporting policy frameworks and regulatory mandates	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<b>Improve the governance of safety</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# PUBLIC SAFETY TARGETS

In the checklist below, targets specifically pertaining to the public safety responsibility are in **bold**, universal targets are not.

Technology	Enabler	Public Safety Targets How smart cities deploy and use ICT to enhance public safety	Implementation Progress			
			None	Partial	Over 50%	Complete
	<b>Instrumentation and Control</b>	Implement optimal instrumentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Connectivity</b>	Connect devices with citywide, multi-service communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Interoperability</b>	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments <b>(Supplement: including physically stored data)</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Security and Privacy</b>	Publish privacy rules Create a security framework Implement cyber security	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Data Management</b>	Create a citywide data management, transparency and sharing policy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Computing Resources</b>	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			
	<b>Analytics</b>	Achieve full situational awareness Achieve operational optimisation Achieve asset optimisation Pursue predictive analytics	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			



# 13

## Finance And Payments

**The introduction of smart city innovations is hampered by a number of financial barriers. The lack of public financial capacity requires business models appropriate to attract private financing. Projects have to be bankable, but even when this is the case, private finance is often not easily available.**



## Economic growth in India

Technology, infrastructure, and social development are keystones of progress in cities. Economic growth is undoubtedly the capstone component to improving urban quality of life. In India, given its demographics and diversity, unique challenges and opportunities exist for developing “smarter” cities which attract increased investment, employ innovative technology, create environmentally sustainable solutions, grow operational efficiencies, and improve the lives of urban citizens.

**T**his chapter covers general rules and solutions for finance, as each project will need its own instrument based on the specific barriers encountered, the institutions involved and the regional economic circumstances. By leveraging the techniques explained in this chapter, city governments can spend less while offering citizens more benefits, more convenience and more inclusion.

Cities are the engines of economic growth. While India’s urban population is currently hovering at around 31% of the total, it contributes over 60% of GDP. It is projected that urban India will contribute nearly 70% of national GDP in the next 15 years. There is accordingly a crying need for cities to get smarter to handle this large-scale urbanisation and find new ways to manage complexity, increase efficiency, reduce expenses, and improve quality of life.

## Why make finance systems smart?

Indian cities are severely challenged by rising population growth, by aging or inadequate infrastructure, by increasing operational costs and by “do more with less” austerity pressures. So how can they compete effectively? How can they pay for the smart infrastructure improvements that attract and keep new businesses, skilled workers, tourists and other trappings of a robust economy?

Cities bring in revenue — from the user charges for the various utilities used by citizens, to the house tax residents pay, to the fees developers shell out for building permits. Money flows the other way too, of course, from salaries paid to city employees to goods and services procured from vendors.

In fact, cities make large volumes of payments to suppliers, to employees and to citizens receiving benefits. They also collect huge amounts in taxes, fines and usage payments. This makes payment systems an important target for modernisation.

Payments touch every aspect of our lives. Removing cash from the economy creates far-reaching and cumulative benefits for all participants — citizens, merchants, tourists and government — improving life for the city

at large. That’s because cash causes problems while increasing costs. By digitalising both disbursements and collections, a city generates significant savings and increases operational efficiency.

But in many cities, that economic engine needs a tune-up. New digital tools — sometimes referred to as e-government or mobile government solutions — can drive more efficient service delivery. For example:

- **Performance Indicators** allow cities to measure progress toward stated goals against a set of key performance indicators (KPIs). With the help of KPIs, cities can continually monitor and improve their strategies. GDP, unemployment rate, inflation rate, interest rate and tax rate are some of the KPIs to measure economic growth in India.
- **E-procurement or online tendering process** moves the entire procurement process to an integrated electronic platform. This allows a city to get real-time access to a database of suppliers to make price comparisons. Andhra Pradesh is the first state in India to implement an e-procurement system. The state benefited with cost savings to the tune of Rs 3,700 crore and improved efficiency (120 days to 32 days). Karnataka saves Rs 2,000 crore of transaction value by e-procurement.

Northern Railways saved Rs 11.40 lakh annually in printing and distribution of its bulletins after switching to e-procurement.

- **Electronic payment systems** “digitalise” a city’s disparate payment mechanisms (licences, social service payments, transit payments, parking meters) into an integrated whole, providing greater efficiency and better oversight. Electronic disbursement of salaries and benefits reduce costs to 60%, according to research by Council member MasterCard. Reducing the cash in a city’s ecosystem also shrinks the grey economy, since digitalisation provides more transparency and control while increasing collections.
- **Advanced revenue collection and payment systems** enable individuals and businesses to submit tax, application permits and the like online. These electronic forms and autofill features can save money and time while reducing errors. Cities can also strengthen compliance by integrating business analytics, big data, business rules and workflow. Some cities report revenue increases of 5% or more as a result.

## Technology + transparency: A win-win for cities

It is now widely accepted that greater transparency — access to information and data on the

day-to-day functioning of government — is key to creating accountable and effective governance systems. The Right to Information Act (2005) has played a significant role in strengthening transparency by committing the government to both proactively provide citizens with information and also respond to specific information requests. While the Act has met with much success — RTI applications are growing by the day — there remain concerns related to quality, and reliability of information and data provided. Moreover, there are still many gaps in the government's efforts to proactively disclose information and data of public relevance.

Technology is one of the many tools that can help address these gaps. There are some incredible initiatives taking place across the world on opening government data and on getting data to work for ordinary citizens.

The California Report Card, OpinionSpace, and the Citizen Report Card are sentiment analysis websites that allow constituents to express

their opinions to make representatives better respond to their needs. It features interactive graphs of the current and past budget, including multiyear trends and departmental revenue and expenditure details.

Increasing transparency also allows cities to get more visibility and control over civil servants' spending as well as over the use of public benefits.

Civil society organisations (CSO) like Janaagraha in Bengaluru utilise ICT platforms to mobilise citizens to reveal government corruption. Janaagraha launched a website called "I Paid a Bribe" in 2010 to allow citizens to develop a record of bribery in public service delivery.

In 2013, they launched mobile apps and SMS services to increase corruption reporting. Their data was later utilised by Bhaskar Rao, a transport commissioner in Karnataka, to create reforms in the motor vehicles department. Citizens now apply for driver's licences online in order to eliminate potential demands for bribes. For instance:

- **Virtual payment cards** can be generated on-the-fly and used only for a specific amount and with a specific supplier. This avoids loss of control over expenses when multiple people get corporate cards or access to payment instruments. Likewise,

travel and expense (T&E) can be loaded and controlled remotely and given to city employees for specific purposes.

- **Prepaid benefits cards** give government agencies much greater control over the use of public funds. For instance, usage can be limited by time of day, category of merchants, or geographical area. Prepaid cards can be used for all kinds of city programmes, including student benefits, cafeteria cards, childcare subsidies, pensions, etc. The city of Toronto is saving roughly \$2.5 million per year by eliminating checks in favour of prepaid benefits cards.

Numerous systems can help cities become more efficient and more transparent. In this chapter we'll introduce a smarter approach to financial management and payments.

So here is the issue that everyone involved in Smart City thinking, planning and execution needs to deal with: how can we find a better way of funding innovative projects that does not rely on tax revenue and does not depend on the whims of external partners? Is there an approach that has the potential to deliver a win-win for all concerned? We think there is.

## Financial strategies for Smart Cities

Robust capital markets, innovative business models, a sound tax environment, public-private partnerships, and world class, investment-grade projects: These are the building blocks for the financial infrastructure on which a smart city thrives.

The risk-return profile of a Smart City investment in India is unique: For both government and investors, strong and continued master planning is the key to dynamic management of both potential risks and opportunities.

To attract financing, policymakers should increase risk mitigation efforts to make their Smart City competitive not just with other Indian urban centers but with comparable global investment opportunities. Tools available toward this goal include planning, credit enhancements, tax incentives, concession agreements, and upgraded reporting and data management systems. Above all else, policymakers should work to ensure a consistent, predictable and transparent business climate for both domestic and global investors with regular, meaningful industry dialogue. At the same time, the private sector should maintain flexibility to consider new, innovative finance structures and will



continue to develop world-class tailored solutions for India's unique urban challenges taking into consideration the needs of all segments of Indian society.

A Smart City is accessible, financially sound, attracts business, and provides a rich social fabric in an environment where people want to live and work. Smart Cities require smart financing that gets the mix of returns, risk, stability, and venture just right.

### **Digitalising payment mechanisms:**

*Digitalising a city's disparate payment mechanisms into a integrated whole provides greater efficiency and oversight.*



Besides Central and state funding, the list includes possible funding from multilateral and bilateral development agencies, pooled municipal debt obligation facilities, municipal bonds, real estate investment trusts and infrastructure investment trusts. For specific needs, depending on the nature of investment required, cities may be able to tap a few other funding sources.

Smart and sustainable projects centred on climate change mitigation and adaptation may access the Green Climate Fund (GCF) of the United Nations Framework Convention on Climate Change (UNFCCC). Recently, the National Bank for Agriculture and Rural Development (NABARD) was accredited by GCF as an implementing entity for undertaking climate change related projects in India.

Projects with positive environmental benefits can also utilise the green bonds route which has seen a lot of activity in the recent past. Projects that are in the spirit of corporate social responsibility (CSR), as defined by the Companies Act, 2013, may attract funds from companies with significant unspent CSR budgets. Crowd funding has also been identified as a potential route for supporting citywide projects.

## Strategy for Smart Funding

- **Financial support from government includes** centre allocation, viability gap funding, National Investment and Infrastructure Fund
- **Debt & PPP.** Borrowing from multilateral & bilateral agencies, municipal bonds, PMDO facility, flexible Public-Private Partnership (PPP) models, infrastructure debt funds
- **Land monetization.** Sale of land and commercial and residential real estate, increasing FAR
- **User charges/fees/taxes.** Tap fees, charges on sale, registration of property, green tax on fuel purchase, urban tax on purchase of new vehicles.

## Tapping innovative financial sources

According to a May 2011 report on urban infrastructure by a high-powered expert panel that was set up by the Ministry of Urban Development, India would have to invest Rs 39.20 trillion over 20 years (between 2012 and 2031 at 2009-10 prices) in public works.

In an April 2010 report, McKinsey Global Institute estimated that India would require \$1.20 trillion between 2010 and 2030, "just in urban infrastructure". The Indian government's Smart City initiative has specified several possible funding sources —both conventional as well as innovative, in order to meet the Rs 7.50 trillion amount required over 20 years.



**Nurturing a business-friendly environment:**

## **EMPOWERING SMALL TRADERS THROUGH DIGITAL PAYMENTS**

**T**here are nearly 60 million small traders in India who contribute 45% of the national GDP employing over 450 million people. Despite their large numbers and significant contribution to the country's economy, these traders have largely remained outside the formal economy and have lacked access to business credit and other banking services. CAIT is the umbrella organisation of over 40000 associations of small and medium traders.

For over 25 years, CAIT has been representing these 60 million small businesses providing a voice to them and advocating their cause at the highest levels in the government and policy making bodies. Amongst other notable achievements, CAIT spearheaded the initiative to institutionalise small ticket lending to small enterprises that resulted in the announcement

of MUDRA scheme by the Prime Minister of India in August 2015.

CAIT has collaborated with Council member MasterCard to create awareness amongst these small traders about modern trade practices and the changing face of commerce.

Through a series of educational workshops called 'Master Your Card' held at major cities in India, MasterCard has demonstrated the impact of digital commerce on modern trade to leaders of CAIT's member associations who in turn have carried the message back to their association members spreading the awareness further.

 **Nurturing a business-friendly environment:**

*Series of educational workshops called 'Master Your Card' held at major cities in India, MasterCard has demonstrated the impact of digital commerce on modern trade.*

To counter the challenge of organised digital retail and online marketplaces, CAIT has launched its own digital marketplace names E-Lala that provides a platform to its members to set up their e-stores and reach out to potential customers across India and the globe. MasterCard has brought in a new technology platform – Simplify Commerce – for seamless on boarding of merchants on the E-Lala portal and acceptance of electronic payments to facilitate transactions on the portal. MasterCard has also facilitated participation of HDFC

Bank in the program to provide a host of banking solutions to the participating merchants for accepting electronic payments and managing their finances. These include co-branded MasterCard Credit & Debit cards, current accounts, payments apps, preferential pricing for loans and other benefits. Through this collaboration, MasterCard has played a part in driving twin goals of a 'less cash' economy and financial inclusion.

## Innovative financing mechanisms

### 1. Tax increment financing (TIF)

Under TIF, if a particular area or zone of a municipal body is developed through a loan, once the project benefiting that area is completed, the residents of that area can be made to bear the cost of the project by increasing property tax for a certain period.

Implementing the concept of land value capture — for instance, property owners close to a newly-constructed Metro system see a rise in value of real estate, and some part of the increased value could be ploughed back to finance the related investment.

Globally, financing models based on user charges have been successful, especially in Bogota (the capital of Colombia) and some South-East Asian countries.

### 2. Municipal bonds

Ten percent of the funding requirement can be raised through Municipal Bonds; civic bodies in the US have raised \$500 billion from them. Recently SEBI approved guidelines for allowing municipal bodies to raise funds through issue of municipal bonds.

### 3. Flexible PPP models

Funding from the private sector is necessary to meet the overall funding requirement — PPP models wherein private sector companies are leveraged for technical support, capital funding and oversight of the operations.

### 4. Infra Debt Funds

IDFs can be directed to invest in municipal bonds by defining these as eligible investments. IDFs can also refinance debt taken during the construction phase as well as additional funds for financing operations.

### 5. Land monetisation

Typically, in brownfield projects, the funds can be raised through the sale of land or commercial and residential real estate. Funds can also be raised by increasing the floor-area ratio, that is, the total floor area of a building in comparison to the size of the land upon which it is built.

## 6. User fees

User fees allow cities to impose a fee to cover the cost associated with funding supporting infrastructure. Under this system, the public jurisdiction shoulders the cost of service/ infrastructure investment and dedicates the fee stream from private users to repayment.

## 7. Tap fees

Tap fees can be levied to cover the cost of tying water meters for new connections to existing lines. Several states in the US such as Michigan and Colorado charge fees for installing water meters, which are usually over and above normal water usage charge based on consumption.

## 8. ADB funding

On June 2015, the Asian Development Bank had announced doubling the funding to support India's urban development from \$2.6 billion per annum at present to up to \$5 billion per annum.

It will also support smart cities and the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) in seven States: Andhra Pradesh, Madhya Pradesh, Karnataka, Rajasthan, Gujarat, Tamil Nadu and Maharashtra.

## 9. Green bonds

Green bonds are debt instruments that raise money to fund clean energy projects. Companies that raise money through these bonds have to invest it only in areas that are environment-friendly such as renewable energy, waste management, clean transport or sustainable land use. In February 2015, Yes Bank became the first Indian entity to raise money through green bonds, raising Rs 1,000 crore from insurance companies, pension funds, mutual fund houses and foreign portfolio investors to fund solar, wind and biomass projects. Later, in March 2015, EXIM Bank raised around \$500 million from international investors through green bonds. CLP India — a power company raised about Rs 600 crore for its wind business through these bonds.

## 10. Other taxes

These can also be leveraged to finance Smart City initiatives. However, they need to be explored further to understand their potential benefit/impact:

**Green tax on fuel purchase.** Urban tax on purchase of new vehicles, betterment charges payable on sale/registration of property.

Lessons can be learnt from other parts of the world — such as imposing a transport tax like French cities do, levying a gasoline tax (also known as gas tax) like the state and federal governments do in the US, and an additional vehicle registration fee — like in Singapore.

In 2009, in order to address the \$500 million deficit, municipalities in Toronto introduced levy of user fee on a set of services, such as \$50 for recreation programs, additional 50 cents for paying parking online, charging new property tax accounts \$50, etc.

In 2006, the state of California estimated that it will grow by 30% over the next 20 years, putting a \$500-billion strain on infrastructure, especially transport. A two-phased 20-year investment plan was proposed, the first phase involved issuance of municipal bonds. To meet the funding requirement, state voters passed a \$37.3-billion bond package, the largest ever offered on a single ballot. The transportation sector received \$19.90 billion of the allocation. These funds went to congestion reduction, highway and local road improvements, transit, air quality, safety and security.

# Benefits of Smart Finance

## Livability

**Making convenience a priority with smart payments.** Long lines at the counter, long hold times on the phone and slow response to emails don't cut it in today's fast-paced world. Smart payments offer faster, more convenient solutions. A few examples:

- The New Delhi (India) Municipal Council introduced smart cards that residents can use to pay their utility bills.
- In London, services such as PaybyPhone enable consumers to pay for parking from their mobile phone; no need to carry change. They can even top up the meter remotely, saving a trip back to the parking spot.
- Instead of standing in line to buy tickets, public transit riders in Sydney, Australia use their prepaid Opal cards to tap on a card reader at the start of a trip and again at the end. And not only do Opal cards offer convenience for bus, ferry and train riders, they also offer fare incentives, including free travel after eight paid journeys in a week.

**Offering one-stop city services.** By modernising IT infrastructure with e-government solutions, cities can transform service delivery in exciting ways. No longer do constituents have to work their way through a maze of city departments when they are trying to take care of city business. By securely integrating previously siloed information from multiple departments into a single system view, city staff and constituents alike can be more efficient.

A couple wanting to get married, for instance, can log on and apply for a marriage licence, reserve a city facility for their reception and pay the required fees in a single transaction. With every interaction, they build an identity with the city which allows them to consume a wide range of services through a single, secure portal.

**Providing financial peace of mind.** Connected, mobile citizens will benefit from emerging digital form factors — digital wallets, for example — that provide a single interface for all of their payment mechanisms, loyalty programs, transportation tokens and more. Using technologies such as near-field communications (NFC), contactless wallets of the future will be the repositories for ID cards, social and health programmes, transportation cards — enhancing livability by having everything at hand and recognised in a second.

**Using consumer data to unearth trends.** Once cities use data analytics to understand citizen behaviours and preferences, they can modify systems to better meet their needs. For instance, public transit operators can analyse payment data to adjust transportation capacity in real time. Or city public health officials might take a cue from disease detectives in British Columbia. They tracked and ended an outbreak of hepatitis A by analysing food purchase histories on grocery store loyalty cards.

## Workability

**Nurturing a business-friendly environment.** A smart city creates the best possible economic environment. One way is through the use of smart payment systems for city government. Another is by integrating a city's own systems with payment networks to make it easier for consumers and local businesses to conduct commerce globally.

**Attracting new businesses.** Cities that offer a welcome climate for companies and highly skilled workers build wealth through the creation of jobs and tax income. Streamlining permitting and licensing processes, leaving out unnecessary steps and reducing paperwork are all ways cities can make it clear that they are open for business.



**Making convenience priority with smart payments:**

## **BENEFITS OF TECHNOLOGY TO GOVERNMENT AND SOCIETY**

 **Making convenience priority with smart payments:**

*A leading destination for travelers, London's contactless payments give visitors using the TfL network the ease, speed and security to maneuver around the city.*

In the fall of 2014, Transport for London (TfL) introduced contactless payments on Tube, tram, DLR, London Overground and National Rail services that accept Oyster.

What that means is contactless debit, credit or pre-paid cards from Council member MasterCard can be used to make quick, easy and secure payments for everyday transit purchases of £20 and under. There is no need for a PIN or a signature; customers simply have to touch their card on the reader.

TfL projects a savings of 25% in operating expenses. By introducing a MasterCard open loop solution, TfL projects a reduction from £0.14 for every £1 of revenue to run its proprietary Oyster card system—£420 million (US\$148 million) a year to under £0.10 per £1

in revenue, resulting in a —£120–130 million a year savings.

“Accepting contactless payments on transport in London is a fantastic achievement for our city,” said Shashi Verma, TfL’s Director of Customer Experience. “It provides our customers with the most convenient way to pay for their travel and highlights the capital’s position as a world leader in transport ticketing.”

In March 2015, the BBC reported that “one million contactless taps are made each day on London’s transport network which TfL claims makes it the fastest growing contactless merchant in Europe after just six months.”



### **Enhancing security and reducing fraud.**

The migration to smarter payment and financial systems is a tremendous protection for business, consumers and the city itself. With the right acceptance tools and payment instruments, merchants know if customers are trustworthy. And they can be paid quickly to reduce working capital requirements.

### **Creating a welcoming environment for visitors.**

Travellers have different needs than residents. Coming from afar, they need convenient and interoperable payment solutions. They also need helpful information in an unknown environment. To attract travellers and tourists, cities need citywide payment systems that can interoperate with those from other parts of the world. For instance, by using their mobile commerce wallets, visitors

can be recognised as such, contacted in their native language, and provided with relevant information, since the system will know the hotel they are staying at, their plane departure times, etc. Integrating their hometown payment instrument into Smart City systems enables them to navigate as seamlessly as if they were at home.

## **Sustainability**

**Improving planning.** Payments are an incomparable source of insight on residents' ways of living, commuting and consuming. Through analysis of payment data, city governments can adapt city infrastructures and services to citizens' preferences while

decreasing inefficient spending. For instance: Putting a new post office at the best location possible to maximise its use, based on insights gained from shopping patterns. Similarly, cities can tailor transportation and other public services based on shopping data.

**Supporting public policies.** Environmental challenges increase the need for innovative solutions to reduce waste, reduce emissions, save energy and foster green transportation. Payment is central to making solutions accessible. Here are a few examples: NFC-enabled public charging stations that enable electric vehicle users to easily pay and recharge; freeway and bridge tolling payment solutions with automatic detection of car registration plates; city parking payment solutions; smart payment devices connected to household energy consumption to help citizens make the most of their solar panels.

**Saving resources.** The flow of outbound and inbound paper cheques, paper invoices, envelopes, etc. alone can add up quickly — especially when you consider how many city agencies around the world are still paper-based. Automating processes to enable electronic invoicing and pay-by-phone, pay-by-portal and related technologies can make a huge dent in the number of trees lost to old-fashioned practices.



Enhancing security and reducing fraud:

## CENTRALISING MONITORING FOR GLOBAL LOCATIONS FOR AN APAC BANK

A major Asia-Pacific bank operating in India needed a good access control system, a backbone of safe and secure operations in banks — a single control centre for 20 countries operated out of India.

The solutions were required to be installed quickly and with low execution risks. It was essential that access control systems were to comply with the requirements in Payment Card Industry Data Security Standard (PCI-DSS).

Council member Tyco assessed needs and risks of execution working closely with the bank and selected Tyco C-CURE system as a solution. The efficiently deployed C-Cure System is designed for the wide geographical distribution of multi-site operations.

C-CURE, a scalable security management solution encompassing complete access control and advanced

event monitoring, integrates highly advanced technologies to provide the most powerful foundation for security management.

The advanced reporting solutions designed in this project harvest and organise the bank's business information, turning business intelligence into security intelligence with its intuitive user interface and ability to produce Web-based reporting.

The solutions were efficiently deployed taking into considerations the risk involved and delivering the bank a full integration and visibility of all centres from one location. The system empowered the bank to utilise IT-standard tools and distributed architecture.



Enhancing security and reducing fraud:

*The advanced reporting solutions designed in this project harvest and organise the bank's business information, turning business intelligence into security intelligence with its intuitive user interface and ability to produce Web-based reporting.*



## Inclusivity

A significant portion of the investment in smart cities is expected to come from the private sector or through public-private partnerships. To consistently access finance, monitor progress, and ensure accountability from city leaders, use of city-level performance metrics across economic, social, and environmental indicators is essential. This will also help attract private investment in cities.

**Financing smart cities.** The High Power Expert Committee (HPEC) has assessed an annual requirement of Rs 35,000 crore for urban infrastructure. One needs to see how these projects will be financed as the majority of projects would need to move through complete private investment or through PPPs.

Most ULBs are not financially self-sustainable and tariff levels fixed by the ULBs for providing services often do not mirror the cost of supplying the same. Even if additional investments are recovered in a phased manner, inadequate cost recovery will lead to continued financial losses.

**Empowering citizens with employment opportunities.** It is the need of an hour to increase employment possibilities by creating skill-work matching systems in PPP models to alleviate the low-income group.



### Empowering citizens with employment opportunities:

*Devising and encouraging frameworks for employment opportunities and budgeting for all.*

## Smart finance systems and payment targets

The best practices and targets listed below will help cities foster smarter approaches to financial management. Several targets are specifically related to smart finance and payment systems and this next section will focus on them. We will also address several targets from the Universal chapter and how they apply here as well. If we fail to mention a Universal target below, it does not mean that it does not apply to city finance and payments. Rather, we simply felt that it did not require additional explanation.



Empowering citizens with employment opportunities:

## INDIA-WIDE SKILLS MATCHING PAYMENT OFFERS SECURITY

 Empowering citizens with employment opportunities:

*Holistic, transparent matching work skills training system helped to create career paths for citizen in rural communities to find valuable employment. MoRD helped over 120 million people find work. Also the system help the officials in managing the staff and financing a total of 14.6 million projects.*

Rural poverty is a giant barrier to overcome, if the goal is to achieve inclusive and sustainable development. After poor monsoon rains or harvests, rural workers struggle to find employment. In 2005, the Government of India embarked on the biggest-ever poverty-alleviation project, and passed the National Rural Employment Guarantee Act (NREGA), guaranteeing adults in every household legal entitlement to 100 days' paid employment each year.

To administer this, the Ministry of Rural Development (MoRD) created a work registry, job-matching, and payments system using Council member Microsoft Technologies that is now operational in all 610 of India's districts. NREGASoft, an online application, now allows all rural officials and officials at every level of government access via a browser. In 2014, this system helped 128 million unskilled labourers find work on local projects each year, giving 50 million rural Indian families greater security. It offers following benefits:

**Empowering rural communities with NREGASoft,** MoRD helped over 120 million people find work. Also the system help the officials in managing the staff and financing a total of 14.6 million projects.

**Holistic, transparent matching work skills training system** helped to create career paths for citizen in rural communities to find valuable employment.

**Top-to-bottom financial accountability** also set standards for financial control, making it easier to reconcile project budgets and payments.

**Transparent government delivery system** enabled the Government of India to fulfil other statutory obligations as well. It freed the department from a massive administrative burden.

**Invaluable resource for social research** — accessible, easy to use, accurate, and totally reliable source of data — attracting over 100,000 hits a day.

## Collaborativity

**Create institutional framework of three-tier governance.** Successful implementation of smart city solutions needs effective horizontal and vertical coordination between various institutions providing various municipal amenities as well as effective coordination between Central government (MoUD), state government and local government agencies on various issues related to financing and sharing of best practices and service delivery processes.

## Governance

**Create an e-governance framework.** All smart cities around the world are using e-governance as an effective tool to serve citizens efficiently, re-engineer internal business processes, increase transparency, accountability and citizen participation, and use resources in an environment-friendly manner. While e-governance initiatives usually account for only 10%-15% of the total investment, they are an essential part of the overall city architecture and require specialised knowledge and expertise both during development/ implementation and for subsequent

maintenance activities. To minimise investments in hardware and application infrastructure, a number of countries have opted for centrally hosted or cloud-based platforms for e-governance/ICT solutions.

One of the most prominent examples is the EU Platform for Intelligent Cities (EPIC) initiative which was first operationalised in 2010. As part of this initiative, a number of cross-cutting applications like relocation planning, 3D urban planning and energy consumption monitoring have been hosted on a cloud-based infrastructure, with each participating city government leveraging this suite to provide services to its own citizens based on an agreed per transaction/ user cost. Closer home in Asia, the ClouT project, a joint initiative between the EU and Japan, seeks to provide cloud-based application services for traffic management, city-level resource management, etc., to multiple city governments.

With most urban local bodies in India facing significant financial and human resource constraints, adopting a centrally hosted cloud-based solution at the level of the Central or State government may be one of the few ways to ensure that the e-governance/ICT component of the smart city architecture does not stand in the way of timely implementation of smart cities on the ground. The existing

schemes for city development possibly need further detailing on this front.

**Reform investment policies.** Smart cities implement successful reform for investment policies and organisational competence. In India social security organisations such as the EPFO (Employees Provident Fund Organisation), and ESIS (Employees State Insurance System), who have large accumulated balances (EPFO's balances are equivalent to 6% of GDP); and National Pension System (NPS) supervised by the PFRDA (Pension Fund Regulatory and Development Authority) whose balances while low currently, (less than 1% of GDP) are expected to rise rapidly when municipal bonds are permitted as an asset class.

The "Smart Cities" project represents an opportunity to experiment with organisational and governance structures of the cities, with a view to enhancing performance-orientation and accountability. Such experimentation could be used as a spur for individual states to provide substantive devolution of powers to the ULBs and to the cities.



Create an e-governance framework:

## BENEFITS OF TECHNOLOGY TO GOVERNMENT AND SOCIETY

The City of Cape Town, with a population of over 3 million, is the second most populous city in South Africa and the largest and diverse portfolio of properties – encompassing almost 1,000 SQ Miles. After continual reassessment of valuation system, the Cape Town Valuations Department, who is responsible for valuing all commercial and residential properties in the City, identified that the system should offer updated features like workflow management tools and the ability to work in multiple databases in order to improve the efficiency, effectiveness, and equality of the valuation system.

The Department implemented the Council member Thomson Reuters's Aumentum software suite, a global solution that addresses these land administration

challenges, to streamline its property valuation process while introducing breakthrough innovations in appraisal and objection processes that have dramatically improved the office's efficiency. The Aumentum system is a software solution that integrates key government functions across various departments, including Cadastre, Registry, Recorder, Valuation, Tax, and e-Government.

Thomson Reuters engaged KPMG to develop an analytical framework to measure the impact of its Aumentum installations and to undertake a pilot impact study of the use of the Aumentum Valuation module by the city.



Create an e-governance framework:

*The Aumentum system is a software solution that integrates key government functions across various departments, including Cadastre, Registry, Recorder, Valuation, Tax, and e-Government. Reduced resolution time for objections and appeals from 3 months to a couple days.*

## Department level impacts:

- Reduced turnaround time for mass valuations by 75% – from 20 days to 5 days
- Reduced resolution time for objections and appeals from 3 months to a couple days, while reduced full time equivalent staff supporting general valuation by less than half
- The external support cost of conducting general valuations has decreased with each cycle since 2000 due to the development of local internal capacity and expertise.
- Reduced historical backlog and clearer ownership/visibility of open cases through use of the workflow tool
- Better integration with the new data management system rolled out in the City across different departments. This has increased collaboration and coordination
- Improved consistency in valuation methodology and data quality – Significant reduction in data errors, objections and appeals

## City level impacts: Reduced valuable lead-time resulted in:

- Increased accuracy of billing by Revenue department
- Reduced valuable lead-time resulted in frequent valuation ensures up-to-date information for tax calculation and quick ownership authentication
- Data used by transportation department for bus route planning, city planning as well as innovative pilot projects

## Societal level impacts:

- Consistent, objective and transparent property valuation
- Increased customer satisfaction and confidence
- Increased identification of indigent/low income, who can be provided with rebates for basic services, works as incentive for citizen to value the property

## Instrumentation and control

### Ensure access to robust banking services.

Cities in the developed world may take convenient, ubiquitous banking as a given. In other parts of the world, however, it is a significant issue. Access to banking services is the key underlying prerequisite to smart payments. It has various implications, from the need for a network of capable ATMs

(automated teller machines) to a sufficient number of bank offices. City leaders must encourage a widespread, safe banking system. If cash and credit cards are currently the basic form factors, the city should encourage smarter versions such as NFC-enabled cards and mobile phones linked to banking. Electronic payments are also the key, as more and more transactions are done remotely. As an illustration, the city of Nice, France massively

communicated the benefits of contactless cards. By pioneering that technology, the city created a favourable climate for adoption and the benefits that followed.

**Implement optimal instrumentation.** There are at least two payment areas where cities need to ensure that the right devices are deployed:

- Acceptance devices. Parking meters, ATMs, utility meters, vending machines and point-of-sale terminals are increasingly used to make payments. Acceptance networks must adapt to emerging payment methods, such as contactless cards and phones, as well as electronic wallets.
- Payment form factors. Smart payment devices do more than paying. For instance, digital wallets gather all customers' existing payments cards in a single device and also combine them with rewards and loyalty cards. They also enrich their functionalities with innovative features to facilitate day-to-day life. In Hong Kong and London for instance, the mass transit systems rolled out contactless electronic cards that people can use to pay for transit, and also use in shops.



connectivity throughout to allow stakeholders to carry out transactions anywhere, anytime. Access to high-speed wireless Internet is a prerequisite. So is good coverage, including areas such as subways and mass transit systems where people spend significant time. Everyone also benefits from a fast and secure network, as it decreases the risk of fraud and reduces processing time to create a seamless experience.

**Connect all financial systems with a citywide, data platform.** Cities need to collect and use data in real time to have complete situational awareness into financial flow. A holistic view that integrates financial data from all city departments is the key to understanding trends and making informed projections about future investments. It is also essential in providing transparency to citizens.



**Connect devices with citywide, multi-service communications :**

*Smart cities need connectivity throughout to allow stakeholders to carry out transactions anywhere, anytime.*

## Connectivity

Connectivity and telecommunications are crucial for the development of smarter financial systems and payments. The smart cities model relies heavily on a fast, secure, real-time transfer of information.

**Connect devices with citywide, multi-service communications.** Smart Cities need

## Interoperability

Interoperability maximises the value of smart financial systems and payments.

### **Adhere to open standards (including across all finance and payment infrastructures).**

Adopting open standards has significant advantages. It ensures fast and broad participation, minimises risk (through investment in tested standards) and drives procurement efficiency (by offering access to greater choice and lower prices). It also facilitates participation by foreign consumers, tourists and business travellers. Open standards must be used at multiple levels including 1) the communications technology, 2) the interaction between payment devices and 3) the data exchanged between the devices. NFC is the perfect example. This contactless communications standard has been broadly adopted by leading merchants, issuers and city leaders around the world. Cities should give preference to global standards to make it easier to do business globally and to attract tourists from other countries.

**Use open integration architectures and loosely coupled interfaces.** Companies are increasingly adopting open integration architectures and exposing their APIs so that third parties can integrate with their systems. In the payments industry, companies such as

MasterCard are adopting this approach. Cities should also adopt a similar strategy when developing their payment infrastructure to rapidly “bulk up” their payment ecosystem and provide more value for all participants.

**Prioritise legacy investments.** Most cities simply cannot afford to replace all of their financial systems overnight, which means priority must go to making the most of existing investments while formulating a roadmap for prudently moving forward with upgrades.

Enable multi-channel access to an integrated customer and business service platform. Cities can't assume that every citizen and every business has a smartphone, computer or reliable Internet access to avail themselves of city resources, sign up for benefits, pay their bills, etc. Public kiosks in public spaces, malls and libraries are one way to bridge the digital divide. Integrated customer and business service platforms also must accommodate people with special needs — different languages and disabilities, for example.

**Have access to comprehensive device management.** Implementing smart payments will expand the number of devices and the volume of data on a city's network. Comprehensive device and network management will improve security, resilience and reliability of the payment system, deliver cost savings and enforce compliance with

city data management, security and privacy policies.

## Security and privacy

A key goal of a payment system — smart or otherwise — is to enforce trust between participants. Similarly, a city gathers significant amounts of financial data from citizens and businesses when they apply for permits, licences and other services. A security or privacy breach, therefore, threatens a city's overall integrity.

### **Publish privacy rules (and apply them to the city's financial and payment systems).**

Cities should publish and enforce clear rules on privacy that apply equally to financial data. From a privacy perspective this includes:

- The respect of anonymity — data should not be “personified” when analysed
- The type of information that can be captured from the client
- What can be shared
- Who has access to it
- How the information is stored and used
- How participants can access it and edit or delete it.



**Publish privacy rules (and apply them to the city's payment systems):**

*Cities must publish clear rules on privacy that apply equally to financial data.*

## Data management

**Create a citywide data management, transparency and sharing policy.** Given the sensitivity of financial data, we want to emphasise the importance of a citywide policy for how data is governed, stored and made accessible. Best practices call for a clear governance directive that establishes the chain of authority and control over data assets and spells out who makes access decisions and who determines accountability.

This citywide policy should cover both private and public data and ensure that data from each department is made available to others. It must also align with the policies in the security and privacy targets discussed previously. A citywide data management plan will increase the city's agility (ability to quickly build new applications as needed) and accuracy (by ensuring everyone is working with correct data). It can also lower costs by reducing errors and eliminating unnecessary duplication.

**Create a security framework.** Cities also need to define the levels of security required for payment, such as two-factor authentication or PIN numbers. Digital wallets are a good example. They secure several payment means, as well as other documents (loyalty cards, etc.) in a single application. This avoids having one's payment references in multiple locations.

**Implement cyber security.** As we've noted, Smart Cities generate mountains of financial data. They also connect critical infrastructure to the Internet. Those actions create many benefits, but they also create new threats. It's best not to leave it to each individual department to come up with a security plan. Instead, implement and enforce best practices citywide.

## Computing Resources

With close to three trillion payment transactions globally every year, payments involve large volumes of data. True value can be derived from payment systems if that data can be analysed.

### **Consider a cloud computing framework.**

Cloud computing is a valid consideration for every city responsibility, but it is virtually a requirement for smart payments. To be usable, the payment solution has to allow information to be securely stored yet accessible anytime, from any place and any device. Only a cloud computing framework can meet these stringent requirements.

Cities may want to consider a hybrid approach — the public cloud for storage and processing, but a local or private cloud for elements with higher-level security and privacy requirements. Either way, cities should ensure that the cloud service they choose includes data encryption, effective data anonymity and mobile location privacy.

## Analytics

Analytics based on payments data can have a significant positive impact on local commerce. It can also inform and improve government policies.

**Achieve full situational awareness (including local commerce trends).** Develop a deep understanding of local commerce trends by analysing payments data. Insights can include macro indicators like retail sales that help decipher the state of the economy and set policy direction. Micro indicators such as tourist spending behaviour by city of origin can help identify places to target for marketing and promotional activities.

**Achieve operational optimization.** Capture and analyse transactional data to get useful insights — for example, citizen usage of public services. Insights such as the number of people using the city's mass transit system (from ticket purchase/validation) versus driving into the city (from toll fees or parking payments) can help cities set policies to reduce congestion. Likewise, accurate monitoring of spending in post offices or licensing offices can allow a better allocation of staff and an improved management of opening hours.

**Implement a KPI dashboard.** Use a city dashboard to measure progress toward stated goals against a set of key performance indicators (KPIs). With a dashboard, city officials can continually monitor and improve their management strategies when new data suggests a course change. A city and its dashboard is one key to ensuring efficient management of a city's services across multiple sectors — transportation, energy and water for example. Comparing performance on standardised KPIs with other municipalities can be an effective way to promote best practices.

**Pursue predictive analytics.** Payments data can predict people's preferences and significantly improve the city's ability to plan for the future. Cities should develop and leverage this capability. For example, a city might adapt its development plan after learning that people are shifting their spending from neighbourhood convenience stores to larger stores at the city outskirts. Predictive models can also be set up to determine the most appropriate locations for commercial or public services.



THOMSON REUTERS™



Create a citywide data management, transparency and sharing policy:

## REAL-TIME LAND REVENUE TRACKING TRANSFORMS JAMAICA

The Estate Management Division, part of the Jamaican National Land Agency (NLA), manages some 40,000 parcels of lands owned by the Commissioner of Land, or approximately 6% of all parcels on the island. The archive — the memory bank for all land transactions — has some 38,000 files with an average of 150 pages of transactional documents per file. In Jamaica, there were concerns as to how secure the paper records were, as paper documents are prone to decay in the tropical Jamaican climate.

Jamaican NLA embarked on a modernisation project to transform the paper-based manual system into a fully digital transactional system. The goals of the project were to improve customer service for the public and other government agencies, such as through reducing the time required to perform searches on specific lands and the transaction-processing times.

The project received funding from the European Union, and Jamaican NLA partnered with Council member Thomson Reuters to provide the information system — the Aumentum software platform.

As a result of improved technology application in Jamaica, greater information about land conveyance transactions are collected and are more widely distributed to internal and external stakeholders. Decisions about how these governments manage land resources are now made quicker, with higher accuracy, and with greater inclusion of the varied stakeholders. Jamaican NLA shortened the land registration process from 15 business days down to just two, resulting in award-winning customer satisfaction. Through improved transparency, the entity will attract responsible, land-based investment for local benefit with a common resource management plan.



Create a citywide data management, transparency and sharing policy:

*Decisions about how these governments manage land resources are now made quicker, with higher accuracy, and with greater inclusion of the varied stakeholders. Jamaican NLA shortened the land registration process from 15 business days down to just two, resulting in award-winning customer satisfaction.*

# ISO 37120: A yardstick for measuring city performance



In 2014, the International Organisation for Standards announced an ISO standard that applies strictly to city performance. The document

-- known as ISO 37120:2014 -- establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right we have indicated how the standards related to Finance correspond to the Council's Payments and Finance targets identified on the next page.

## FINANCE AND PAYMENTS TARGETS

		Ensure access to robust banking services	Connect financial systems with citywide platform	Multi-channel access to integrated platform	Integrate all transport modes for optimization	Create a citywide data management policy	Achieve full situational analysis	Achieve operational optimization	Achieve asset optimization
<b>Core</b>	9.1	Debt service ratio (debt service expenditure as a percentage of a municipality's own-source revenue)	●	●	●	●	●	●	●
	8.2	Particulate matter (PM10) concentration	●	●	●	●	●	●	●
<b>Supporting</b>	8.3	Own-source revenue as a percentage of total revenues	●	●	●	●	●	●	●
	8.4	Tax collected as a percentage of tax billed	●	●	●	●	●	●	●

# FINANCE AND PAYMENTS TARGETS

In the checklist below, targets specifically pertaining to the finance and payments responsibility are in **bold**, universal targets are not.

	Enabler	Finance and Payment Targets How smart cities deploy and use ICT to enhance their payments	Implementation Progress			
			None	Partial	Over 50%	Complete
Human	Inclusivity	Achieve accessibility optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate citizen reporting framework for outcome thinking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Achieve citizen engagement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Collaborativity	Create institutional framework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Pursue multilateral collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional	Governance	Achieve existing infrastructure optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Create institutional framework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<b>(Supplement: across three-tier governance)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Formulate new supporting policy frameworks and regulatory mandates	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<b>(Supplement: Create an e-governance framework)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Reform investment policies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# FINANCE AND PAYMENTS TARGETS

In the checklist below, targets specifically pertaining to the finance and payments responsibility are in **bold**, universal targets are not.

Technology	Enabler	Finance and Payment Targets How smart cities deploy and use ICT to enhance their payments	Implementation Progress			
			None	Partial	Over 50%	Complete
	<b>Instrumentation and Control</b>	Ensure access to robust banking services Implement optimal instrumentation <b>(including acceptance devices and new payment form factors)</b> Connect devices with citywide, multi-service communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Connectivity</b>	Connect devices with citywide, multi-service communications <b>Connect all financial systems with a citywide data platform</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Interoperability</b>	Adhere to open standards <b>(including across finance and payment infrastructures)</b> Use open integration architectures and loosely coupled interfaces Prioritise use of legacy investments <b>Enable multi-channel access to an integrated customer and business service platform</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Security and Privacy</b>	Publish privacy rules Create a security framework Implement cyber security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Data Management</b>	Create a citywide data management, transparency and sharing policy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Computing Resources</b>	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Analytics</b>	Achieve full situational awareness Achieve operational optimisation Achieve asset optimisation Pursue predictive analytics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# 14

## Ideas To Action



In this chapter, you'll learn how a simple roadmapping process can put you on the path to a smart city. We've hinted at this next point before, but now we're just going to say it: Technology is the easy part. The hard part is turning ideas into action. Fortunately, help is at hand from those who have gone before. In reviewing hundreds of successful pilots and interviewing dozens of experts, several themes have emerged, which we have shared on the pages that follow.



Please note that the Smart Cities Council does NOT believe in roadmaps in isolation. Rather, the roadmap should be linked to a city's vision document or comprehensive plan. We believe wholeheartedly in digital technology. But that technology should be in service to a city's larger goals.

## The importance of a roadmap

Why a roadmap? The path to a smart city is a long one. It can easily take 5, 10, even 15 years to make smart technologies pervasive. It is essential to have a clear, consensus goal to motivate citizens. And clear targets to guide the course corrections that will be needed along the way.

As we use the term in this Guide, a roadmap is a simplified outline of the major steps to becoming a smart city. It is NOT a vision document or a master plan or a detailed project plan. Those other things come into play, but you also need a high-level, '30,000-foot view' of your future. As experts point out, academics think about the 'why' of Smart Cities while technology companies focus on the 'what'. Yet you also need to figure out the 'how'... and that's where a roadmap comes in.



### The importance of roadmap

*Masdar city is a great example that demonstrate the importance of the having a roadmap early in the planning phase.*

If you've completed the other chapters in this Guide, you now have a set of targets to guide your smart city efforts. But you don't know yet where to apply those principles first or how to translate those concepts into on-the-ground realities. In these next pages, we'll explain how a roadmap can be the bridge between ideas and action. We'll cover:

- The importance of a roadmap
- The elements of a roadmap
- The process of building a roadmap
- Success strategies for a roadmap.

## Overcoming smart city hurdles

A roadmap can help you overcome obstacles to a smart city transformation. One such hurdle is human nature. People are naturally resistant to change. Yet we live in an era where change is constant. As a result, an entire management science has arisen around 'change management' – around successfully transitioning companies to a desired future state.

Cities face a similar challenge... but they can't simply order residents to attend a change management seminar. Nor can they fire the ones who won't go along. Instead, city government must influence and inspire the population. A roadmap is a powerful tool in that effort.

Effecting change is made even more difficult by the stove-piped nature of most city governments. For at least the last 100 years, cities have been divided into departments, each with its own specialty and each with a high degree of autonomy. To become a smart city, it is necessary for those departments to collaborate more effectively and to share resources. As you will read below, the roadmapping effort obliges departments to work together.

Becoming a smart city is further compounded by overlapping boundaries. Urban challenges —

crime, transportation, water supply, economic development, etc., don't stop neatly at city borders. Jurisdictions overlap as well. Many metropolitan regions have dozens of cities and townships within their sphere. They also embrace hundreds of school districts, water districts, transit authorities, port authorities, human services agencies and other organisations. Consider the Greater Chicago metropolitan area by way of example. It crosses 14 counties in three states and contains approximately 350 municipalities, 350 school districts and 140 library districts.

Meanwhile, cities are also subject to rules and regulations from federal agencies, state or provincial governments, county or parish governments, public utility commissions and so on. And, to top it off, cities must contend with myriad advocacy groups, special interest groups, neighbourhood associations, business associations and other groups whose agendas can sometimes be at cross purposes. The United States provides an example. By one count, it has roughly 20,000 municipal governments, 13,000 school districts and 37,381 special authorities.

Done right, roadmapping is a process that involves and pulls together these disparate groups.

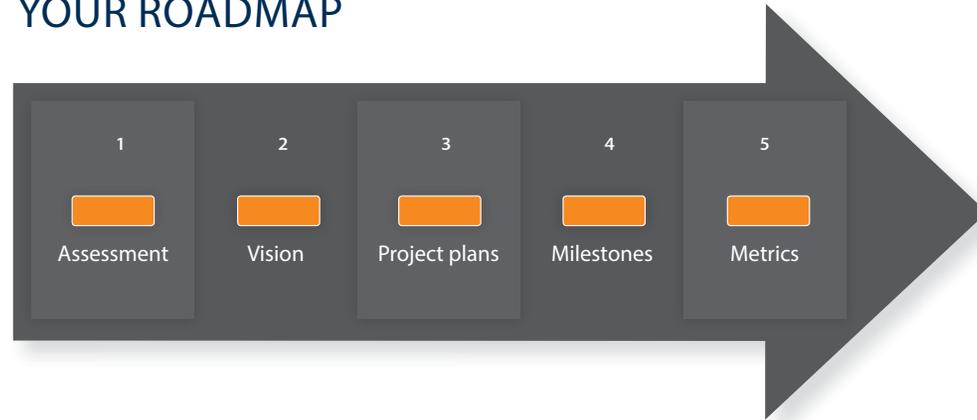
## Other roadmapping benefits

In addition to the advantages mentioned above, a smart city roadmap has these additional benefits:

- **Maximising synergies and minimising costs.** Considering the big picture can help a city find ways to share infrastructure and share costs — doing away with unnecessary duplication of ICT investments.
- **Identifying the best places to start.** Picking the 'low-hanging fruit' — projects that have a big return for a relatively small investment in money and time — usually makes sense. If a city starts with quick, "big bang" projects, it can build momentum and public support. It can also help pay for future projects with savings from the early ones.
- **Enabling cities to build in stages.** With a plan in place, you can be confident everything will work together in the end because you're adhering to principles and standards that ensure interoperability and collaboration. With such a framework, a city can move forward one step at a time, knowing that individual projects will be compatible with each other, even if they are built at different times.

- **Attracting talent and business.** Cities everywhere want to woo talented professionals and job-creating businesses, but both are increasingly choosy when deciding where to establish themselves. They are attracted to cities that have a strong, compelling vision for a better future and a path to get there. Your roadmap, in other words, is also a recruiting tool.
- **Increasing public support.** A roadmap paints a picture of future improvements in livability, workability and sustainability. It can dramatically increase public understanding and cooperation. It can also rally support and financing from private sector.

## YOUR ROADMAP



## The elements of a roadmap

Many authorities recommend that your roadmap include these five elements at a minimum:

- **An assessment** of where you are
- **A vision** for where you want to go
- **Project plans** for the key components
- **Milestones** to mark progress
- **Metrics** to measure and prove success

**Assessment** – a clear picture of where the city is now, measured in terms of the key performance indicators you will use to quantify success. For instance, in the pages to follow, you’ll learn how Vancouver, BC’s action plan included baseline numbers to indicate the city’s current level of performance.

**Vision** – a clear picture of the ultimate outcomes, expressed in terms of citizen benefits. The vision should not be expressed solely as technical achievements but also as the lifestyle and workstyle improvements the technology makes possible. It is essential to build that vision with citizen involvement.

First, you’ll get better and more diverse suggestions. Second, you’ll build consensus and commitment. You’ll also want to re-imagine what your city’s departmental organisation should look like.

**Project plans** – ‘blueprints’ for the most important components of the smart city. Possibilities include master plans for land use and the built environment; for digital infrastructure (communications and computing resources); for data; for transportation; for business and commerce, and for city services. These plans are also helpful for creating visibility around smart city drivers.



Pursue predictive analytics:

## ANALYTICS HELPS IN UNDERSTANDING PASSENGER FLOW THROUGH STATIONS

**W**olving passenger expectations have opened numerous opportunities to improve service and grow revenues for SNCF (Société Nationale des Chemins de fer Français). Gares and Connexions is the largest branch of the SNCF that will commercially develop the 3,029 railway stations, which comprise 180,000 square meters of commercial space and revenues of 1.2 billion euros (\$US1.4 billion), to improve passenger flow and security.

As stations alternate between transport access points and waiting zones, they become critical to fulfilling SNCF's promise of door-to-door service. The challenge is huge, given the large number of passengers and facilities. Until now, we were limited in the ability to compare train stations. We needed more analytic capacity, including the ones we could use in an ad hoc, interactive manner. Technological innovations at these stations significantly increase the availability of useful data and workable information and analysis would increase revenue.

SNCF Gares and Connexions, the French national railway station business unit, selected SAS® Analytics from Council member SASfor key analysis in Project Magnolia, a new program to meet the rising needs of its passengers. Using SAS Analytics SNCF understands the annual flow of 2 billion passengers, who pass through stations and connect with other transport, such as bus, coach, taxis and bike shares.

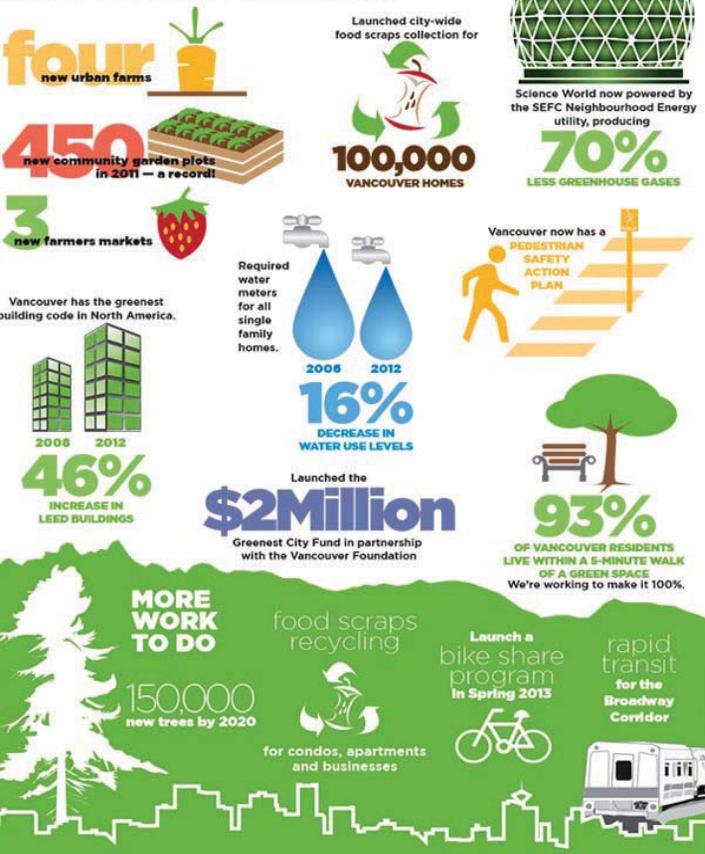
SNCF uses SAS predictive analytics that reduce uncertainty in development, planning or yield management, and provides ease of use, interactive report building and simple distribution via web and mobile device with integrated suite of tools including Geo-mapping capabilities. SNCF made quick work of the deployment, and started seeing initial results in just three months, with positive impact on marketing and sales, as well as station operations and our return on investment.



Pursue predictive analytics:

*SNCF uses SAS predictive analytics that reduce uncertainty in development, planning or yield management, and provides ease of use, interactive report building and simple distribution via web and mobile device with integrated suite of tools including Geo-mapping capabilities*

## WHAT WE'VE ACCOMPLISHED



**Milestones** – waypoints at which you measure progress, share lessons learned and discuss course corrections and strengthen commitment. For instance, Vancouver has annual implementation updates. (Click to view an overview of Vancouver’s 2011-2012 Implementation Update.)

It also holds an annual Vancouver Cities Summit, a discussion platform for business and urban leaders to exchange ideas and best practices. And it issues periodic updates in various media to keep citizens informed and enthused

Your residents can be a valuable tool in the measurement process. Social media can help you reach out to them to see how technology adoption is progressing, further connecting government and people.

**Metrics** – key performance indicators that quantify success. Examples include carbon footprint, average commute time, percentage of citizens with broadband, energy efficiency achievements, water efficiency achievements, new businesses formed, patents filed, students graduated, doctors and hospital beds per capita, percentage of city services available online, etc. In some cases, it is possible to choose metrics that also let you calculate your return on investment.

Installing metrics early in your smart city efforts can ensure transparency and improve citizen buy-in. Vancouver’s action plan has a list of very specific targets. For instance, it seeks to double the number of green jobs from 2010 to 2020, and double the number of companies who have “greened” their operations. It seeks to reduce greenhouse gas emissions by 33% over 2007 levels. It has similar easy-to-measure targets for all 10 of its sub-components.



### Milestones to mark progress:

*Vancouver has annual implementation updates and monitors what’s been accomplished so far and what still needs to be done as 2020 approaches.*



Vancouver's action plan:

## MOBILIZING 35,000 VANCOUVERITES TO BUILD AN ACTION PLAN

In 2009, Vancouver Mayor Gregor Robertson put together a Greenest City Action Team. Its job was to construct a plan to transform Vancouver into the greenest city on earth. Although only part of the plan references digital technology, all of it represents a sterling example of engendering citizen involvement.

More than 35,000 people participated in the process in one way or another. Many of them monitored progress online via social media (and continue to do so). Others took part in face-to-face workshops and events. More than five dozen city staff, 120 different organizations and 9,500 individuals actively contributed ideas and feedback.

Those contributors had a strong preference to create opportunities immediately as they worked for long-term success – to build a strong local economy and vibrant

neighborhoods while creating a city that meets the needs of generations to come.

The resulting Vancouver Greenest City 2020 Action Plan was adopted by the Vancouver City Council in July 2011. The plan addresses three overarching areas of focus: carbon, waste and ecosystems. It is divided into 10 smaller plans, each with a long-term goal for 2050 and a shorter-term target for 2020.



**Vancouver's action plan:**

*The No. 1 goal of Vancouver B.C.'s 2020 Action Plan was to secure the city's international reputation as a mecca of green enterprise by doubling the number of green jobs and doubling the number of companies actively engaged in green operations.*

# VANCOUVER PLAN GOALS

The Vancouver Greenest City 2020 Action Plan includes 10 “sub-plans,”

each with a long-term goal plus metrics to measure success

	Gole	Targets
<b>1. Green Economy</b>	Secure Vancouver’s international reputation as a mecca of green enterprise Ad hoc and decentralized	<ul style="list-style-type: none"> <li>• Double the number of green jobs</li> <li>• Double the number of companies actively engaged in greening operations</li> </ul>
<b>2. Climate Leadership</b>	Eliminate Vancouver’s dependence on fossil fuels	<ul style="list-style-type: none"> <li>• Double the number of companies actively engaged in greening operations</li> </ul>
<b>3. Green Buildings</b>	Lead the world in green building design and construction	<ul style="list-style-type: none"> <li>• Require all buildings constructed from 2020 onward to be carbon neutral in operations</li> <li>• Reduce energy use and greenhouse gas emissions in existing buildings by 20% over 2007 levels</li> </ul>
<b>4. Green Transportation</b>	Make walking, cycling and public transit preferred transportation options	<ul style="list-style-type: none"> <li>• Make the majority (over 50%) of trips by foot, bicycle and public transit</li> <li>• Reduce the average distance driven per resident by 20% from 2007 levels</li> </ul>
<b>5. Zero Waste</b>	Create zero waste	<ul style="list-style-type: none"> <li>• Reduce solid waste going to the landfill or incinerator by 50% from 2008 levels</li> </ul>

## VANCOUVER PLAN GOALS

The Vancouver Greenest City 2020 Action Plan includes 10 “sub-plans,”

each with a long-term goal plus metrics to measure success

	Goal	Targets
<b>6. Access to Nature</b>	Vancouver residents will enjoy incomparable access to green spaces, including the world’s most spectacular urban forest	<ul style="list-style-type: none"> <li>All Vancouver residents live within a five-minute walk of a park, greenway or other green space by 2020</li> <li>Plant 150,000 new trees by 2020</li> </ul>
<b>7. Lighter Footprint</b>	Achieve a “one-planet” ecological footprint	<ul style="list-style-type: none"> <li>Reduce Vancouver’s ecological footprint by 33% over 2006 goals</li> </ul>
<b>8. Clean Water</b>	Clean Water Vancouver will have the best drinking water of any city in the world	<ul style="list-style-type: none"> <li>Meet or beat the strongest of provincial and federal drinking water quality standards and guidelines</li> </ul>
<b>9. Clean Air</b>	Breathe the cleanest air of any major city in the world	<ul style="list-style-type: none"> <li>Always meet or beat the most stringent air quality guidelines from Metro Vancouver, British Columbia, Canada and the World Health Organization</li> </ul>
<b>10. Local Food</b>	Vancouver will become a global leader in urban food systems	<ul style="list-style-type: none"> <li>Increase citywide and neighborhood food assets by a minimum of 50% over 2010 levels</li> </ul>



## The process of building a roadmap

There's no 'standard' way to create a smart city roadmap. Below we've suggested one approach that combines advice from many experts. It includes six steps:

1. Find a champion
2. Assemble a team
3. Borrow from the larger vision
4. Establish metrics
5. Prioritise your targets
6. Use experts to produce specific plans

### Find a champion

The best roadmapping strategy is to involve all important stakeholder groups. Even so, the effort is unlikely to succeed without a champion. Typically this is the mayor or city manager. But some successful efforts have been led by private developers, civic groups, local universities, city council members or other prominent individuals.

The champion's job is to sell the overall vision to city employees and city residents, and to the financial and technical partners the city must recruit. The job requires energy and salesmanship throughout the life of the project. Most experts call for a strong external leader — typically an elected official — teamed with a strong internal advocate, someone in a staff position who can lead the day-to-day activities.



### Assemble a team:

*Many practitioners suggest that cities start by setting up an interdepartmental task force.*

### Assemble a team

When you assemble your team, you will be balancing two needs. On the one hand, you need expertise from many different areas, which suggests a large team. On the other hand, you need to be fast and efficient, which argues for a small team. Some experts feel the ideal situation is a small group at the core that meets on a regular basis with a much larger group of experts and stakeholders.

Many practitioners suggest that cities start by setting up an interdepartmental task force. Since a smart city is a 'system of systems', every decision taken in one area has an impact on others. It is essential to take a cross-functional approach. Some cities bring in a representative from every major department. Others form a core team and consult with other departments as needed. The planning and ICT departments are almost always involved. It's also common for the mayor to lead the task force or to designate a senior staffer.

The task force must have the authority to demand cooperation. Equally important, it should have oversight of departmental projects, at least to the extent of ensuring that those projects adhere to established standards. Even if departmental infrastructure will not be interconnected immediately, you want the ability to do so when the time is right.

And that requires that departments adhere carefully to standards for interoperability, security, privacy, data management, etc.

Many cities will move from an outside task force to an inside smart city department that will, in some ways, resemble today's well-accepted ICT departments. Like ICT, the smart city department will have cross-cutting responsibilities. Unlike ICT, however, it will not have specialisation as its goal. Rather, its role will be one of coordination, setting overall standards and ensuring that 1) all departments have a common smart city platform to build upon and 2) all individual projects are coordinated with the larger smart city vision.

Some cities put external stakeholders on the task force. However, the most common method is to use city employees and paid consultants for the working team, then to hold meetings to gather input from important stakeholder groups. Some cities own and operate most services — transportation, electric power, water, telecommunications, etc.

In other cases, the private sector provides all or most of those services, with the city government providing boundaries and oversight. Cities that do not control their own infrastructure must consult closely with the electric, gas and water utilities that service their territory.

Skilled smart city suppliers can also be a resource at this stage, especially those experienced in master planning and systems integration. Even if the city does not hire them immediately, they can provide directional guidance and recommendations based on their experience helping many different cities.

Although the Smart Cities Council does not do consulting for pay, it does work with selected Spotlight Cities in the early stages of their planning. The Council advises those cities in their use of the Readiness Guide. And it assembles ad hoc teams of experts for brief 'mentoring' sessions to get cities 'unstuck'.

## **Borrow from the larger vision**

We've emphasised that a smart city roadmap should be in service to larger community goals. Many cities maintain 10- or 20-year plans that are updated regularly. Others have vision documents, typically around goals for sustainability or economic development. And most large private developments have a master plan that has given careful consideration to the region's strengths, needs and cultural preferences.

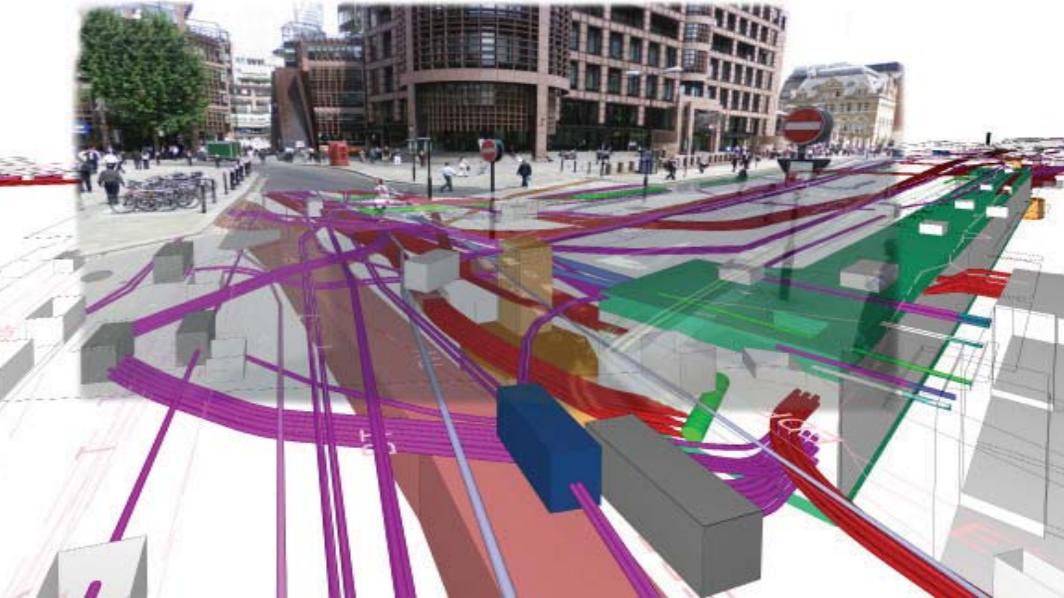
Many cities also have plans for particular neighbourhoods, such as ecodistrict plans or revitalisation plans. For instance, the

Loop Media Hub Ecodistrict, led by Council advisor David Sandel, is a St Louis community initiative. It hopes to accelerate economic growth by providing one gigabit (1,000 megabits) of Internet access to each building along the city's Loop Trolley right-of-way.

Your smart city roadmap should draw from these plans to establish your goals, priorities and metrics. Smart technology should be the means to an end. So first you need to determine what that end should look like. Every city has a unique mix of strengths, challenges and cultural preferences. Thus, every city will have different goals. Is your economy based on manufacturing? On tourism? On high-tech services? Every city should tailor its roadmap to buttress its strengths and compensate for its challenges.

For instance, cities emphasising a lower carbon footprint (as with the Vancouver, BC example featured earlier) might prioritise projects that impact emissions, such as smart grid, energy efficiency and electric vehicles. Cities aiming to become high-tech hubs might emphasise such things as broadband connections and mass transit.

If your city has no long-term plans, even for individual districts, then you may want to include a visioning exercise as an early step in your roadmapping process.



## Establish metrics

At this point, you have a team in place and you have broad goals pulled from your city's long-term vision.

A valuable next step is to establish metrics to measure progress towards those goals. A comprehensive smart city roadmap should have 1) measurable goals for livability, workability and sustainability and 2) timely reports of progress toward those objectives.

Some of those metrics will be 'inward-looking' as a way for city government to monitor its own performance. But we urge you to include metrics that speak directly to citizens and their quality of life.

Elsewhere in this chapter and in the appendix, you will find examples of city plans and metrics to study for ideas. You may also want to consult published 'city indicators'. Examples include the Global City Indicators Facility (GCIF), Mercer Quality of Living Survey, USGBC LEED for Neighbourhood Development and the Circles of Sustainability Urban Profile from the UN Global Compact Cities Programme.

## Prioritise your targets

With your vision and your metrics in place, you are ready to prioritise the targets you developed in earlier chapters to achieve those goals.

We have placed a summary checklist at the end of this chapter. Use it to consolidate the work from the previous chapters and determine which targets to emphasise first. How do you choose your priorities? These four steps will help:

1. Start with the fundamentals
2. Consider overall goals
3. Bolster your weak spots
4. Seek out quick paybacks

Each of these four steps will screen out some of the possibilities. If you apply these filters in order, you'll end up with a much shorter list of possible first projects.

**Start with the fundamentals.** Certain targets are so essential that every city should put them in place at the beginning. Or, at the very least, get started on them right away, even if they also do other projects in parallel. Review the five targets below to see if your city is missing any of these basics:

- Citywide multi-service communications
- Adhere to open standards
- Publish privacy rules
- Create a security framework
- Create a citywide data management, transparency and sharing policy



Seek out quick paybacks:

## 8 AREAS THAT CAN PRODUCE WINS QUICKLY

**A**lthough every city is different, here are seven areas that have proved to be excellent places to look for quick payback. By the way, payback isn't always financial. Sometimes it comes in other forms, such as popularity rankings, business startups or civic enthusiasm.

**Smart transportation.** This sector is the number one source of smart city projects. Most cities suffer from congestion and most citizens put traffic at the top of the list of things they want solved. According to some studies, congestion reduces a city's gross domestic product by somewhere between 1% to 3%. Smart transportation may not result in fare decreases. But it often reduces costs for the operators. And it almost always rewards citizens with lower congestion and shorter travel times.

**Energy efficiency.** Energy efficiency programs can often get underway without large expenditures. Many gains are possible through simple behavior changes – for instance, learning ways to save water, substituting more efficient light bulbs or learning to postpone non-essential electric use to non-peak times. Many energy services contractors will undertake work for no upfront costs. Instead, they take a portion of the savings.

**Smart grids.** The payback from a smart grid is not necessarily in lower electric rates. Rather, it may come in the form of reduced outages and greater reliability against storms and sabotage. In areas subject to hurricanes, tornadoes, tsunamis, earthquakes or floods, resilience is highly valued. City governments can gain great approval if they improve reliability and resiliency – and face great wrath if they do not.

 **Seek out quick paybacks:**

*The payback from a smart grid is not necessarily in lower electric rates. Rather, it may come in the form of reduced outages and greater reliability.*

**Smart water networks.** Council member Itron estimates that 30% of all the water pumped worldwide does not reach its destination. A smart water network can pinpoint leaks and theft, gaining a quick payback in regions where water is scarce and costly.

**Smart streetlights.** A confluence of several factors make smart street lighting an excellent prospect for a first project. First, the latest generation of LED lighting makes possible big savings in energy costs. Second, the same LEDs that save energy also save on “truck rolls.” They last much longer, so maintenance crews don’t have to spend as much time replacing lamps. Third, by networking the streetlights — adding communications to each one — you make possible numerous smart applications, including remote diagnostics and control. Fourth, once you have a ‘canopy network’ in place for streetlights (and paid for by the savings in energy and maintenance), you can use that network for other smart city applications.

After all, streetlights already have power, already exist throughout the city and already sit up high — the perfect places to play host to a citywide network. The cities of Paris and Bristol in the UK are working with Council member Silver Spring Networks to install canopy networks for intelligent street lighting and other city services.

**Public safety.** Smart policing can have a dramatic impact on crime rates and public confidence. By feeding current and past crime statistics into analytical programs, cities can predict where crime is most likely to occur. And by equipping officers with cameras, laptops, tablets or smartphones, they can reduce the time spent on bureaucratic paperwork and increase the time on patrol.

Digital government services. You can often get a quick win by converting a government service from ‘manual’ operation to a more convenient online or smartphone version. Done well, such projects can save money for the city while simultaneously improving citizen satisfaction (no more standing in line). There are dozens if not hundreds of possibilities, including licences, permits, registration for social services, purchase of fare cards, reporting potholes and many, many more. Setting up simple e-government apps can be a matter of months or even weeks.

For example, Council member Civic Resource Group International offers a next-generation digital platform called CivicConnect. CivicConnect provides a tightly integrated suite of information-rich smart city applications, including portal management, transportation demand management, 311 citizen requests, open data and more.

**Smart payments.** Payback from smarter payments can be quick — and significant. Cash and other physical means of payments are generating huge costs for city administrations, as well as being very risky and needing secured transfers. By digitalising all disbursements and collections, a city can generate significant savings and increase its operational efficiency.

One example: By switching city service benefits from direct deposits and check cashing services to a prepaid card, the city of Toronto generated huge savings for both social assistance recipients and the city. Public estimates claim that more than \$250 a year can be saved for a single client receiving \$600 a month, and the city itself expects net savings of at least \$2.5 million annually by eliminating the cost of issuing checks. This program was rolled out in less than a year.

These five targets have the most profound effect on a city's ability to transform itself. Put another way, these five targets are the ones that will get you in the most trouble if you fail to get them right. Imagine, for example, leaving each individual department to figure out cybersecurity on its own. Some departments may have access to specialised expertise in-house or via consultants. But others are likely to fail at this challenging task, putting the entire city at risk.

Reminder: You don't have to build all of these things yourself, but you must ensure that they are in place. In some cases, the private sector may step up. (Many cities already have citywide communications in place, for instance). In other cases, you may be able to borrow ideas from cities that have gone before rather than start from scratch. (You can already find several solid privacy frameworks, for instance). In other cases, your city may have un- or underutilised assets that can be put into service. For instance, many cities have unused 'dark fibre' — fibre optic cables that were installed but never put into service — that can be used for citywide communications.

**Consider overall goals.** Once you're comfortable that you have the fundamentals in play, filter your possible projects against your city's overall goals. As explained earlier, look to broader city vision documents and plans that set out long-term goals. Your smart city

roadmap should prioritise projects that make progress against those objectives.

If your plan calls for the expansion of tourism, for instance, you'll want to prioritise projects that contribute to that objective. If the long-term plan calls for you to accommodate a large influx of new residents, you should emphasise projects that help you answer that imperative.

**Bolster your weak spots.** If you still have too many possibilities, you can narrow your choices

by looking for projects that shore up your weak spots. The checklists in each chapter (and the summary checklist at the end of this chapter), contain a column to note where you are weak or strong.

**Seek out quick paybacks.** Finally, if you still have more candidates than you can tackle, look for easy wins. Give preference to projects that can be completed quickly and that have a rapid return on investment. Time and again, we hear from smart city experts that it is essential to demonstrate success early. For your long-term smart city transformation to succeed, you must have some early, short-term wins. These early successes will build enthusiasm and momentum. And, done right, they will create value streams that can help to pay for future projects.



### Payback from smart payments can be quick:

*and significant. Accepting smart payments, as in the Nice, France public bicycle sharing station above, makes it easy for citizens to access city vices and also reduces the amount of time cities spend managing tokens or cash.*



## Use experts to produce the specific plan(s)

At this stage, you have a prioritised list of targets plus ideas for your first projects. You may even have a cross-departmental implementation calendar that looks several years ahead.

If you are not already consulting with experts, now is the time to bring them on board. Their job will be to produce specific, detailed project plans and engineering specifications. (If you are building a city from scratch, then the experts' job will be to produce a master plan).

Finding the right experts is an important task. They must have a holistic, big-picture outlook



### Use expert.

*Finding the right experts is an important task. They must have a holistic, big-picture outlook to help your city find cross-departmental synergies.*

to help your city find cross-departmental synergies. But they must also have access to specialised knowledge to produce detailed technical specifications. Ideally, they will also have experience in smart city projects.

'Outsourcing' all or part of your project implementation can have important benefits. First, few city employees will have the up-to-the-minute technical skills to ensure that the city is getting state-of-the-art solutions. Second, few city employees have the time to take on such a complicated extra job. Smart city projects demand focused effort. Most city employees — and most city leaders — are focused on too many initiatives to truly drive the smart city charge, even if they have the technology skills. Outsourcing allows for a passionate focus on the project.

And outsourcing can survive and bridge a change in government if elections or appointments occur in the middle of the project. Where do you find such experts? Many cities have had success working with regional universities. Many cities bring in consulting firms to administer the overall process, trusting those consultants to bring in other specialists as needed. And many cities have found success working directly with experienced smart city suppliers like the Council members listed in this Guide's appendix.

The suppliers in the appendix have demonstrated exceptional smart city capabilities. They have collectively worked on thousands of projects that relate to smart cities. They know what works in real life, what problems are likely to occur, and which technologies are truly ready for prime time. It is no exaggeration to say that they represent the planet's very best smart city suppliers.

And they've also demonstrated a vitally important characteristic — the willingness and ability to collaborate with others. No single company can create the totality of a smart city. It takes a small army of specialists to build out the "system of complex systems" that is a smart city. Membership in the Smart Cities Council signals a firm's commitment to collaborating with other companies to produce the best possible solutions.



Achieve smart transportation:

## HYDERABAD METRO PROVIDES MULTI-MODEL CONNECTIVITY FOR GROWING DEMAND

Spread over 650 square kilometres, Hyderabad is one of the largest metropolitan areas in India. As investments in manufacturing, R&D, IT and biotech industries have flocked to the fourth most populous city in India - population over 7.8 million, it has strained the existing infrastructure of the city. As the proactive response, Hyderabad has come up with a metro rail project with multi-modal connectivity under public-private partnership (PPP).

The project is being implemented not as a simple mass transit system, but as an urban redesign concept with emphasis on last-mile connectivity, room for cycling and other non-motorised transport, pedestrian facilities, green areas and public spaces with an eye for aesthetics.

The project uses state-of-the-art technology with stringent technical specifications, performance criteria and safety standards. For example, a communication-based train control (CBTC) system is being introduced as a signalling system, which can accommodate much greater frequency of train traffic than the distance-to-go system.

A revenue model has been carefully worked out, with a mix of affordable and predictable passenger fares and lease rentals and real estate development at the metro stations. This business model based on transit-oriented development makes metro stations hubs of economic activity, increases metro ridership, reduces road congestion, and improves financial viability of the metro system.

 Achieve smart transportation:

*This business model based on transit-oriented development makes metro.*

The metro rail project is even more commendable when it uses an innovative financial design so as to require very little public funds. It was awarded through a transparent process of competitive bidding, based on a model concession agreement for urban transit prepared by the Planning Commission. Out of a total investment of Rs 14,132 crore (\$2.6 billion), the Government of India has sanctioned Rs 1,458 crore as VGF (viability gap funding), amounting to 10 per cent of the project cost. The remaining Rs 12,674 crore is being invested by the private partner, L&T Metro Rail (Hyderabad) Ltd.

The fares have been set keeping in mind considerations of affordability and compatibility with bus fares in Hyderabad. To protect the consumer

from the private operator's over-charging and also to ring-fence the mega PPP project from possible political or bureaucratic interference, passenger fares and the fare-escalation formula have been frozen and notified in advance.

The Hyderabad project is one of the largest metro rail projects built by a private entity anywhere in the world. It demonstrates how large volumes of private capital can be deployed in public projects in a transparent, efficient and competitive manner. It is not surprising that the project was selected for the Global Engineering Project of the Year Award earlier in 2013 by the sixth Global Infrastructure Leadership Forum in New York.

## Success strategies for a roadmap

Much of this Guide gives advice with a technical flavour. However, when it comes to building a compelling and effective roadmap, the most important advice pulls from sound judgment. Cities should:

- Think big... but start small
- Work together... but move fast
- Emphasise synergies and interdependencies
- Borrow from the best
- Harvest good ideas

**Think big...** Earlier we said that a smart city roadmap should be subservient to a city's long-term vision. Don't hold back when setting those long-term goals. Be bold. Aim high. With the help of digital technology and willing citizens, virtually any city can achieve a greater level of health, happiness and prosperity. Yes, it will take longer for some cities. But the beauty of the digital revolution is that it offers hope to all, regardless of location. Indeed, in many cases digital technology allows smaller, secondary cities to leapfrog cities from large metropolitan areas. It is evident in the nomination process of the Smart Cities Mission — where smaller cities have outdone the state capitals to find a place in the list. Since they have much smaller investments in legacy

infrastructure, they can jump straight to the better technologies now available.

**... but start small.** Growth always lies in 'small' due to the multiplier effect. With your grand plan in place, start small at first. Pick a project that has a small upfront investment, a quick turn-around and a rapid payback. Ideally, this first target will be a consensus priority — something that is near the top of the list for all of the key stakeholder groups. Invest in one or a few select projects with the biggest and fastest payback. On the financial side, this allows you to apply the savings from the first project(s) to finance the next one(s). On the public relations front, it allows you to get an early win that builds support and momentum.

Starting small can also mean taking a neighbourhood-by-neighbourhood approach. Many cities start their smart city journey by designating one area for a pilot project. Districts — neighbourhoods, if you prefer — are small enough but big enough too. They are small enough to be manageable and nimble. But they are big enough to have a critical mass of constituents and to gain some economies of scale. And they are small enough to innovate quickly but big enough to have a meaningful impact.

If the neighbourhood approach is not right for your city, you might look for other self-contained environments such as industrial parks, campuses, leisure complexes, transport hubs, etc.

**Work together...** Time and again, we hear that collaboration is the key to successful smart city projects. “When it comes to achieving the high-tech, sustainable, and smart cities of the future, there is one word that sums up the pathway to success: partnership,” explained Terry Kirby in the Guardian in May 2013. Kirby and other observers say those partnerships should include (at a minimum) local governments, local utilities, local universities, local business groups, local developers and property owners and relevant advocacy groups (such as those that promote sustainability).



### Start small:

*With your grand plan in place, start small at first. Pick a project that has a small upfront investment, a quick turnaround and a rapid payback.*



Smart city pioneers agree that collaboration is the key — and that it can be surprisingly hard to achieve given the ‘stove-piped’ structure of many city governments and the sometimes adversarial relationship between the public and private sectors. First, city governments need to get better at collaborating internally after decades of working in departments with strict boundaries. Second, cities need to get better at collaborating with business and with the public.

Gartner analyst Andrea Di Maio argued in 2012 that “technology is mostly irrelevant unless policymakers, city managers, heads of department and city CIOs get the fundamentals right. What really matters is how different sectors

cooperate and how they can exchange meaningful information. Of course there is technology involved, but that’s not enough to make cities smart.

“Cooperation requires solid governance and a roadmap that is respectful of 1) the different — and potentially diverging — business objectives and timeframes of different stakeholders and 2) the inevitable resource constraints.”



**... but move fast.** Those who hesitate may not be lost, but they will be passed by. As part of your planning, identify 'hot spots' or priorities to enable a quick start on the journey to becoming smarter. For one thing, cities are in constant competition with each other to attract business, talent and creative types. Cities need to begin their smart city journey soon, or they will forever be playing catch-up to their rivals.

In addition, starting fast with an easy win can help with the political realities. Many elected officials operate on a relatively short horizon. Yes, they may have long-term goals for their cities. But they must operate within the constraints of frequent elections. They must show short-term progress along the way if they hope to be re-elected.

**Emphasise synergies and interdependencies.** Done well, your roadmap will consider the totality of the city, not just one or two important departments. In the beginning and at every progress review you should be looking for inter-departmental synergies.

If, for example, you target water alone, you will fail to capture the interdependencies with other departments such as energy. For instance, pumping water for irrigation and human consumption can represent 20% of a city's overall energy budget. Often a city can slash its energy bill just by shifting pumping to off-peak hours when there is less demand on the power grid. Likewise, the same communications system that carries messages for smart water meters can often handle smart electric meters as well, doing away with the expense of a second network. These kinds of synergies and savings don't show up when systems are studied in isolation.

In previous chapters, we've highlighted the interdependencies between different responsibilities. For instance, the built environment relies heavily on services from energy, telecommunications and water systems. Likewise, public safety relies heavily on services from telecommunications, energy and transportation.

The roadmapping phase is when you put the theories of synergy and interdependency into practice. All the more reason to work together — to construct a task force that gets input from all the departments.

**Borrow from the best.** Study those who've gone before. It's smart to learn from your mistakes. It's even smarter to learn from the mistakes of others. And it's smartest of all to learn from the successes of others. Hundreds of cities have embarked on smart city initiatives big and small, so there's no need to invent your smart city plan from scratch. Study their roadmaps and plans (most are public documents).

**Harvest good ideas** wherever you find them. You'll find links to several smart city plans and related tools in the appendix of this Guide. The Smart Cities Council website can also help. You'll find success stories in the examples and case studies section. And you'll find advice on building plans in the visioning and roadmapping tools section.

Now you're ready to get started. It will be hard work, but it will also be rewarding. The roadmap you create will be the jumping-off point for a better city for the current residents and the generations that follow.



Consider digital government services:

## NEW TAIPEI USES SENTIMENT ANALYSIS TO GAUGE CITIZEN ATTITUDES

With over 3.9 million citizens and more than 500 administered institutions and schools, New Taipei city government began constructing and integrating the public cloud and service cloud, not only to strengthen city government operations and that of its subordinate agencies, but also to determine public sentiment regarding government services.

One of the biggest challenges was that complaints filed by citizens and their subsequent status were processed manually, and saved in various data sources. This meant that it took a lot of time and resources to perform this task. It was a major bottleneck. Additionally, the user experience left a lot to be desired.

The major complaint was the slow response time from the NTPC government regarding their complaints or

requests. This was aggravated by the high number of inconsistencies in the responses that the citizens received.

New Taipei city government's public cloud and service cloud, whose main architecture is built on top of the CityNext Big Data framework from Council member Microsoft's Asia-Pacific Research & Development product team, comes with a sentiment analysis tool that enables the administration to use big data analytics to determine the general feedback and sentiment of citizens regarding government services. With sentiment analysis, NTPC officials can better understand the prevailing issues within their city and associate these with attached geographical information.



Consider digital government services:

The New Taipei City Government uses a public and service cloud, big data and sentiment analysis to better understand citizen attitudes about government services.

# CREATING YOUR ROADMAP

Priority <sup>1</sup> -high <sup>2</sup> -medium <sup>3</sup> -low	Enabler	Universal Targets How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress			
			None	Partial	Over 50%	Complete
<input type="checkbox"/>	<b>Inclusivity</b>	Achieve accessibility optimization <b>(Supplement: including physical and web accessibility)</b> Formulate citizen reporting framework for outcome thinking Achieve citizen engagement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<b>Collaborativity</b>	Create institutional framework <b>(Supplement: across multiple transit systems)</b> Pursue multilateral collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<b>Governance</b>	Achieve existing infrastructure optimization <b>Instigate 'soft mobility'</b> Facilitate revenue generation for the city <b>(Supplement: using demand-based road user charging)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<b>Instrumentation</b>	Implement optimal instrumentation <ul style="list-style-type: none"> <li>• Supplement: for all transportation modes (Transportation)</li> <li>• Supplement: across the watershed (Water and Wastewater)</li> </ul> Ensure universal high-speed broadband access (Telecommunications) Ensure a citywide wireless network (Telecommunications)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<b>Connectivity</b>	Connect devices with citywide, multi-service communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# CREATING YOUR ROADMAP

Priority <sup>1</sup> -high <sup>2</sup> -medium <sup>3</sup> -low	Enabler	Universal Targets How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress			
			None	Partial	Over 50%	Complete
<input type="checkbox"/>	<b>Interoperability</b>	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments • Supplement: including physically stored data (Public Safety) Enable distributed generation with interconnection standards (Energy) Enable multi-channel access to an integrated customer transportation account (Transportation)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<b>Security and Privacy</b>	Publish privacy rules Create a security framework Implement cybersecurity De-identify patient and student data for storage in the cloud (Health and Human Services)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<b>Data Management</b>	Create a citywide data management, transparency and sharing policy • Supplement: including energy usage data (Energy) • Supplement: including water usage data (Water and Wastewater) Architect a single health history for citizens (Health and Human Services)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<b>Computing Resources</b>	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# CREATING YOUR ROADMAP

Priority <sup>1</sup> -high <sup>2</sup> -medium <sup>3</sup> -low	Enabler	Universal Targets How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress			
			None	Partial	Over 50% complete	Complete
<input type="checkbox"/>	<b>Analytics</b>	Achieve full situational awareness <ul style="list-style-type: none"> <li>• Supplement: across the watershed, and informed by weather data (Water and Wastewater)</li> </ul> Achieve operational optimization <ul style="list-style-type: none"> <li>• Supplement: for sustainability, efficiency, and cleanliness and safety (Water and Wastewater)</li> </ul> Achieve asset optimization           Pursue predictive analytics <ul style="list-style-type: none"> <li>• Supplement: integrate all transport modes for multi-modal transportation optimization (Transportation)</li> </ul> Automate fault and outage management (Energy)           Automate fault and leak management (Water and Wastewater)           Segment and personalize programs for customers (Energy)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



**On the pages that follow, learn more about the work of the Smart Cities Council and its partner companies and advisors who rank among the world's foremost experts on smart cities.**

## INTRODUCING SMART CITIES COUNCIL INDIA LEAD PARTNERS

**Cities seeking expert guidance regarding their smart city initiatives will discover valuable partners in the companies featured on the pages that follow.**

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[ESSEL INFRA](#)

[ORANGE SMART CITY](#)

[THOMSON ROUTER](#)

[3M](#)

*Partners are listed according to the date they joined the Council; longest-standing members appear first.*



**Tyco is the world's largest pure-play fire and security company. Tyco provides more than three million customers around the globe with the latest fire protection and security products and services. A \$10+ billion company, Tyco has more than 57,000 employees in 900 locations in nearly 50 countries serving the world's most demanding environments, including banking and financial services, oil and gas, marine, government, healthcare, retail, home security, transportation and commercial and industrial**

**Our 57,000 employees in over 900 locations around the world take a consultative approach to delivering tailored, industry-specific solutions. Our global reach allows us to anticipate changes**

**across geographies and industries, and deploy the right solutions rapidly.**

**In the most challenging and demanding environments, we help our customers achieve their safety, security and business goals.**

**For more than half a century, Tyco has been delivering the latest solutions to unique business challenges. Today, the passion to protect what matters most is stronger than ever. With a tradition of customized service and a passion for technology and innovation, Tyco develops practical, integrated fire protection and security solutions for increasingly complex environments**



**Established in 1976, Essel Group, led by its Chairman Dr. Subhash Chandra, is amongst India's most prominent business houses with a diverse portfolio of assets in Media, Technology, Entertainment, Packaging, Infrastructure, Education, Healthy Lifestyle & Wellness, Financial Services and Precious Metals, with worldwide operations and a workforce of over 10,000 dedicated employees**

**Essel Infraprojects Ltd. the flagship Infrastructure vertical of Essel Group, headquartered in Mumbai, India, aims to transform quality of lives of people through its various projects in line with the Essel Group's philosophy of "Faith in innovative and organized growth".**

**Essel Infraprojects is among the top 5 infrastructure companies in India pioneering in infrastructure and integrated utilities space comprising three strategic business units (SBU) comprising (a) Core Infra comprising of Transport (Roads, Airports, Metros & Monorails), Power Transmission & Distribution, Urban Infrastructure (b) Green consisting of Municipal Solid Waste, Waste Water Treatment and Water Desalination, Renewable Energy (Solar, Hydro and Wind), and (c) Integrated Utilities (Power Distribution, Water Distribution, Solid Waste Management and Cable & Broadband).**

**The Company has embarked on an exciting and ambitious roadmap to transform the urban Indian landscape by actively partnering with the Government of India for 100 Smart Cities initiatives.**



**Orange Smart City is a revolutionary greenfield smart industrial development in close proximity to India's financial capital, Mumbai. It is envisaged to be a city of the future that offers the best of business, living, learning, recreation, health and smart solutions.**

**Spread over 1,000 acres, Orange Smart City offers the state-of-the-art infrastructure and globally benchmarked smart features amidst stunning natural surroundings. It enjoys excellent national and international connectivity and is strategically located close to the Jawaharlal Nehru Port, the proposed Navi Mumbai International airport, and the proposed Mumbai Trans Harbour Link. Huge**

**urban markets of Mumbai, Navi Mumbai, Pune and Nasik, with a populace base of over 20 million, are inside the catchment areas of the Orange Smart City. The project site is at the confluence of various industrial, knowledge and economic corridors and falls within the influence zone of the Delhi-Mumbai Industrial Corridor, thereby presenting unique development opportunities.**



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**Introduction page:**

**Effective land administration and property taxation are essential to good governance around the world. To achieve it, you need solutions that enhance revenue generation fairly—making the process of measuring, managing and taxing**

**property more efficient. Our Aumentum solutions are helping transform public taxation and land administration in more than 1000 jurisdictions and 40 countries around the world.**

**Aumentum delivers sustainable, automated tax and land administration solutions integrating information that exist across your offices and agencies. This integration eliminates problems associated with redundant data, increases accuracy by reducing manual entry errors, streamlines workflow processes and efficiently utilizes tight budget dollars. For Smart Cities, this results in improved service delivery and provides you as well as other policy and decision makers, businesses and private citizens more timely access to information enhancing transparency and increasing public confidence.**



**3M is a diversified technology company serving customers and communities with innovative products and services. Each of our five businesses are committed to making our customers lives easier and better**

**With \$32 billion in sales and operations in more than 70 countries, 3M sells more than 60,000 products and employs close to 90,000 people worldwide who collaborate actively to design, manufacture and engage in the delivery of innovative products & services. 3M Science is the foundation of our 46 technology platforms that combine in unique and imaginative ways, leading to innovative solutions for a variety of industries like Automotive, Commercial Solutions, Communications, Consumer, Design & Construction, Electronics, Energy, Health Care, Manufacturing, Mining, Oil & Gas, Safety & Transportation.**

**3M has over a 100 year track record of being one of the most innovative companies worldwide. In 2014, 3M earned its 100,000th patent, a testament to the strength and resilience of our innovation engine and we continue to earn an average of 3,000 patents every year.**

**We reduce the weight of power lines so they can carry more power to more people. We help manufacturers use less while accomplishing more. We automate health care data so the right people get the right information. Across the globe, 3M is inspiring innovation and igniting progress, all while contributing to true global sustainable development through environmental protection, corporate and social responsibility and economic progress. We are applying our science and innovation to make a real impact in every person's life around the world.**

# INTRODUCING SMART CITIES COUNCIL INDIA ASSOCIATE PARTNERS

**Cities seeking expert guidance regarding their smart city initiatives will discover valuable partners in the companies featured on the pages that follow.**

[EXCELIZE](#)

[VOTARY TEXCH](#)

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*Partners are listed according to the date they joined the Council; longest-standing members appear first.*



Excelize, having its marketing office in US & India and production center in India, is a pioneer in BIM (Building Information Modeling) & CAD for various engineering and construction sectors. We help construction companies, general & specialty contractors, architects, engineers and building owners to seamlessly integrate BIM technology into their projects within their predefined timelines, standards and budget thereby ensuring maximum return on their investment. We follow a well-structured production process along with a refined quality assurance procedure to ensure that the project objectives are met to the satisfaction of the client.

Excelize is a leading offshore production AEC and BIM services company presently assisting some of the top Globally listed Architects, Design Build and General Contracting firms in US, Middle East, Europe as well as in Asia for their projects worldwide. With about a decade's experience in offshore AEC business, today we are 50+ technically staffed professionals, assisting our clients at different phases of their projects (right from concept to completion) limiting our self as their extended production AEC & BIM arm.

Architects, Engineers and Production staff in Excelize have worked on various national-international BIM and AEC projects and have a sound knowledge of different global standards and codes. Educational, Healthcare, Institutional, Hospitality, Workplaces, Retail, Residential projects are the market segments we focus for our services with over 31 million sq.ft of BIM work done till date.

Excelize has been specializing in BIM solutions, architectural BIM services, BIM coordination, BIM clash detection and BIM families, since 2004. With an established clientele in USA, UK and India, Excelize is expanding its reach in other regions like MINA, Australia and European countries.

Excelize is a global architectural services firm that specializes in providing Building Information Modeling (BIM Solutions) & Design Management Services (DMS) to General Contractors, Design Build Contractors, Real Estate Developers, Architecture and Engineering firms.



VotaryTech, promptly rooted in the mobile technology industry with the vision of excelling in the domain, is focused on delivering the pre-eminent qualities in result-oriented outputs, having world-class standards in constant check. Combining technological innovation and experience, Votary's engineers have developed most of the in-house multi-platform solutions and services, in both legacy and modern mobile platforms. They successfully work on various mobile platforms such as Android, iPhone, Windows, 4G LTE, 3G, WIFI, Bluetooth, RFID, NFC, Qt, BlackBerry, Tizen, Bada and BrewMP.

In a short period of time, Votary has established relations with some of the major Fortune 500 companies in the world and have exhibited tremendous growth. This was no coincidence but a combination of technological competence with over two decades of indelible mobile technology experience.

Our mission:

Help our customers WIN the Market:

- By providing innovative, next generation solutions and world class battle ready talent
- By identifying the gaps and offering services to quickly fill the same

Areas of operation:

VT operates in the areas of Technology Solutions Development, Mobile Platform Testing, System Engineering, System Architecture & Design, Platform and Product Validation, Consultancy services, Offshore/Offsite Development Centre, Resource Augmentation and safety related technologies.

# fluentgrid

Fluentgrid Limited (Formerly Phoenix IT Solutions Ltd.) offers ICT solutions based on its mPower™ software suite to facilitate uninterrupted flow of multiple utility services in a smart city through coordinated instrumentation, centralized command center, precise automated metering, accurate billing, revenue collection, participative governance, multi-channel citizen engagement and deeper insights into city data for continuous improvement.

Fluentgrid Limited is implementing alongwith IBM India's First Greenfield Smart City Project – Pallava City in Maharashtra. Fluentgrid Won the Prestigious IBM Beacon Finalist Award 2015 in the Outstanding Smart Cities Solutions Category.

Fluentgrid leverages its proven mPower™ suite of robust software products, extensive domain expertise and successful project execution ability to offer turnkey integrated solutions for transforming utilities and cities with lower TCO and faster RoI. mPower CIS™, a revenue and customer management product suite, is featured in Gartner Magic Quadrant for utility CIS systems consecutively in 2013, 2014 and 2015. mPower MDMS™, a smart grid product, is positioned in Gartner Magic Quadrant 2014 for Utilities – Meter Data Management products. Fluentgrid has proven solutions for utilities to increase revenue realization, improve customer satisfaction, facilitate smart metering, enable smart grids and optimize asset utilization. Their solution offerings are based on an advanced technology framework that allows seamless integration of multiple applications, services and devices in a future proof manner. The solution framework helps achieve business agility, anywhere information access, multi-modal communication, multi-device integration, business intelligence and enterprise integration through service oriented architecture.

# CORNING

Today's world depends on fast-flowing information, and plenty of it Corning continues to revolutionise the way data keeps moving  
Faster Broadband and Beyond

Internet users – consumers and business organisations alike – are sending, receiving and storing more data than ever before. With network usage doubling every couple of years, worldwide demand for bandwidth is also sky rocketing. That's putting extra pressure on the edges of networks, closest to where the data is created. It's no easy task to create seamless bandwidth capacity across continents or within a complex environment like a hospital, data centre or sports stadium. But as a world leader in this market, Corning provides a powerful combination of optical solutions to meet the very toughest of network demands.

We helped to enable the Internet explosion when our scientists developed the world's first low-loss optical fibre in 1970. Building on the knowledge that optical fibre far surpasses copper in terms of bandwidth capacity – while also being strong, lightweight, and flexible – we quickly expanded our products and innovations. Fibre-to-the-home, wireless, data centre solutions and consumer products are all part of our innovative portfolio. Today, we continue to set the standard for the cutting-edge fibre, cable, connectivity and wireless solutions to keep the world more connected than ever before. Our innovations also help our customers – in healthcare, government, finance and a host of other industries – to take full advantage of emerging phenomena like remote storage, cloud computing and fibre-to-the-desktop.



As a leading communication network infrastructure provider we will be a prime driver of connectivity

In the future cities, an adequate telecommunications infrastructure will be vital for business and industry as well as residents.

TE - Broadband Network Solution - makes it possible for power and massive volumes of data and signal to move efficiently and reliably, so a whole world of information can move seamlessly from origination to destination from the data center, to the desktop, the chip and right to the device in the palm of your hand and back

#### Smart fiber infrastructure

The demand for data is growing at an astronomical rate —data that will largely be delivered through fiber optic cables that run across the ocean, to and from data centers, offices, wireless base stations, access points, inside homes and devices, and directly to the chip. Fiber is the backbone of the world's information infrastructure, enabling society's ever-increasing reliance on high-speed, media-rich communications. At TE - Broadband Network Solution, we make fiber come alive from origination to destination—providing fiber connectivity solutions that enable every modern Telecom, Cable and Wireless network. Whether it's for in-building central office, data center and enterprise applications or meeting the rigorous challenges of buried, aerial and undersea outdoor networks around the globe.

#### Smart physical layer management

Smart cities rely on networks of sensors in everything from parking spaces to heating and cooling systems. And while most of the attention has been on sensors and software for interpreting masses of smart city data, a smart city isn't so smart if the physical network breaks down.

With a PLM system in place, the network manager knows the state of the network in real time, and can plan for capacity and access changes as needed.

TE's physical layer management solution is a hardware and software system that allows you in real-time to know when and where physical connectivity changes take place in network.

## INTRODUCING SMART CITIES COUNCIL LEAD PARTNERS

Cities seeking expert guidance regarding their smart city initiatives will discover valuable partners in the companies featured on the pages that follow.

[IBM](#)  
[Itron](#)  
[Alstom](#)  
[Microsoft](#)  
[GE](#)  
[Cisco](#)  
[S&C Electric Co.](#)  
[Bechtel](#)  
[Qualcomm](#)

[MasterCard](#)  
[Enel](#)  
[Ooredoo](#)  
[Daimler](#)  
[Cubic Transportation Systems](#)  
[Allied Telesis](#)  
[Schneider Electric](#)  
[Verizon](#)  
[SAS](#)

Partners are listed according to the date they joined the Council; longest-standing members appear first.



As a leading producer of smart technologies and services, IBM is pleased to lend its expertise to the Smart Cities Council's efforts to support and educate city leaders, planners and citizens.

Cities everywhere are reinventing themselves to better integrate across functions and collaborate with new partners to create and nurture the strong, differentiating identities that attract new citizens and businesses.

Combining world-class business, industry and technology expertise, IBM is able to apply innovation to help cities achieve their objectives. Drawing on thousands of client engagements across virtually every industry, only IBM offers the experience that today's challenges demand.

IBM smarter cities resources:

- [Smarter Cities press kit](#)
- [Smarter Cities web page](#)
- White Paper: [Smarter, More Competitive Cities](#)
- [People for Smarter Cities](#)
- [Smarter Cities YouTube Channel](#)

IBM worked with the city of Madrid to improve city life for three million citizens through a project that will use IBM's Smarter Cities technology to improve the efficiency of city services and provide citizens new tools to interact and communicate with the city council.

Leveraging big data and analytics, IBM helped Madrid transform its supplier management model by allowing the city to manage and pay each service provider based on the attainment of service levels. The platform integrates information provided by citizens with other data streaming in from sensors, devices, cameras, inspectors and suppliers as well as data from human resource management, job scheduling and geographic information systems to provide a comprehensive view of city services.

By helping Madrid manage an inventory of more than five million assets – ranging from park swings to traffic cameras – and the contracts of service suppliers, the project will deliver results for citizens by improving the management of public services such as street maintenance, lighting, irrigation, trees and green spaces and waste management.



“By enabling cities to better manage energy and water resources, Itron believes that, with collaboration and innovation, we can help cities not only adapt to address challenges, but also thrive. By drawing on today’s best minds and technology, the Smart Cities Council and its members are committed to achieving just that.”

– Russ Vanos, Itron’s senior vice president of strategy and business development

Itron is a world-leading technology and services company dedicated to the resourceful use of energy and water. We provide comprehensive solutions that measure, manage and analyze energy and water. Our broad product portfolio includes electricity, gas, water and thermal energy measurement devices and control technology; communications systems; software; as well as managed and consulting services. With thousands of employees supporting nearly 8,000 customers in more than 100 countries, Itron applies knowledge and technology to better manage energy and water resources. Together, we can create a more resourceful world. Join us: [www.itron.com](http://www.itron.com)

As a founding member and lead partner in the Smart Cities Council, Itron is helping to advance Smart City initiatives at a time when it is critical to

take action. We believe Smart City initiatives will be incredibly important in the 21st century. Currently, more than half of the world’s population lives in towns and cities for the first time in history, which puts a strain on energy and water resources. In addition to the strain on resources, there is also an incredible amount of energy and water lost due to waste – approximately 30% of all treated water is lost and electricity losses cost utilities \$24B per year. In order to ensure sustainability and viability of our cities for future generations, smart technology needs to be utilized to reduce waste and empower people to manage and conserve resources.

Itron is collaborating with Microsoft to provide actionable data to help cities meet their objectives to reduce their carbon footprint and lower energy consumption. [Learn more >](#)

Smart City innovation has turned Uptown Charlotte into a living laboratory. Envision

Charlotte Executive Director Amy Aussieker shares insights about the project. [Learn more >](#)

Itron’s water AMI solution helps the City of Kalgoorlie, Australia to manage resources more effectively and provide greater control over water wastage. [Learn more >](#)

Itron’s Mobile AMR solution allowed Alabama Gas Corporation to reduce CO<sup>2</sup> emissions with fewer vehicles while gaining greater meter reading efficiency. [Learn more >](#)



As a leading producer of smart technologies and services, Alstom Grid is pleased to lend its expertise to the Smart Cities Council's efforts to support and educate city leaders, planners and citizens.

To meet today's increasing global energy demands and challenges, networks must evolve and become smarter. Alstom Grid enables an efficient transmission and distribution of electricity and supports the development of Smart Grids and Supergrids with engineered solutions for applications in utility and industry settings; updating existing grids; integrating and customizing solutions such as alternating current and direct current substations from medium up to ultra-high voltages. Alstom Grid is a key player in developing and implementing solutions to manage electric grids in the new era of increasing renewable energies and distributed energy resources, by enabling real-time two-way management of electricity and information.

At the heart of the Smart Grid revolution, its solutions provide immediate benefits in many eco-city projects, thus enabling end-consumers to benefit from better energy consumption. Alstom Grid's knowhow is displayed in over <sup>30</sup> large scale

demonstration projects in the US and Europe with partners from both the public and private sectors.

The North Carolina Smart Grid Project in the USA led by the US Department of Energy (DoE) is designed to integrate distributed energy resources into the electrical grid efficiently in order to help the DoE reach its smart grid targets for <sup>2030</sup>, including a <sup>40%</sup> improvement in system efficiency. The NiceGrid smart district project developed with the French Distribution System Operator ERDF, located in the city of Nice (French Riviera) aims at developing several microgrids with integrated renewable energy sources and electricity storage with a scalable and cloud-based IT platform.



Founded in 1975, Microsoft is the worldwide leader in software, services, devices and solutions that help people and businesses realize their full potential. Microsoft CityNext is an extension of that vision with a people-first approach to innovation that empowers government, businesses and citizens to shape the future of their city. People first means harnessing all the ideas, energy and expertise of a city's people as it creates a more digital, healthy, educated, safe, and sustainable place to live.

With a broad suite of platform and productivity solutions for a mobile-first, cloud-first world, a vast global network of partners, and a history of successful education and social programs, Microsoft CityNext helps cities find the right answers for their local challenges and opportunities.

With Microsoft CityNext's partners, we are committed to helping cities:

- Transform operations and infrastructure with Microsoft CityNext and our partners' solutions by connecting systems, data, and people across departments to make information more accessible and services more affordable
- Engage citizens and businesses by enabling real-time communication services through devices and

apps to provide additional value to citizen services, reach a broader population of citizens, and engage citizens and businesses more deeply with intelligent experiences. This includes connections between governments and citizens, governments and businesses, and other governments.

- Accelerate innovation and opportunity through programs that prepare youth to become the next generation of highly skilled workers, nurture entrepreneurs' bold ideas, and create jobs that help cities compete in the global marketplace by delivering excellent education, use data from the Internet of Things to develop new services and businesses, and attract talent and new business with a modern infrastructure.

Through a people-first approach and strategic partnerships, cities can enable sustainable cycles of innovation, opportunity, and progress for years to come.

Find out how Microsoft CityNext and our partners are enabling cities worldwide to harness the new era of innovation.

[Learn more >](#)

Microsoft CityNext helps city leaders turn their smart city vision into reality.

[Learn more >](#)



Imagine a world that connects data to people to machines, making lives better in the cities where people work live and explore. It's a world where city leaders could tap into endless intelligence to eliminate costly redundancies and develop a more workable and livable community.

That world is here, and it's powered by [Predix™](#), GE's cloud platform for the Industrial Internet. Through GE's Intelligent Environments for Cities solution, communities around the world will experience pioneering solutions from such businesses as [GE Software](#), [GE Lighting](#), [GE Healthcare](#) and [GE Power & Water](#). At GE, we look at innovation through a broad lens. By taking breakthroughs in one business and applying them to others, we push expectations and change the idea of what's possible – all for the benefit of cities around the globe.

[GE Software](#) is bringing the Industrial Internet to life by connecting minds and machines through innovative technology. In building our applications and [GE Predix](#), we combine decades of experience manufacturing industrial machines with cutting-edge data science and analytics expertise. The Predix platform has helped our developers save both GE and our customers time, energy and money, and now we are

releasing it so that your developers can leverage its advanced computing power and built-in integrations to develop innovative applications across industries. We have transformed our business and invite you to join us on this path as we ignite the next Industrial Revolution together. Learn more at [gesoftware.com](#) and [predix.io](#).

#### Seeing More than Light

One of GE's Intelligent Environments for Cities solutions uses LED street lighting and wireless sensors to connect, collect and analyze data, harnessing the power of the Industrial Internet to solve countless challenges facing cities and communities across the globe.

Cities on both U.S. coasts are piloting the Intelligent Cities technology to help solve these challenges and enhance the quality of life for residents and visitors. In San Diego, California, sensor technology has been added to existing GE LED streetlights, with a focus on parking solutions in its urban core. The city of Jacksonville, Florida is piloting the solution to access real-time data and focus on increasing efficiency through energy savings and better asset management of street lights.

From curbing street lighting costs to improving traffic monitoring, enhancing pedestrian crosswalk detection, mitigating illegal dumping and monitoring adverse weather conditions, the potential solutions from this technology are endless. [Learn more about the pilot programs.](#)

GE supports the Smart Cities Council's vision to transform urban areas into more livable, workable and sustainable communities. As a technology company, sustainability is embedded in GE's culture and business strategy. Working to solve some of the world's biggest challenges inspires our thinking and drives our actions.

Visit [www.ge.com](#) to learn more.



As world populations shift to urban areas, community leaders are pressed for answers to related problems. These include overcrowding, pollution, budget and resource constraints, inadequate infrastructures and the need for continuing growth.

Cisco Smart+Connected Communities solutions use intelligent networking capabilities to bring together people, services, community assets and information to help community leaders address these world challenges. By connecting the unconnected, we can do amazing things to address these real world challenges and create a more sustainable environment.

Cisco Smart+Connected Communities™ help transform physical communities to connected communities and achieve economic, social and environmental sustainability.

[Transforming communities >](#)

Retrofitting existing cities with smart solutions is the urban challenge of the 21st century.

[Learn more >](#)



# S&C ELECTRIC COMPANY

Excellence Through Innovation

S&C proudly supports the Smart Cities Council in advocating the evolution toward smart, sustainable cities.

S&C Electric Company's innovative solutions for distribution automation and power delivery are helping cities around the world transition to cleaner and more reliable supplies of electricity required in the 21st century. S&C's groundbreaking technologies can reduce the length and frequency of power outages, improve energy efficiency, support advanced microgrids and grid-scale energy storage, and make it practical to use such variable renewable energy sources as wind and solar power on a larger scale.

With its unmatched heritage of innovation and performance, S&C delivers both products and services to address not only today's power grid challenges, but tomorrow's as well.

Additional information is available at [sandc.com](http://sandc.com).

Additional resources:

- Reducing Momentary Outages for Florida Power & Light: [Press release](#), [Video](#)
- S&C Ties California Utility's 2-MW Solar PV Project to the Grid: [Case study](#)
- Oncor's Microgrid Solves Electrical Distribution Challenges: [Video](#)
- Energy Storage to Smooth Solar Power: [Case study](#)
- Utility-Scale Energy Storage System Islands Remote Town During Outages: [Video](#), [Case study](#)
- Improving Reliability by more than 50% with Self-Healing Technology: [Case study](#)
- What do outages cost cities? [Video](#)
- Microgrids: An Old Idea with New Potential: [White paper](#)
- The Role of Energy Storage in Smart Microgrids: [White paper](#)
- Smart Microgrid at Illinois Institute of Technolo-



Bechtel is pleased to support the Smart Cities Council's aspirations to foster the creation of smarter cities around the world by sharing our experience delivering major infrastructure projects and knowledge of planning, financing and sustainable solutions.

As a company, we work hard to build a more sustainable world. In our work with cities and governments we enhance local communities and improve the quality of life for people around the world. Time and again our work has demonstrated that the only limits on human achievement are those that we place on ourselves.

Bechtel is a global leader in engineering, procurement, construction and project management. Bechtel's diverse portfolio encompasses energy, transportation, communications, mining, oil and gas and government services.

We have been privileged to contribute towards some of the most significant urban infrastructure projects around the world, including the Channel Tunnel, Hong Kong International Airport, the Athens Metro system and work on more than 20

new cities and communities. In order to deliver projects of such magnitude successfully, we combine smart planning, technical know-how and an integrated approach to make visions become a reality. We look forward to sharing the benefits of this experience and our knowledge of planning, financing and sustainable solutions to support the Council's aspirations to foster the creation of smarter cities around the world.

Since its founding in 1898, Bechtel has worked on more than 22,000 projects in 140 countries on all seven continents. Today, our 53,000 employees team with customers, partners and suppliers on diverse projects in nearly 50 countries. We stand apart for our ability to get the job done right - no matter how big, how complex or how remote. [www.bechtel.com](http://www.bechtel.com)



Qualcomm Incorporated is the world leader in 3G, 4G and next-generation wireless technologies. Qualcomm Incorporated includes Qualcomm's licensing business, QTL, and the vast majority of its patent portfolio. Qualcomm Technologies, Inc., a wholly-owned subsidiary of Qualcomm Incorporated, operates, along with its subsidiaries, substantially all of Qualcomm's engineering, research and development functions, and substantially all of its products and services businesses, including its semiconductor business, QCT. For more than 25 years, Qualcomm ideas and inventions have driven the evolution of digital communications, linking people everywhere more closely to information, entertainment and each other. Qualcomm innovation and technology can be used by cities worldwide to provide smart, efficient and sustainable services, including:

**Cellular Grid Connectivity** – ubiquitous consumer coverage, high bandwidth and real-time communications of 3G and LTE cellular networks that enable critical smart grid functionality such as advanced smart metering, demand response, distribution automation, and outage management.

**Home Area Connectivity** – unsurpassed whole-home coverage, performance and reliability in an energy-efficient manner.

**Connected Vehicle** – anywhere/anytime emergency assistance services, remote monitoring and diagnostics, advanced driver assistance features, GPS and GLONASS-enabled position/location features and services.

**Wireless Electric Vehicle Charging** – a simple, no-fuss way to charge your electric vehicle. No cables, no wires, just park and charge.

**Mobile and Wireless Health** – broadband technologies enabling mHealth devices and services for chronic disease management, remote patient monitoring, diagnostic care, as well as products associated with general health, wellness, fitness, and aging.

**Mobile Learning** – mobile broadband technologies enabling personalized experiences within collaborative communities, transforming the work of teachers/students in K-20 schooling.



## MasterCard

MasterCard shares the Smart Cities Council's vision of a world where digital technologies and intelligent design are harnessed to create smart, sustainable cities with high-quality living and high-quality jobs.

MasterCard is a global payments and technology company. We operate the world's fastest payments processing network, connecting consumers, financial institutions, merchants, governments, cities and businesses in more than <sup>210</sup> countries and territories.

Our products and solutions are advancing the way consumer and business cardholders around the world shop, dine, travel, and manage their money, enabling transactions that drive global commerce and improve peoples' lives.

Passionate about innovation, MasterCard is constantly seeking to develop and test new payment channels and digital solutions that are safe, simple and smart.

Payments touch every aspect of our lives. Removing cash from the economy creates far-reaching and cumulative benefits for all partici-

pants — citizens, merchants, tourists and government —improving life for the city at large.

Cities are becoming smarter, and whether it is to simplify internal processes, facilitate micro payments (transit, commerce...), optimize collection of funds or improve disbursement methods, MasterCard is developing inventive ways to support Cities digital strategy, drive local business growth, fuel commercial development, increase citizen's satisfaction and reduce costs.

Special and Unique Offers with MasterCard  
Priceless Cities: [www.priceless.com](http://www.priceless.com)

London bus passengers speed up their journey times with contactless card payments.

[London bus cards >](#)

The global journey from cash to cashless: boosting economic growth and advancing financial inclusion.

[Learn more >](#)

Digital sharing and trust project: understanding the five online personas.

[Learn more >](#)



Enel is a multinational power company and a leading integrated player in the world's power and gas markets, with a particular focus on Europe and Latin America. The Group operates in over <sup>30</sup> countries across four continents, generating power from over <sup>90</sup>GW of net installed capacity and distributing electricity and gas through a network spanning around <sup>1.9</sup> million km. Enel, with its <sup>61</sup> million end users worldwide, has the largest customer base among its European peers and is among the leading power companies in Europe in terms of installed capacity and reported EBITDA.

Enel was the first utility in the world to replace the traditional electromechanical meters with smart meters, making it possible to measure consumption in real time and manage contractual relationships remotely. Today, around <sup>32</sup> million Italian retail customers are equipped with smart meters developed and installed by Enel. The Group is deploying an additional <sup>13</sup> million smart meters to its customer base in Spain as well as running pilot tests for the smart cities of Búzios (Brazil) and Santiago (Chile). This innovative tool is key to the development of smart grids, smart cities and electric mobility.

Enel is strongly committed to renewable energy sources and to the research and development of new environmentally friendly technologies. Enel Green Power (EGP) is the Group's publicly listed renewable energy generation company, operating over <sup>9.8</sup>GW of net installed capacity of hydro, wind, geothermal, solar, biomass and co-generation sources in Europe, the Americas and Africa. Enel Green Power is, technology-wise, the most diversified renewable company among its global peers.

[Enel website >](#)

[Enel on sustainability >](#)

[Enel on innovation >](#)



Headquartered in Doha, Ooredoo is Qatar's leading communications company and is dedicated to supporting the Qatar National Vision 2030.

Ooredoo has an active strategic and supportive role in shaping the telecom and ICT strategies in Qatar as part of its goal to make the country one of the best-connected nations in the world. The "smart city" concept is central to the long-term development vision of Qatar, placing technology at the heart of new projects to enable a smart economy, smart mobility, a cleaner environment and smart governance.

To support this vision, Ooredoo has developed and launched a host of next generation technology from smart infrastructure (4G+ and Fibre), smart entertainment, connected cars, next-generation education, health and workplace solutions, intelligent transport and smart stadiums, demonstrating the company's leadership in driving the latest and the best technology.

Ooredoo is spearheading this technological boost by working with a number of leading enterprises including KT Corporation of Korea and Lusail Real

Estate Development Company, to ensure the development of smart city technology.

Ooredoo is becoming a leader in the provision of the network infrastructure required to build the Smart Cities of the future, and is leading the efforts for the first-ever Smart City in Qatar – the state-of-the-art Lusail City – which will be supported by Ooredoo's faster and bigger network. Residents and businesses will have access to a variety of smart services powered by a citywide Ooredoo Fibre network and managed through a centralised control centre.

The company has introduced a host of cutting-edge Ooredoo Machine to Machine (M2M) services to Qatar, enabling companies to connect business assets directly with each other or with a central command centre, removing the need for human involvement, and introducing new solutions directly into homes and businesses.

Ooredoo has also launched The Smart Living Baytcom Project – a 'Proof of Concept Demo House' filled with smart living concepts.

[Ooredoo website >](#)

# DAIMLER

## About Daimler AG:

Daimler AG is one of the world's most successful automotive companies. With its divisions Mercedes-Benz Cars, Daimler Trucks, Mercedes-Benz Vans, Daimler Buses and Daimler Financial Services, the Daimler Group is one of the biggest producers of premium cars and the world's biggest manufacturer of commercial vehicles with a global reach. Daimler Financial Services provides financing, leasing, fleet management, insurance and innovative mobility services.

The company's founders, Gottlieb Daimler and Carl Benz, made history with the invention of the automobile in the year 1886. As a pioneer of automotive engineering, we continue to shape the future of mobility today: Our focus is on innovative and green technologies as well as on safe and superior automobiles that appeal to and fascinate our customers. For many years now, Daimler has been investing continually in the development of alternative drive systems with the goal of making emission-free driving possible in the long term. So in addition to vehicles with hybrid drive, we now have the broadest range of locally emission-free electric vehicles powered by

batteries and fuel cells. This is just one example of how we willingly accept the challenge of meeting our responsibility towards society and the environment.

Daimler sells its vehicles and services in nearly all the countries of the world and has production facilities on five continents. Its current brand portfolio includes, in addition to the world's most valuable premium automotive brand, Mercedes-Benz, the brands smart, Freightliner, Western Star, BharatBenz, Fuso, Setra, Thomas Built Buses, moovel and car2go. The company is listed on the stock exchanges of Frankfurt and Stuttgart (stock exchange symbol DAI). In 2014, the Group sold 2.5 million vehicles and employed a workforce of 279,972 people; revenue totaled €129.9 billion and EBIT amounted to €10.8 billion.

## About Business Innovation:

Since 2007 the Business Innovation department has been Daimler's lab for innovative business ideas that reach out well beyond the company's core business of automotive manufacturing. Business Innovation tracks current trends and monitors

technological, social and cultural developments with a view to developing new and profitable business solutions. Numerous pilot projects initiated in recent years have already led to the establishment of successful corporate units such as car2go, moovel or the Mercedes-Benz Driving Academy. There are now Business Innovation teams based all over the world. As well as at the headquarters office in Stuttgart, they are to be found in Istanbul, São Paulo, Beijing, Buenos Aires and Sunnyvale, California.



Cities around the world are facing the growing problem of aging and overburdened infrastructure needing to carry more people but without the ability to move those people effectively. What's the answer? Cubic is doing this through NextCity, our vision for the future of urban mobility.

At Cubic, we love to solve problems and help travelers pay their fares quickly and safely through the revenue management and Intelligent Transport Systems (ITS) systems and tools we deliver to choose the smartest and easiest way to travel and pay for their journeys.

We also enable transportation authorities and agencies to manage demand across the entire transportation network – all in real time. Today, all of our payment and information technology and services have been merged into an overarching vision called NextCity. Through NextCity and its subsystems, we are able to extract the data from our electronic payment systems and other system sensors. This data becomes actionable information for transportation operators to understand what their ridership is doing – where they come from, where they go, the routes they take and the times at which they travel. Better under-

standing of demand allows for better understanding of supply and capacity needs.

This data also empowers the travelers with information they can use to choose the best mode of travel as well as to know what and where the slow downs or service alerts are to aid their journey planning.

Transport for London in partnership with Cubic is transforming the payment experience in one of the world's biggest cities. [Learn more >](#)

NextCity takes us further than we've ever been before. [Learn more >](#)



Allied Telesis maintains a long history of helping cities implement their visions of interconnected, smarter operations on a citywide basis.

Using the Company's resilient switching products and sophisticated network monitoring services, cities around the world have deployed IP video cameras, and made hospitals and homes smarter and more livable. Allied Telesis wireless solutions allow cell-based or blanket technologies to cover anything from small businesses to large venues with exceptional bandwidth and service.

We are at the start of a revolution with Smart Gigabit Cities around the globe. Cities that enable people to communicate at gigabit speeds on wireless and wireline networks are well positioned to attract the best and brightest business leaders, while enabling economic prosperity. The Internet of Things (IoT) and Smart Gigabit Cities are synonymous, and represent key aspects of any city revitalization process.

Smart Gigabit Cities deploying integrated safety solutions from Allied Telesis are able to protect and serve their communities by integrating a plethora of sensor types, providing a geospatial representa-

tion of their installed area, and taking the operations of a municipality to a new level of efficiency and safety. Using Allied Telesis EtherGRID solutions, city planners can fully integrate historical data about operations in their cities with sensor inputs, give a real-time view of current events, and utilize advanced spatial analytics. These capabilities provide planners and city managers the tools needed to elevate planning and decision-making to a new level of effectiveness.

Allied Telesis website

[Learn more >](#)

Communications solutions

[Learn more >](#)

Education solutions

[Learn more >](#)

Healthcare solutions

[Learn more >](#)

Transportation solutions

[Learn more >](#)



As a leading provider of smart city solutions and services, Schneider Electric is pleased to lend its expertise to the Smart Cities Council's efforts to support and educate city leaders, planners, and citizens.

A global specialist in energy management with operations in more than 100 countries, Schneider Electric offers integrated solutions across multiple market segments, including leadership positions in Utilities & Infrastructures, Industries & Machine Manufacturers, Non-residential Buildings, Data Centres & Networks and the Residential sector. The group is focused on making energy safe, reliable, efficient, productive and green, through an active commitment to helping individuals and organisations make the most of their energy.

Schneider Electric delivers urban efficiency. The group is a trusted partner in cities around the world and works collaboratively with visionary city leadership, engaged stakeholders, and a dynamic network of partners to address each city's unique challenges. With solution and services expertise in the critical infrastructure areas of energy, buildings, water, transportation, public services and

integration, Schneider Electric is able to effectively bridge traditional information silos. The group's innovative solutions and pragmatic integration capabilities combine both operational and information technology, for impactful implementations that deliver the short-term, visible, maximum return on investment results that cities need.

[Learn more](#) about Schneider Electric's smart city solutions.

Schneider Electric helps to advance a smart city at the foot of the Sierra Nevada mountains

[Learn more >](#)

German city consolidates building management and cuts energy use with Schneider Electric solutions

[Learn more >](#)

White papers:

- [Urban Mobility in the Smart City Age](#)
- [The Smart City Cornerstone: Urban Efficiency](#)



[Verizon's Smart Cities solutions](#) empower municipalities to solve some of today's biggest challenges – including public safety, traffic and energy management, intelligent transportation and precision agriculture – using a powerful combination of advanced networking, cloud computing, security and device management. By making cities “smarter,” local governments, in collaboration with Verizon, are able to become more efficient, resilient, address aging infrastructure, generate more revenue and better protect the local communities they serve.

[Verizon's Smart Cities solutions](#) help municipalities quickly and cost-effectively support initiatives for managing buildings, roadways, utilities and transportation systems. Using applications such as fleet and asset management, smart lighting, condition-based maintenance and smart grid technology – enabled by Verizon's network and cloud infrastructure – Verizon helps city planners develop sustainable platforms to use resources more efficiently. The goal is to help generate non-tax city revenue, create safer municipalities, engage constituents and promote urban renewal – all of which can attract businesses, residents and workers.



Verizon smart cities and Internet of Things resources:

- News article: [Verizon Accelerates Move to Smart and Sustainable Cities:](#)
- Video: [Verizon on Smart Cities](#)
- Webinar replay: [“The Art of Smart Cities”](#)
- Case study: [Building Smarter and Safer Communities](#)
- Case study: [Helping the City of Charlotte Envision a More Sustainable Future](#)
- Case study: [City of Napa Improves Visibility and Efficiency with Networkfleet](#)
- Infographic: [Moving to a Smarter City](#)
- News article: [Verizon Delivers Smart Energy As-A-Service](#)
- News article: [The Future of Smart Grid Technology](#)

On the Verizon website:

- [Verizon Smart Cities Solutions](#)
  - [Solutions for State & Local Government](#)
  - [Solutions for Public Safety Services](#)
- [Verizon Grid Wide Utility Solutions](#)



Cities have an abundance of data that has the potential to provide cost savings, improve citizen services and enhance quality of life. In addition to data from traditional administrative systems, they now have explosive emerging data sources, such as social media and the Internet of Things (IoT). Add to that expanding online services. All this data can fuel efficient and innovative city management – if cities can harness it.

Advance analytics has become a cornerstone of city management. SAS provides enterprise wide Advance Analytics platform for Big Data Analytics and Internet of things. SAS® Analytics has helped cities, states and countries worldwide improve citizen services, prevent losses from fraud, preserve natural resources, promote transportation alternatives, and more.

Additional information – [www.sas.com](http://www.sas.com)



### **When their world was shaken, the people of Nepal turned to IOM. And IOM turned to SAS.**

Data analysis is crucial to the level of response humanitarian organizations can provide. SAS is excited about helping IOM and other relief agencies understand what's possible when they modernize their approach to using analytics and respond positively to an event

[Watch the Video](#)

#### **Additional resources**

- 10 ways analytics can make cities smarter – White paper Video
- IDC Ranks SAS a Major Player in Worldwide Smart City Business Analytics
- Software – Press Release Video
- Smart Grid Analytics ROI to exceed \$121.8 billion globally by 2020 – Press Release Video
- SAS joins Envision America to help cities use analytics to save money and improve services and quality of life – Press Release
- Internet of Things – What it is and Why it matters – Insights
- Ensuring a safe and efficient transportation system – Solution Brief
- Making sense of stream data – Insights
- The Connected Vehicle: How Analytics Drive Telematics Value -- Video

## INTRODUCING SMART CITIES COUNCIL ASSOCIATE PARTNERS

Council Associate Partners are leaders in their sectors.  
Learn more about them on the pages that follow.

[ABB](#)

[Alphinat](#)

[SunGard Public Sector](#)

[CH<sup>2</sup>M](#)

[Imex Systems](#)

[Neptune Technology Group](#)

[Siemens](#)

[Enevo](#)

[OSisoft](#)

[Saudi Telecomm](#)

[Black & Veatch](#)

[Organic Energy Corp.](#)

[Urban Integrated Inc.](#)

[Space-Time Insight](#)

[Elster](#)

[Bit Stew Systems](#)

[Silver Spring Networks](#)

[Civic Resource Group International](#)

[Badger Meter](#)

[Entrigna](#)

[Apex CoVantage](#)

[Veolia](#)

[Intel](#)

[West Monroe Partners](#)

[Spire Metering](#)

[TROVE](#)

[K<sup>2</sup>Geospatial](#)

[Clevest](#)

Partners are listed according to the date they joined the Council; longest-standing members appear first.



ABB strongly supports the Smart Cities Council's goals of livability, workability and sustainability"

"Cities today are home to over <sup>50</sup> percent of the world's population and account for <sup>80</sup> percent of global GDP. By <sup>2050</sup>, an additional <sup>2.9</sup> billion people will be living in cities, and urban dwellers will represent <sup>70</sup> percent of the world's population. About <sup>90</sup> percent of this growth will be in developing economies as people are drawn to urban areas by the perceived economic advantages. These cities will need new and intelligent infrastructure to meet the needs of their citizens and businesses.

Other cities that are not facing dramatic population increases are setting goals to ensure their long-term prosperity. With businesses and workforce becoming increasingly mobile, they are shaping their futures around competitiveness, liveability and sustainability.

An effective way to support these city goals is by using technology to more intelligently monitor, optimize and control key systems and infrastructure. In other words, to operate as a 'smart city'.

Many intelligent power and automation solutions already exist to enable cities to automate their key public and industrial services in the areas of:

- City Communication Platforms
- Electricity Grids
- Water Networks
- Transport
- Buildings
- District Heating and Cooling

ABB's heritage in power and automation is one of continued innovation and delivery on behalf of our customers, spanning over <sup>125</sup> years. Our products and solutions are at the heart of a city's critical infrastructure, relied upon for everything from the supply of power, water and heat, to the automation of factories and the buildings we live and work in."

ABB Smart Cities portal: [Smart Cities >](#)

ABB Smart Grids portal: [Smart Grids >](#)



As a leading producer of smart technologies and services, Alphinat is pleased to contribute to the Smart Cities Council Readiness Guide and other materials to help accelerate the move to smart, sustainable cities.

Alphinat is a software editor of SmartGuide® the leading "one stop" Web, Mobile and Cloud Solution Development Platform that enable cities to easily create, deploy and manage intelligent personalized web applications.

With our partners we are looking to give client cities constituents a simpler user experience that can guide them to an optimal experience in a mobile or traditional browser-based environment. SmartGuide provides organizations and other software editors with the agility to quickly deliver efficient online services to their stakeholders unleashing the full value of existing IT assets. An Alphinat partner is delivering intelligent e-services for municipalities in the Netherlands in SaaS and on-premises modes incorporating SmartGuide® into their suite giving municipal clients the ability to quickly deploy intelligent online services. Citizens no longer need to fill in data already known to the government. Furthermore, these online services are accessible on Smartphone or tablets.

SmartGuide allows municipalities to deliver e-services with personalized, real time data exchange. With these intelligent e-services, municipalities greatly enhance the quality of their online service delivery and increase citizen satisfaction. The e-services offered automatically determine whether a citizen is entitled to a particular service such as a tax refund or a parking permit. These complex real-time validations delivered by the digital service bureau result in tremendous time savings for citizens and the community.

Alphinat technology can benefit city of all sizes by helping them modernize, automate and render cost-effective a many business processes at a fraction of the cost associated with conventional customized solutions. Alphinat is headquartered in Montreal, Quebec, with offices in Paris, New York and Zurich.

For more information, visit:

- [Alphinat website >](#)
- [Alphinate DGME case study >](#)

# SUNGARD® PUBLIC SECTOR

SunGard Public Sector is a leading provider of software and services for local governments, public safety and justice agencies and nonprofits. More than 150 million citizens in North America live in municipalities that rely on our products and services.

For more than 30 years, SunGard Public Sector has leveraged ground-breaking technology and our innate understanding of the needs of the public sector toward the development of public administration and public safety software. SunGard Public Sector's products enable our customers to experience the future happening today. Visit us online at [www.sungardps.com](http://www.sungardps.com).

SunGard Public Sector's software products not only enhance the way municipalities, public safety and justice agencies, and nonprofits conduct business – they redefine the way citizens and employees interact with government.

The City of Oviedo, Florida has been a SunGard Public Sector customer since 1995. In 2004, the city switched its implementation to SunGard Public Sector's Horizon Government Cloud, a powerful resource for local governments seeking to do more with less. Prior to switching to Horizon, the City of Oviedo found the cost of equipment, expertise and time to maintain their existing premise-based computer system challenging. When financial resources became limited, the city began seeking alternative solutions. The switch to Horizon has ultimately helped Oviedo become smarter with the way they do business. [Read more >](#)

Located just a few miles northeast of Atlanta, Johns Creek, Georgia can go an entire winter without seeing snow. But that changed in January 2014, when the entire Atlanta area was rattled by ice storms and heavy snow. To keep residents of Johns Creek apprised of the situation, the local police department started centrally distributing information through its Facebook and Twitter accounts on a regular basis. Johns Creek Police Department is a customer of SunGard Public Sector and a user of SunGard Converge Police to Citizen (P2C), which allows the department to share public information with citizens in a central way and lets citizens search police records and download reports. The proprietary P2C system, called JCPD4Me, is interoperable with social media platforms like Twitter and Facebook, which means that citizens can get this information and interact with the police department through the platforms they already know. [Read more >](#)

At CH2M, we naturally take pride in the projects we deliver, but we never forget what our work is really about: clean water to drink, affordable energy, sustainable cities for families now and in the future, more closely connected communities and so much more. Every project we take on is a chance to move the world forward one more step, and we think that's an incredible privilege.

We're excited by tough challenges — the tougher they are, the more excited we get. We love to take on our clients' most complex infrastructure and natural resource problems, turning them upside down and inside out, solving them in ways nobody has thought of before. Together, we create new pathways for human progress, breathing fresh life, energy and enterprise into every community we touch.

Our partners and clients include governments, cities and businesses in more than 50 countries. To meet their biggest engineering challenges, we tap deeply integrated capabilities across our organization — in transportation, water, environmental, nuclear, oil & gas, industrial and urban environments. And we draw on the exceptional skills and creativity of 25,000 teammates with an outstanding track record of expertly executing projects both big and small.

We love what we do, but we care just as much about how we work. Deep respect for our family of employees, our clients and the communities we serve guides us at every step. We aim to meet each day with integrity, an adventurous spirit, and dedication to the well-being of people in our lives and work.

Read all about some of our projects in these sectors:

- [Energy >](#)
- [Transit & Rail >](#)
- [Water >](#)



Neptune Technology Group Inc. is a pioneer in the development of automatic meter reading (AMR) and advanced metering infrastructure (AMI) technologies for more than 47 years.

Neptune has continually focused on the evolving needs of utilities – revenue optimization, operational efficiencies and improved customer service. The company offers a fully integrated migration path for its utility customers to meet their needs now and in the future.

Each utility has its own unique needs, based on size, geography, infrastructure and other factors. Neptune makes it a point to understand your specific needs so that we can offer a solution that suits you the best. That's how we strive to become your most valued partner.

Once we understand the challenges that your utility is facing, our people are trained to help you determine the best meter reading systems and tools that can be used to meet those needs, maximizing accuracy and efficiency while reducing costs and labor. And while providing for your present needs, Neptune helps utilities to always keep an eye toward the future not only with advanced technology but also with systems that allow for easy migration to adapt to changing requirements.

At Neptune, we have a rich history of innovation in meter reading systems on which we continue to build.

See/read about how Neptune is helping water utilities keep an eye on the future:

- [Indio Water Authority General Manager Brian Macy uses Neptune's R900 System to help reduce Non-Revenue Water](#)
- [Neptune Territory Manager Andy Bohn helped Indio Water Authority share data through all their department](#)
- [Read more about Indio as well as other case studies](#)

Learn more at: <https://www.neptunetg.com>



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Learn more at: <https://www.neptunetg.com>



The megatrends urbanization, climate change, globalization and demographic change will shape the future of cities. With the need to improve the quality of life and economic competitiveness, cities have to become more resource-efficient and environmentally friendly.

Technologies are major levers and base for further sustainable city development. An effective infrastructure contributes to economic prosperity, improving quality of life. Urban residents need clean air, potable water as well as security. They need efficient buildings, a reliable power grid and capable mobility solutions.

The complexity involved requires a holistic view and sustainable solutions for cities. Siemens has the portfolio, know-how and consulting expertise to make cities more livable, competitive and sustainable.

Infrastructure is the backbone of our economy. It moves people and goods, it powers our lives, it fuels growth. Across the world, more and more people are struggling with systems that are aging or overwhelmed. Siemens offerings include:

- Total integrated power solutions for safe, reliable, efficient power distribution
- Smart grid technologies that balance supply and demand, prevent power outages and integrate renewable power cost-effectively
- Integrated mobility solutions that move people and goods faster, safer and with fewer resources
- Smart building technologies that drive energy efficiency, reduce costs, and protect and secure all assets

[Siemens website >](#)

[Infrastructure & Cities Sector >](#)

Video: [Powering the Charge for Electric Cars](#)



Enevo is pleased to support the Smart Cities Council and contribute to its Readiness Guide.

Enevo brings together software and telecommunication engineers, data analysts, network gurus and seasoned waste management experts to create smart logistics optimizations solutions for the waste management and recycling industry. We help both commercial waste management companies and public organizations to operate more resource efficiently.

Until now collecting waste has been done using static routes and schedules where containers are collected every day or every week regardless if they are full or not. Our flagship solution Enevo ONE changes all this by using smart wireless sensors to gather fill-level data from waste containers. The service then automatically generates schedules and optimized routes which take into account an extensive set of parameters (future fill-level projections, truck availability, traffic information, road restrictions etc.). New schedules and routes are planned not only looking at the current situation, but considering the future outlook as well.

Collection based on Enevo's smart plans significantly reduces:

- Costs
- Emissions
- Road wear
- Vehicle wear
- Noise pollution
- Work hours

Enevo ONE provides organizations up to 50% in direct cost savings in waste logistics. And that's not all! Reducing the amount of overfull containers means less litter and happier customers! Enevo ONE provides a significant increase in efficiency across the whole value chain.

[Visit the Enevo website >](#)

[Learn more about Enevo ONE >](#)



OSIsoft provides an open infrastructure to connect sensor-based data, operations and people to enable real-time intelligence. The flagship product, the PI System, enables your organization to capture and leverage sensor-based data across the enterprise to improve efficiency, sustainability, quality and safety.

The PI System empowers organizations across a range of industries in activities such as exploration, extraction, production, generation, process and discrete manufacturing, distribution and services to leverage streaming data to optimize and enrich their businesses. For over thirty years, OSIsoft customers have embraced the PI System to deliver process, quality, energy, regulatory compliance, safety, security and asset health improvements across their operations. Founded in 1980, OSIsoft is a privately held company, headquartered in San Leandro, California, USA, with offices around the world.

“Sensor-based data is different and requires different approaches to manage and process before it can be used reliably, efficiently and continuously within big data analysis. Sensors can deliver continuous or fragmented time series data streams in immense volumes and high frequency. Whether batch processing or streaming sensor data for big data analytics, sensor data needs manipulation, indexing, aggregation, contextualization and governance before delivering to big data analytics engines. It’s essential to get this right otherwise the value of the data will be lost.”

Richard Beeson  
Chief Software Architect and CTO  
OSIsoft

Read the Gartner/OSIsoft white paper:

[Architecting an Industrial Sensor Data Platform for Big Data Analytics: Continued](#)

Additional resources:

- [City of Calgary: Using Data to Predict and Mitigate Floods](#)
- [JuiceBox Charging Solution Leverages Data from Connected EV Network for Smart Charging and Grid Optimization](#)
- [Itochu's Innovative Cloud-Based Services Connect Japan's New Energy Ecosystem](#)

[OSIsoft website >](#)



Saudi Telecom Company (STC) is the largest telecommunication services provider in the Middle East and North Africa. It is the leading operator within the Kingdom of Saudi Arabia, and its international presence extends to nine countries.

The company is working continuously to fulfill and satisfy the market requirements, keeping pace with the emerging technologies in the telecommunications sector and satisfying its customer's needs. STC has put in its consideration that this is the way to reinforce its position and identity in view of a changing world where the role and usage of telecommunications became more significant.

STC offers mobile, landline, television and Internet services. Its goals include becoming the next-generation leader in broadband.

Saudi Telecom Company is a member of the Telecom Council of Silicon Valley. The Council connects companies and individuals involved in the communications technology industry with one another for business development, collaboration and education. STC is the first telecom company in the Middle East to join the Council, which has over 100 member companies.

[Saudi Telecom website >](#)



Black & Veatch is an employee-owned, global leader in building critical human infrastructure in the Energy, Water, Telecommunications and Government Services sectors. Since 1915, we have helped our clients improve the lives of people in more than 100 countries through consulting, engineering, construction, operations and program management.

In keeping with our Building a world of difference® mission, Black & Veatch is committed to the innovation and adoption of advanced technology solutions to build more sustainable cities and communities. Black & Veatch is at the forefront of the movement toward smarter, more integrated infrastructure systems that extend beyond company and industry boundaries. We deliver new sources of value through the integration of distributed infrastructure, smart sensors, communications networks, automation systems, and big data and analytics. These Smart Integrated Infrastructure (SII) solutions increase system-wide intelligence to improve the efficiency, reliability and resiliency of the fundamental services we rely on every day.

Black & Veatch SII solutions for Smart Cities include:

- **Design & Construction:** In addition to engineering, procurement and construction (EPC) services for core Energy, Water and Telecom infrastructure, we provide EPC services for distributed infrastructure systems including stationary storage, Electric Vehicle (EV) charging stations, microgrids and distributed generation systems.
- **System Integration:** As consultant, program manager and integrator, we combine our own expertise with our world-class partner network to plan and implement turnkey smart city solutions.
- **Smart Analytics:** Leveraging our ASSET<sup>360</sup>™ analytics platform and third-party technologies, we provide community-scale data management and analytics solutions that enable integrated management of resources such as energy, water and gas.
- **Operations Support:** We help clients with the ongoing lifecycle management of their smart systems – maintaining overall performance and supporting individual community participant needs.

Learn more: [Smart Integrated Infrastructure](#)

Related links:

- [Peoria, Arizona - Butler Water Reclamation Facility](#)
- [Los Angeles: Echo Park Lake Rehabilitation](#)
- [SDG&E Sunrise PowerLink project](#)



Organic Energy Corporation is an advanced municipal solid waste (MSW) separation and re-purposing company. OEC specializes in maximizing the recovery and diversion of recyclables and resource feedstock from landfill bound MSW.

OEC currently holds five patents on the MaxDiverter™ sorting process and has numerous additional patents pending.

OEC is also the driving force and lead partner for EcoHub, an innovative collaboration of premier organizations working together to reclaim discarded resources to achieve a waste free society.

Using proven technology that has been organized and utilized in innovative ways, EcoHub allows for every piece of the waste stream to be collected using “one bin” and accurately sorted into separate resource categories. EcoHub’s manufacturing partners then re-pur-pose these resources into new, viable products (e.g., paper products, building products, natural gas, etc) that can be distributed to the local community – a true closed-loop solution for the world’s growing waste disposal problem.

With long-term access to the waste stream, OEC/EcoHub can help partner cities reduce costs, catalyze economic development and generate improved environmental outcomes.

[Learn more about Organic Energy Corporation >](#)

[Learn more about EcoHub >](#)



Urban Integrated Inc., part of The Urban Institute® group, is a leading software and consulting company for Smart City Solutions. In particular, [ui!] offers integrated cloud based services that bring together the various data sources across the city into one platform.

UrbanPulse consolidates and readies data from the various sources across the city into actionable intelligence, using big data analytics and algorithms for decision-making and automation. Users are the city government, businesses, utility providers and citizens. The solution is presented as an open cloud based platform and is available for others to build on top.

The Urban Institute was established in Germany to help cities define and realize their smart city strategies in line with the European Union directive Euro 2020, that foresees a 20% reduction in energy usage, 20% reduction in emissions, and a 20% increase in the use of renewables by 2020.

Making cities even smarter :

- [Urban Integrated website](#)
- [The Urban Institute website](#)
- [Case Study City of Darmstadt published by Microsoft](#)



Space-Time Insight helps asset-intensive organizations make faster, more-informed decisions. Our real-time visual analytics applications correlate, analyze, and visualize large volumes of business, operational and external data, spatially, over time and across network nodes. Our award-winning software powers mission-critical systems for some of the largest organizations around the world, helping them reliably, efficiently and economically deliver services and rapidly plan for and respond to a full range of operating events.

Space-Time Insight provides solutions for utilities and government, among others.

Utilities: Space-Time Insight's breakthrough situational intelligence applications for utilities provide unprecedented 360-degree operational and planning insight by correlating, analyzing and visualizing IT, OT and external 'XT' data sources spatially, over time and across network nodes. Our applications deliver greater capital and operational efficiency, safety, and reliability in a matter of months. Space-Time Insight's software helps some of the largest utilities around the world reduce costs, uncover revenue opportunities and deliver more reliable services to their customers. [Learn more >](#)

Government: Cities need a smarter way to work together across functional and organization divides to plan, justify, and allocate capital efficiently in support of building, operating, and maintaining the digital infrastructure of the Smart City. To deal with major events, either planned or unplanned, cities require a single, shared view of the situation they face. Space-Time Insight helps break down governmental organization and data silos by ingesting disparate data sources into its patented in-memory system, correlating the data across space, time, and node, and extracting the key information or events that become the basis for better, more informed decision making. [Learn more >](#)

[View video](#) about Space-Time Insight at Sacramento Municipal Utility District

Visit [spacetimeinsight.com](http://spacetimeinsight.com)



As the new hallmark for a more sustainable future, smart communities start with a smart grid. They are the heartbeat that powers the community's critical infrastructure and the foundation for enabling power, water, transportation, public safety and other services to function in harmonious, mutually supportive concert. And when it comes to smart grid, Elster provides the solutions needed to vitalize our communities by bringing smart meter data to the people and processes that depend on it.

With smart grid and AMI solutions, plus street and area lighting, Elster is a one-stop shop for smart community solutions and is helping public power utilities everywhere unlock the value of their meter data.

In an Elster-enabled smart community, power demand and consumption are automatically controlled to reduce peak demand. Smart sensors monitor and control streetlights based on brightness and time. Municipal broadband communications platforms underpin smart grid operations – and also provide the community with free Wi-Fi. Utilities proactively notify customers about leaks before they become a problem.

When communities are smart, energy intersects with traffic control, electric vehicles, solar power, security systems – the list has no limits. The result? Happier customers, improved system reliability, enhanced operational efficiency and better environmental sustainability.

This is the smart community future. And it's enabled by Elster – today.

Learn more about Elster:

[Elster Solutions website](#)

[Connexo: Simplifying the utility journey](#)

[Advanced Meter Fort Collins](#)

Videos:

[Transformer Optimization](#)

[Leak Detection](#)

[Nontechnical Loss](#)

[Outage Management](#)

[Smart Communities](#)



Bit Stew Systems is the creator of the market leading platform for Software Defined Operations for the Industrial Internet.

Bit Stew's revolutionary information processing engine, Mlx Core™ enables complex event processing, advanced analytics and sophisticated machine intelligence. The Mlx Core technology has proven scalability to provide end-to-end operational visibility for billions of connected devices and trillions of data points—making it the ideal platform for the Industrial Internet. This same Mlx Core technology can also be embedded in devices, gateways and routers for intelligence and automation directly at the edge of the network.

Bit Stew's flagship product solution, Grid Director™ is built on Mlx Core and designed specifically to meet the exacting demands of the utility industry. Grid Director offers customers complete visibility and control of their networks enabling more agile and informed decision-making that improves reliability, efficiency and performance. Grid Director provides real-time analytics, pattern recognition, dynamic event management and rapid integration across enterprise systems and applications.

Incorporated in 2009, Bit Stew Systems is a venture-backed private company that is headquartered in Canada with offices in the USA, Australia and Europe. Bit Stew was named on the Gartner Cool Vendors in Energy & Utilities list for 2014 and the Frost & Sullivan Entrepreneurial Company of the Year – North American Service Solutions for Utilities.

[Visit the Bit Stew Systems website >](#)



Silver Spring Networks is a leading networking platform and solutions provider for smart energy and smart city networks. Silver Spring's pioneering IPv6 networking platform, with more than 20 million Silver Spring enabled devices worldwide, is connecting critical infrastructure around the globe to help improve energy reliability, enable cities to provide better services to citizens, and unlock the next generation of applications for the Internet of Things.

Silver Spring's innovative solutions enable utilities and cities to gain operational efficiencies, improve grid reliability, and empower consumers and citizens. Silver Spring's major utility customers include Baltimore Gas & Electric, CitiPower & Powercor, Commonwealth Edison, CPS Energy, Florida Power & Light, Jemena Electricity Networks Limited, Pacific Gas & Electric, Pepco Holdings, Progress Energy and Singapore Power, among others.

Silver Spring connects smart city infrastructure in cities on 5 continents including Bristol, Chicago, Copenhagen, Glasgow, Melbourne, Miami, Paris, Sao Paulo, San Francisco, Singapore and Washington, D.C. Silver Spring is partnering with Florida Power & Light for the world's largest connected lighting project, nearly 500,000 networked street lights across South Florida.

Silver Spring's smart city platform helps municipalities deploy canopy networks connecting critical infrastructure assets such as public lighting and others. These intelligent lighting systems dramatically improve system reliability, increase energy efficiency, lower operational costs, and enhance citizen safety and quality of life. Silver Spring's open, standards-based network also enables cities to establish a platform for future smart city applications and services such as traffic management, environmental sensors, smart parking, electric vehicle charging, electricity metering, water conservation, and many others.

[Learn more at our website >](#)



[Civic Resource Group International's](#) mission – Fulfilling the Promise of Technology – is perfectly aligned with the Smart Cities Council's vision of "a world where digital technology and intelligent design have been harnessed to create smart, sustainable cities with high-quality living and high-quality jobs"

CRG International is one of the world's leading providers of digital government solutions. The company develops innovative, highly secure digital solutions built on CRG's flagship product [CivicConnect™](#), a first-of-a-kind fully integrated Mobile/Cloud/Data Platform delivered in a SaaS model (Software as a Service) for the broad public sector. With its major focus on the key "smart" sectors, such as public transportation, environmental/utilities, tourism/economic development, regional planning/MPOs and health care, CRG's work touches every facet of citizens' lives. The company's "Smart" Offering – CivicConnect combined with CRG's CivicConnect business-specific line of products such as "Smart City," "Water," "Traveler Relationship Management (TRM)," "Parking," "Geo-Social Mapping," CivicAR™ (Augmented Reality for Public Sector) and "Community," among others, have been developed to address fast-changing public sector needs resulting from the massive move to the emergence of the Internet of Things.

Since 2000, CRG has been "fulfilling the promise of technology" for clients in the broad public sector by leveraging the award-winning [CivicConnect™](#) Platform and deep domain expertise. CRG's impactful, engaging and cutting-edge products have a proven record of facilitating openness, transparency, safety and efficient service delivery for communities and their constituents. CRG is a new breed of company with a new approach, blending the best of technology, design and communications in the digital age to support Sustainable Communities, Efficient Public Services, Engaged Citizens and Overall Better Quality of Life.

In early 2015, CRG was named to CIOReview's [Top 20 Most Promising Government Technology Providers](#) list, recognizing CRG's role in leading the digital transformation of the broad public sector in both the U.S. and international markets.



Badger Meter's commitment to helping municipalities improve operational efficiency and conserve their precious resources makes supporting the Smart Cities Council a natural fit.

Badger Meter offers end-to-end solutions that help water utilities generate needed revenue, monitor and conserve their resources and help them better serve their valued end water customers. Industry-leading smart water solutions include a comprehensive mechanical and electronic metering line, proven AMR/AMI technology and the powerful analytics tools that truly help in Making Water Visible® for thousands of cities.

Badger Meter smart water solutions:

- Increase visibility of water consumption through tools like [BEACON® Advanced Metering Analytics](#), providing faster leak detection, revenue management, water conservation clarity, and easier data collection for compliance reporting.
- Enhance customer service for citizens through powerful apps that provide greater water usage visibility directly to their PCs, tablets and smartphones.
- Minimize deployment and system maintenance through a managed solutions approach that reduces required operational management of AMI and analytics, allowing water departments to do what they do best—delivering high quality water to customers.
- Future-proof technology by working with cities to ensure their water system design keeps pace with technology advancements for the long term.

Founded in Milwaukee, Wisconsin in 1905, Badger Meter has earned an international reputation as an innovator in flow measurement and control products, serving water utilities, municipalities, and commercial and industrial customers worldwide.

[Learn more about Badger Meter Water Utility Solutions.](#)



Entrigna's software enables cities to radically change the way they make real-time decisions. Entrigna is excited to support the Smart Cities Council and help contribute to building tomorrow's cities today. Our software sits squarely in the "crunch" function of a smart city.

With the infrastructure to collect and communicate data, tremendous opportunity exists to derive value from the data by making real-time decisions and taking immediate action without human intervention. Entrigna's software provides the smart city a central "brain" to enable this capability, which goes far beyond reports and dashboards.

The human brain processes data in real time from senses and memory and applies several techniques seamlessly in parallel and in series to make decisions and take an action – e.g. if it's Monday, then I will do xyz; if I have 10 items on my To-Do list, I will prioritize them in this order; based on similar prior experiences, I think xyz is the best decision. It's a complex and amazing process.

Just like a human brain, Entrigna's software can ingest data from a variety of sources streaming in real time. The data can be anything that is collected and communicated through the smart city infrastructure such as water meter reading, traffic conditions, geo location of an individual, data from wearable devices.

With maximum flexibility to combine in parallel and in series, decision frameworks are configured to make "brain-like" decisions. These frameworks automatically run in real time ('milliseconds') and do not require manual intervention by a person.

Mathematical and algorithmic techniques are leveraged to mimic a brain, such as a rules engine, complex event processing, optimization, regression, clustering/classification, natural language processing, machine learning and artificial intelligence.

Because of Entrigna software's unique design and architecture, implementation delivers a full set of functionality but at less than 50% of traditional timeliness and less than 50% traditional costs.

To learn more, please visit our website: [www.entrigna.com](http://www.entrigna.com).



Throughout the world, city leaders recognize LED lighting as the most efficient entry point on their journey to becoming a smarter city. Not only do LED lights deliver more than 50% in energy and operational savings, but this infrastructure upgrade can also provide a new network to support a wide range of smart city and smart grid applications, like enhanced public safety, air quality and traffic monitoring.

ProFieldLight, our award-winning mobile workforce management technology, helps ease the road to smart city implementation by effectively managing a variety of LED lighting initiatives. ProFieldLight ensures safety, reliability and on-time project completion so our customers reap the benefits of energy efficiency while protecting their bottom line.

No matter where you are on the road to Smart Cities, ProField® can light the way.

Visit: [Apex LED lighting solutions](#)



Around the globe, Veolia helps cities and industries to manage, optimize and make the most of their resources. The company provides an array of solutions related to water, energy and materials – with a focus on waste recovery – to promote the transition toward a circular economy.

Veolia's 187,000 employees are tasked with contributing directly to the sustainability performance of customers in the public and private sectors, allowing them to pursue development while protecting the environment.

To this end, the company designs and deploys specialist solutions to provide, protect and replenish resources while increasing their efficiency from an environmental, economic and social standpoint. Such initiatives are all part of Veolia's ongoing campaign to resource the world.

- [We turn waste into materials](#)
- [We work to save water and energy](#)
- [We work with municipalites around the world](#)

[Learn more at our website >](#)



Today the Internet of Things (IoT) has enormous potential to drive economic value and social change. But with 85% of things still unconnected and security threats pervasive, the industry has yet to tap IoT's enormous potential.

[The Intel® IoT Platform](#) breaks down these obstacles. It provides an end-to-end platform for connecting the unconnected – allowing data from billions of devices, sensors, and data bases to be securely gathered, exchanged, stored, and analyzed across multiple industries.

Once largely a PC-oriented company, Intel® increasingly provides the vital intelligence inside a wide range of devices, from the lowest-power mobile devices to the most powerful supercomputers in the world.

Since introducing the industry's first commercially available memory chips in 1969 and the first microprocessor in 1971, Intel makes hardware and software products that power the majority of the world's data centers, connect hundreds of millions of cellular handsets and help secure and protect computers, mobile devices and corporate and government IT systems. Intel technologies are also embedded in intelligent systems including for automobiles, digital signage, automated factories and medical devices.

Related resources:

[San Jose and Intel leverage IoT innovations](#)

[Smart Cities UK: Imperial College and Intel IoT Project](#)

[Urban Growth and Sustainability: Building Smart Cities with the Internet of Things](#)

[Pecan Street Project: Smart Grid and Internet of Things](#)



West Monroe Partners is an international, full-service business and technology consultancy focused on guiding organizations through projects that fundamentally transform their business.

With the experience to create the most ambitious visions as well as the skills to implement the smallest details of our clients' most critical projects, West Monroe Partners is a proven provider of growth and efficiency to large enterprises, as well as more nimble middle-market organizations.

Our consulting professionals – more than 550 and growing – drive better business results by harnessing our collective experience across a range of industries.

West Monroe Partners is dedicated to helping cities leverage technology and update their processes to transform how they serve their citizens, optimize their physical assets, and how they partner with their employees.

- [Learn about our work in Energy & Utilities](#)
- [Learn about our work in Healthcare](#)
- [Learn about our Advanced Analytics](#)

[Visit the West Monroe Partners website >](#)



Spire Metering Technology is a leading manufacturer and global provider of flow- and energy-management solutions. Through continuous innovation, we transform cutting-edge technologies into affordable, reliable and simple-to-use tools for accurate utility measurement. SpireMT's technological innovations help cities, governments and industry leaders preserve our precious natural resources.

Water and energy usage have a significant impact on communities around the world. SpireMT's meters and metering systems help regulate water and energy consumption in commercial and residential buildings, along with municipal and government facilities.

Thanks to SpireMT's diverse product line, our partners can rely on our technology to overcome the challenges of measuring a variety of fluid types, including water, oil, electricity and chemicals. Our products satisfy all their project needs, from flow measurement to energy measurement to wireless telemetry systems, AMR/AMI systems and billing software for instantaneous results. By utilizing SpireMT's solutions, our partners are empowered to responsibly manage their resources. SpireMT's comprehensive utility metering systems help to ensure tomorrow by measuring today.

Spire Metering Technology provides a wide variety of flowmeter products to meet the demanding requirements of several applications, including:

- [Water and wastewater](#)
- [Utility management](#)
- [Building automation](#)

[Learn more at our website >](#)



Around the globe, Veolia helps cities and industries to manage, optimize and make the most of their resources. The company provides an array of solutions related to water, energy and materials – with a focus on waste recovery – to promote the transition toward a circular economy.

Veolia's 187,000 employees are tasked with contributing directly to the sustainability performance of customers in the public and private sectors, allowing them to pursue development while protecting the environment.

To this end, the company designs and deploys specialist solutions to provide, protect and replenish resources while increasing their efficiency from an environmental, economic and social standpoint. Such initiatives are all part of Veolia's ongoing campaign to resource the world.

- [We turn waste into materials](#)
- [We work to save water and energy](#)
- [We work with municipalites around the world](#)

[Learn more at our website >](#)



Since 1995, K2 Geospatial has been committed to bringing spatial information and analysis tools within everyone's reach by developing software solutions that provide effective visual aids to decision-makers. K2's Map-Based Solutions connect, consolidate and publish data which are managed and stored in silos in different systems. Employees and citizens can then easily access the information, analyze it and have a real-time ability to decide.

These solutions are designed for land, infrastructures, buildings management as well as for environmental and public safety purposes. They are used by cities, regional governments, ports, airports, road authorities, railways, public utilities and natural resources companies.

K2's solutions are powered by JMap, a map-oriented integration platform designed to connect silos and offer easy-to-use interfaces dedicated to non-technical users. Furthermore, for software developers, JMap can be easily embedded in their existing solutions.

JMap is deployed and used by hundreds of organizations in North and South America as well as in Europe. Each day, thousands of employees and citizens from different organizations in different contexts and with different requirements, use JMap to access their spatial and non-spatial data (from GIS, databases, sensors, GPS, RFid, Web Services, videos, etc.) in order to get a global and a real-time overview of their operations.

With JMap, cities easily implement Spatially Smart Solutions which improves their operational and strategic decisions.

[Learn more about JMap >](#)

[Visit the K2 Geospatial website >](#)



At Clevest, we share the Smart City Council's vision of cities that are livable, workable and sustainable. As a leading provider of mobile workforce automation solutions for smart grid and smart city field operations, Clevest is proud to support and educate city leaders, planners and citizens in building sustainable cities.

Clevest provides the only complete solution for mobile workforce automation, smart grid and smart city operations exclusively for utilities and city operational departments. Over 150 customers worldwide have chosen Clevest to transform their field operations by harnessing the power of our software and deep domain knowledge of mobile computing and field operations.

We are specialists at enabling cities to transform their field operations by rapidly automating and optimizing field installation, operations and maintenance of new smart technologies. Our solutions improve worker and citizen safety, reduce the environmental impact of field work and increase operational efficiency to drive down the cost to serve citizens.

Clevest Smart City solutions are purpose-built for city operations departments to effectively deploy, operate and maintain new metering, monitoring and control, and network communications technologies within their smart city infrastructure. In the control room, our solution enables real-time insight to the location and status of field workers, trouble events and field work locations in the visual context of city infrastructure. This allows the quick identification of work to be completed, seamless appointment bookings, and the automatic scheduling and assignment of work. In the field, our streamlined workflows help field workers quickly complete work on a mobile device, view contextual data on maps and stay safe with support from nearby workers and alerts to the control room.

Clevest offers the complete solution for the smart city mobile workforce to help deploy, operate and maintain your smart city infrastructure.

[Learn more about Clevest](#)

[Learn more about our solutions](#)

# Smart Cities Council ADVISORY BOARD

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Architecture <sup>2030</sup>

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U.S. Green Building Council

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<sup>100</sup> Resilient Cities

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**Smart City strives to be citizen-centric, inclusive, economically viable, and sustainable that considerably reduces costs and resource use to offer better quality of life for the citizens and environmental conditions for today and generations to follow.**

**Published by**

**SmartCitiesCouncil India**  
Livability | Workability | Sustainability

A-303, Navbharat Estates, Zakaria Bunder Road,  
Sewri (West), Mumbai-400 015.

Tel: 022-2419 3000. Fax: 022-2417 5734.