भारतीय मानक
Indian Standard

IS 18010 (Part 5/Sec 1) : 2020

यूनिफाइड डिजिटल इन्फ्रास्ट्रक्चर यूनिफाइड लास्ट माइल कम्युनिकेशन प्रोटोकॉल स्टैक

भाग 5 नेटवर्क एक्सेस लेयर (IEEE 802.15.4)

अनुभाग 1 विशिष्टि

Unified Digital Infrastructure Unified Last Mile Communication Protocols Stack

Part 5 Network Access Layer (IEEE 802.15.4)

Section 1 Specification

ICS 35.100.10; 35.100.20

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Smart Infrastructure Sectional committee, LITD 28

FOREWORD

This Indian Standard was adopted by Bureau of Indian Standards on recommendation of the Smart Infrastructure Sectional Committee, and approval of the Electronics and Information Technology Division Council.

This standard is one of the series of Indian Standards on 'Last mile communication protocols'. Other standards published so far in the series are:

> Part 1 Unified digital infrastructure — Unified last mile communication protocols stack — Reference architecture (UDI – ULMCPS - RA)

The development of a series of standards for a unified digital infrastructure across the country was motivated by the smart cities initiative of Government of India. A defining feature of smart cities is the ability of various components and systems to function efficiently in an integrated manner as well as independently. A unified, smart, and secure digital infrastructure will facilitate efficient integration of various systems and applications/services across the city.

The Standard IS 18000 'Unified digital infrastructure ICT reference architecture (UDI – ICTRA)' (under development) defines a comprehensive ICT reference architecture for a resilient, secure and sustainable digital infrastructure for smart cities, districts, states or nations.

IS 18010 (Part 1) 'Unified last mile communication protocols stack — Reference architecture (ULMCPS RA)' is an integral part of the UDI – ICTRA and the reference architecture described in IS 18010 (Part 1) enables a seamless exchange of information among devices that operate using different communication technologies and deployed under different topologies.

This Standard establishes the network access layer of ULMCPS RA and specifies the physical and medium access control layers based on IEEE 802.15.4 – 2020 specifications customized to comply with Indian spectrum regulatory notifications in the de-licensed Sub GHz 865 – 867 MHz band.

The composition of the committee responsible for the formulation of this standard is given at Annex C.

0 INTRODUCTION

The rapid growth in communication technologies for last more than four-five decades has provided the users with multiple choices with their respective diversities and USPs for different applications and use cases. As a result, stakeholders of different ecosystems have chosen different technologies and protocols to meet their respective applications needs. In some cases, even different segmented stakeholders of a common ecosystem have developed/adopted different, communication technologies, protocols, data semantics and standards.

The siloed way of deploying the IoT/M2M infrastructure is not desirable and need was felt to have a harmonized **common last-mile communication architecture** approach. In a smart city scenario, to enable interoperability between divergent devices as well as applications while maintaining identity and access control, it is desirable to have common last-mile communication architecture. This will also ensure feasibility in the sharing of data with ensured security and privacy.

The unified last mile communication protocols stack reference architecture is an integral part of the unified digital infrastructure ICT reference architecture and it layouts the contours of unified communication for 'Smart City' and 'Digital Infrastructure'.

The key characteristic of "Last-Mile" communication technologies and their respective communication protocols defined as one of the principal constituents of the unified digital infrastructure reference architecture is the need to connect heterogeneous devices with heterogeneous applications while maintaining the necessary interoperability across all such devices (irrespective of the diversity in the PHY and Link-Layer Technologies) and offer a seamless view to the Applications. They should also allow connectivity to existing infrastructures and to the internet.

The ULMCPS reference architecture (Fig. 2) is derived from the well-established and globally accepted standard – the OSI Model (Fig. 1). The Standard OSI model has been improvised to ensure the multiple communication technologies can work in homogenous manner.

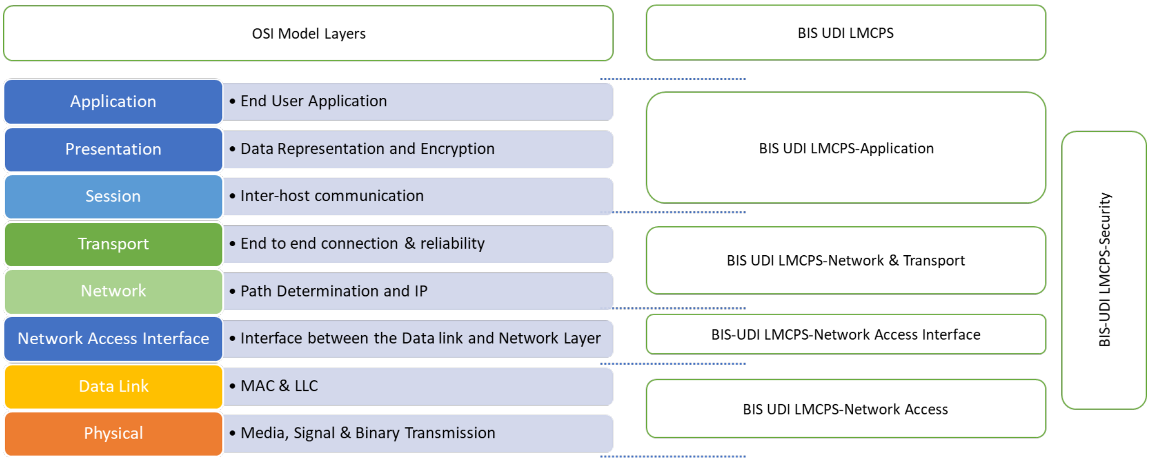

FIG. 1 REFERENCE PROTOCOL STACK

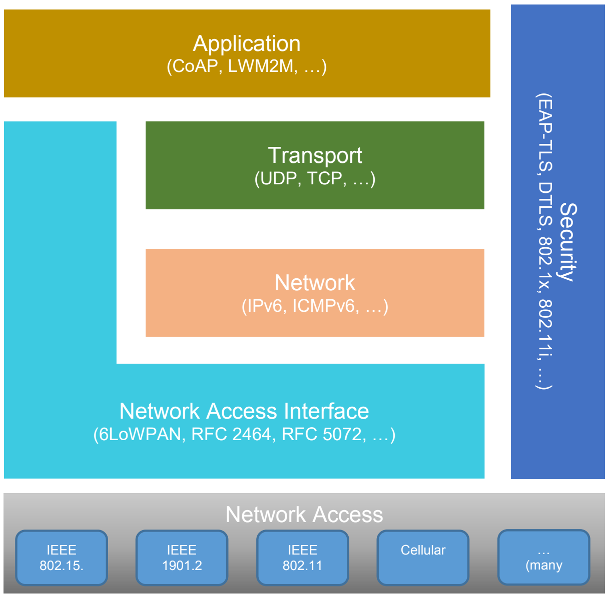

FIG. 2 ULMCPS REFERENCE ARCHITECTURE

This Standard establishes the network access layer of ULMCPS reference architecture and specifies the physical and medium access control layers based on IEEE 802.15.4 – 2020 specifications customized to comply with Indian spectrum regulatory notifications in the de-licensed Sub GHz 865 – 867 MHz band.

Indian Standard

UNIFIED DIGITAL INFRASTRUCTURE UNIFIED LAST MILE COMMUNICATION PROTOCOLS STACK

PART 5 NETWORK ACCESS LAYER (IEEE 802.15.4)

Section 1 Specification

1 SCOPE

1.1 This Standard (Part 5/Sec 1) establishes the network access layer of unified last mile communication protocol stack reference architecture (ULMCPS RA) and specifies requirements the physical layer and medium access control layer for the communication devices deployed in digital infrastructure.

1.2 This standard is based on IEEE 802.15.4 – 2020 and customized to comply with Indian spectrum regulatory notifications in the de-licensed Sub GHz 865 – 867 MHz band.

The current specification adds the SUN-FSK modulation schemes only. Other modulation schemes defined in IEEE 802.15.4 - 2020 may be considered in the future revisions of this standard based on the requirements.

1.3 This standard is applicable for constrained application with for low-data-rate wireless connectivity with fixed, portable, and moving devices with no battery or very limited battery consumption requirements.

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards:

IS No./Other Publications	*Title*
IS 18010-1	Unified digital infrastructure — Unified last mile communication protocols stack — Reference architecture
IEEE Std. 802.15.4™ - 2020	IEEE Standard for Low-Rate Wireless Personal Area Networks (WPANs)
EUI 64	Guidelines for 64-bit Global Identifier (EUI-64) Registration Authority
IEEE Std 802.15.9™ - 2016	IEEE Recommended Practice for Transport of Key Management Protocol (KMP) Datagrams

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 18000 and IS 18010 (Part 1) shall apply in addition to the following:

3.1 Digital Infrastructure Device — Different communication devices used in smart infrastructure. Like sensor nodes, gateway, relay nodes, etc.

3.2 LMCP Device — Communication device deployed in the digital infrastructure that achieves the last mile connectivity.

4 SYMBOLS AND ABBREVIATIONS

a)	CRC	Cyclic Redundancy Check
b)	FCS	Frame Check Sequence
c)	FEC	Forward Error Correction
d)	FHSS	Frequency Hopping Spread Spectrum
e)	FSK	Frequency Shift Keying
f)	PHR	PHY Header
g)	PHY	Physical Layer
h)	PPDU	PHY Protocol Data Unit
j)	PSDU	PHY Service Data Unit
k)	SUN	Smart Utility Network
m)	SFD	Start-of-frame Delimiter
n)	LMCP	Last Mile Communication Protocol
p)	LMCP-PHY	Last Mile Communication Protocol – Physical Layer

q) LMCP - NAL	Last Mile Communication Protocol – Network Access Layer
r) SHR	Synchronization Header. *See* [IEEE 802.15.4].
s) AR	Acknowledge Request. *See* [IEEE 802.15.4].
t) [MAC]	Medium Access and Control
s) MPDU	MAC Protocol Data Unit.
v) MSDU	MAC Service Data Unit.
w) SHR	Synchronization Header. *See* [IEEE 802.15.4].
y) PICS	Protocol implementation Conformance Statement

5 SUN FSK PHY LAYER SPECIFICATION

The PHY layer shall use Frequency Shift Keying (FSK) Modulation derived from the subset of IEEE Std. 802.15.4™ - 2020 SUN FSK PHY.

LMCP devices shall support the SUN FSK PHY. The Protocol implementation conformance statement (PICS) for the Physical Layer implementation is provided in ANNEX A.

5.1 PPDU Format

PPDU format shall be supported as described in Fig. 19-1 of section 19.2 of IEEE Std. 802.15.4™ - 2020, with the following configuration:

5.1.1 *Preamble Field*

The preamble pattern shall be as defined for 2-FSK in **19.2.3.1** of IEEE Std. 802.15.4™ - 2020.

The preamble shall be set to as shown in Table 1.

Table 1 Preamble Lengths per Operating Modes

(*Clause* 5.1.1)

Sl No.	Operating Modes	Preamble Length (Bytes)
(1)	(2)	(3)
i)	1	8
ii)	2	8
iii)	3	12

5.1.2 *SFD*

When FEC is disabled, the SFD shall contain the value specified for uncoded PHR + PSDU with phy Sun Fsk Sfd set to zero as described in Table 19-2 of **19.2.3.2** of IEEE Std. 802.15.4™ - 2020.

When FEC is enabled, the SFD shall contain the value specified for coded PHR + PSDU with phy Sun Fsk Sfd set to zero as described in Table 19-2 of **19.2.3.2** of IEEE Std. 802.15.4™ - 2020.

5.1.3 *PHR*

PHR format shall be as described in Fig. 19-4 of **19.2.4** of IEEE Std. 802.15.4™ - 2020. The fields of the PHR shall be set to the following as described below in this section.

The mode switch field shall be always set to zero upon transmission and ignored upon reception.

FCS shall be set to 4-octet, the FCS type field shall be set to 0. Packets received with the FCS field set to 1 may be discarded.

The data whitening field shall be set to 1 (data whitening enabled). Packets received with the data whitening field set to 0 shall be discarded.

The frame length field shall be set to as described in **19.2.4** of IEEE Std. 802.15.4™ - 2020.

All reserved fields shall be set to zero upon transmission and ignored upon reception.

5.2 FEC

FEC is optional and may be supported.

If FEC is supported, it shall be compatible with the non-recursive and nonsystematic code (NRNSC) as defined in **19.3.5** in IEEE Std. 802.15.4™ - 2020.

5.3 Modulation and Coding

The modulation for the FSK PHY shall be 2-level FSK. A device shall support operating mode # 1 and operating mode # 2 as described in Table 2. A device may additionally support operating mode #3 as described in Table 2.

5.3.1 *Symbol Rate and Modulation Index*

This section describes modulation and channel parameters for all the operating PHY modes supported with respective modulation index.

Table 2 PHY Operating Modes and Symbol Rates

(*Clauses* 5.3 *and* 5.3.1)

Sl No.	PHY Operating Modes	Symbol Rate (ksymbol/s)	Modulation Index
(1)	(2)	(3)	(4)
i)	Operating Mode # 1	50	0.5
ii)	Operating Mode # 2	100	0.5
iii)	Operating Mode # 3	150	0.5

5.3.2 *Frequency Bands and Channel Parameters*

The channel center frequency Chan Center Freq shall be as described in **10.1.3.9** of IEEE Std. 802.15.4™ - 2020 by the following formula:

Chan Cente Freq = Chan Center Freq 0 + (Num Chan × Chan Spacing)

Where Chan Center Freq 0 is the first channel center frequency in MHz, Chan Spacing is the separation between adjacent channels in kHz, Num Chan is the channel number from 0 to Total Num Chan – 1, and Total Num Chan is the total number of channels for the available frequency band. The parameters Chan Spacing, Total Num Chan, and Chan Center Freq 0 for different frequency bands and modulation schemes are specified in Table 3.

Table 3 PHY Operating Modes and Symbol Rates

(*Clause* 5.3.2)

Freq Band (MHz)	PHY Modes	ChanSpacing (kHz)	Total Num Chan	Chan Center Freq0 (MHz)
865-867	Operating Mode # 1	100	19	865.1
	Operating Mode # 2 and # 3	200	10	865.1

5.4 Data Whitening

Data whitening shall be performed as defined in **19.4** of IEEE Std. 802.15.4™ - 2020.

6 PHY Layer RF Requirements

6.1 Transmit Spectral Mask

The transmit spectral mask value shall be as defined in **19.6.6** of IEEE Std. 802.15.4™ - 2020.

6.2 Radio Specification

A node shall comply with the radio specifications as given in Table 4.

Table 4 Radio Specification

(*Clause* 6.2)

Radio Specification Parameter	Value	Section Reference in IEEE Std. 802.15.4™ - 2020
Transmit frequency tolerance	± 20 ppm	–
Transmit spectral mask/ACPR	As defined in 19.6.6 of IEEE Std. 802.15.4™ - 2020	19.6.6
Transmit deviation tolerance	± 30 percent	19.3.4.2
Transmit zero crossing deviation	± 12.5 percent	19.3.4.3
Adjacent channel rejection	10 dB	19.6.8
Alternate channel rejection	30 dB	
Minimum receiver sensitivity	As specified in **19.6.7**	19.6.7
Average symbol rate tolerance	± 100 ppm	–

7 MAC LAYER SPECIFICATION

The MAC sub-layer shall be constructed using data structures defined in IEEE Std. 802.15.4™ - 2020.

The MAC sub-layer shall operate in non-beacon enabled mode (no periodic beacon frames are defined) and hence, no contention free period exists. All channel access shall operate using contention access mode. The IEEE Std. 802.15.4™ - 2020 association procedures shall not be used. Short addressing is not within scope of this specification.

LMCP devices shall use EUI-64 based MAC address as defined in IEEE Std. 802.15.4™ - 2020. The data and enhanced acknowledge frames shall be used and extended with a set of information elements.

The protocol implementation conformance statement (PICS) for the media access layer implementation is provided in Annex B.

7.1 Constants

Table 5 contains definitions of constants used for the data link layer. The LMCP device shall use the constants with the values defined in Table 5.

Table 5 MAC Constants

(*Clause* 7.1)

Name	Description	Value
Broadcast address	Address which identifies all nodes within radio range.	Broadcast address value 0 × FFFF. FFFF. FFFF. FFFF
Response delay	For the any non ACK frame exchange pattern, the Response Delay is the time from the end of the last symbol of the previous frame to the start of the first symbol of the preamble of the subsequent frame, observed at the local antenna. Note this value applies for both secured and non-secured frames.	No sooner than 1 ms and no later than 5 ms
Tack	The time at which a frame acknowledgement shall be transmitted, measured from the time between reception of the last symbol of the received frame and transmission of the first symbol of the PPDU preamble of the response frame.	No sooner than 1 ms and no later than 5 ms

7.2 MAC PIB

Table 6 contains definitions of constants used for the data link layer.

Table 6 MAC PIB's

(*Clause* 7.2)

Name	Description	Value
Mac Extended Address	The extended address assigned to the device.	As per section **8.4.3** of IEEE Std. 802.15.4™ - 2020
Mac Max Be	The maximum value of the back off exponent, BE, in the CSMA-CA algorithm, as defined in Section **6.2.5.1** of IEEE Std. 802.15.4™ - 2015.	As per section **8.4.3** of IEEE Std. 802.15.4™ - 2020
Mac Max Csma Backoffs	The maximum number of backoffs the CSMA-CA algorithm will attempt before declaring a channel access failure.	As per section **8.4.3** of IEEE Std. 802.15.4™ - 2020
mac Max Frame Retries	The maximum number of retries allowed after a transmission failure.	As per section **8.4.3** of IEEE Std. 802.15.4™ - 2020
Mac Min Be	The minimum value of the backoff exponent (BE) in the CSMA-CA algorithm, as described in Section **6.2.5.1** of IEEE Std. 802.15.4™ - 2015.	As per section **8.4.3** of IEEE Std. 802.15.4™ - 2020
Mac Pan Id	The identifier of the PAN on which the device is operating. If this value is 0xffff, the device is not associated.	As per section **8.4.3** of IEEE Std. 802.15.4™ - 2020
Mac Security Enabled	Indication of whether the MAC sublayer has security enabled. A value of TRUE indicates that security is enabled, while a value of FALSE indicates that security is disabled.	TRUE, FALSE

7.3 Data Structures

7.3.1 *Frame Formats*

Only IEEE Std. 802.15.4™ - 2020 data and enhanced acknowledge frames shall be used. Other frame types SHOULD be discarded, and the node shall continue normal operation.

7.3.1.1 *Data frame*

All the frame exchange done from upper layer is done using data frame as defined in section **7.3.2** of IEEE Std. 802.15.4™ - 2020.

The data frame shall be formatted as illustrated in Fig. 3.

The addressing field shall be set as EUI-64 source or destination address as indicated in frame control field.

If the frame is sent as a secured frame, the Security field in the frame control field SHALL be set to 1, an auxiliary security header shall be included and security level, key Id mode, key source and key index fields shall echo the corresponding fields of the frame being acknowledged. *See* section **7.5** for further details.

IE field shall be populated if the IE Field is set to 1 in frame control filed. *See* section **7.4** for further details.

Data payload shall be set as it is received from the upper layer.

The FCS field shall be set to the 4-octet value as calculated in IEEE Std. 802.15.4™ - 2020.

The frame control field of the data frame shall be formatted as shown in Fig. 4.

Below are the values to be set of the individual fields:

a) Frame type field shall be set as 1 (data frame);
b) The security field MAY be set to either 1 or 0;
c) Frame pending field shall be set as 0;
d) The AR field MAY be set to either 1 or 0;
e) The PAN ID Compression field MAY be set to either 1 or 0;

Octets 2	0/1	Variable	6	Variable	Variable	4
Frame Control = (*see* Fig. 4)	Sequence Number	Addressing Fields = (*see* below)	AUX Security Header = (*see* below)	IEs = (*see* below)	Data Payload (*see* below)	FCS

Fig. 3 Data Frame Format

Frame Control										
Bit:0-2	3	4	5	6	7	8	9	10-11	12-13	14-15
Frame Type = 1	Security	Frame Pending = 0	AR = 1/0	PAN ID Compression = 1/0	Reserved = 0	Sequence Number Suppression = 1/0	IEs Present	Destination Addressing Mode = 3/0	Version = 2	Source Addressing Mode = 3/0

Fig. 4 Data Frame Control Format

f) The reserved field MAY be set to either 1 or 0;

g) The sequence number suppression field MAY be set to either 1 or 0;

h) The IE present field MAY be set to either 1 or 0.

j) The destination addressing mode shall be set to 3 if the source address is present otherwise set to 0;

k) Version field shall be set as 2; and

m) The source addressing mode shall be set to 3 if the source address is present otherwise set to 0.

7.3.1.2 *Acknowledgment frame*

The acknowledgment frame, when requested, is used to confirm frame reception.

The acknowledgement frame shall be formatted as an enhanced acknowledge defined in IEEE Std. 802.15.4™ - 2020 section **7.3.3** as shown in Fig. 5.

The destination address shall be set to the EUI-64 source address of the frame being acknowledged.

The source address field shall be set to the EUI-64 MAC address of the transmitting node.

The FCS field shall be set to the 4-octet value as calculated in IEEE Std. 802.15.4™ - 2020.

The frame control field of the acknowledgement frame shall be formatted as shown in Fig. 6.

If an acknowledgement frame is sent in response to a secured frame, the security field shall be set to 1, an auxiliary security header shall be included and security level, key Id mode, key source and key index fields shall echo the corresponding fields of the frame being acknowledged. *See* section **7.5** for further details.

If an acknowledgement frame is sent in response to a non-secured frame, the security field shall be set to 0 and the Auxiliary Security Header shall be omitted from the acknowledgement.

The sequence number suppression field shall echo the value from the frame being acknowledged. When present, the sequence number field shall echo the value from the frame being acknowledged.

7.3.2 *Bit Order of Transmissions*

Unless otherwise specified the following conventions shall be used in frame format descriptions in this standard. Frame format figures shall follow the conventions used in IEEE Std. 802.15.4™ - 2020.

Each frame is described as a specific sequence of fields depicted in the order in which they are transmitted by the PHY, from left to right, where the leftmost bit shall be transmitted first in time. Bits within each field are numbered from 0 (leftmost and least significant) to k – 1 (rightmost and most significant), where the length of the field is k bits. Fields that are longer than a single octet shall be sent to the PHY in the order from the octet containing the lowest numbered bits to the octet containing the highest numbered bits.

Character string values, when specified, are treated with left-to-right orientation. The octet containing the leftmost character shall be transmitted first.

Extended address values are 64-bit extended universal identifiers as defined in EUI64. The EUI-64 shall be transmitted in descending index order as depicted in EUI64, with eui[7] transmitted first and eui[0] transmitted last.

7.4 Information Elements

Several Information Elements (IEs) are to be support in the operation of this network. These IEs defined fall into two categories:

a) Header IEs (HIEs). MAC management information carried in the frame header; and

b) Payload IEs (PIE). MAC management information carried in the frame payload.

The choice of a management IE being implemented as a HIE or PIE is based on several factors: PIEs can be much longer than a HIE, PIEs can be secured as part of the payload content, etc.

In addition to the special defined Information Elements, the node employs the MPX-IE as defined in IEEE Std. 802.15.9™ - 2016 to support MSDU protocol dispatch and optional Layer 2 fragmentation (6LoWPAN fragmentation being mandatory).

Octets: 2	0/1	8	8	6	Variable	4
Frame Control = (*see* below figure)	Sequence Number = (*see* below)	Destination Address = (*see* below)	Source Address = (*see* below)	AUX Security Header = (*see* below)	IEs = (*see* below)	FCS

Fig. 5 Acknowledgement Frame Format

Frame Control										
Bit:0-2	3	4	5	6	7	8	9	10-11	12-13	14-15
Frame Type = 2	Security = (see below)	Frame Pending = 0	AR = 0	PAN ID Compression = 1	Reserved = 0	Sequence Number Suppression = (see below)	IEs Present = 1	Destination Addressing Mode = 3	Version = 2	Source Addressing Mode = 3

Fig. 6 Acknowledgement Frame Control Format

If an IE not defined by this specification is encountered in a frame, that IE MAY be ignored, and the rest of the frame shall be processed as normal including any additional IEs.

7.4.1 *Header Information Elements (HIEs)*

A HIE shall adhere to the format of the header information element described in **7.4.2.1** of IEEE Std. 802.15.4™ - 2020 (Fig. 7).

The Element ID field shall be set to the HIE Identifier value (0 × 2A).

The Type field shall be set to 0 (short).

The FAN defines the IE Content field as a HIE Sub ID field followed by a HIE Content field.

7.4.2 *Payload Information Elements (PIEs)*

A PIE shall adhere to the format of the MLME information element described in **7.4.3.3** of IEEE Std. 802.15.4™ - 2020 (Fig. 8).

The Group ID field shall be set to the PIE Identifier value (0 × 04).

A PIE MAY only contain one or more Nested-IEs defined in this clause. Each sub-IE shall conform to the long or short Nested-IE format defined in clause **7.4.4.1** of IEEE Std. 802.15.4™ - 2020.

7.5 Security

FAN nodes shall implement AES-CCM* based Frame Security as specified in section 9 of IEEE Std. 802.15.4™ - 2020.

7.5.1 *Auxiliary Security Header*

The auxiliary security header shall be encoded as described in section **9.4** of IEEE Std. 802.15.4™ - 2020 and shall be populated as follows:

a) *Security Control Field:*
   1) Security level shall be set to 6 (ENC-MIC-64);
   2) Key identifier mode shall be set to 0×01 (key indicated by the key index field); and
   3) Frame counter suppression shall be set to 0.

b) Frame counter shall be encoded as described in section **9** of IEEE Std. 802.15.4™ - 2020.

c) *Key identifier field*:
   1) Key source field shall be omitted; and
   2) Key index field is handled as per the upper layer.

The MAC Layer shall support multiple security keys handling as defined in section **9** of IEEE Std. 802.15.4™ - 2020

The border router signals the current active key index to be used for transmission/encryption *via* the key index field of the auxiliary security header of the PAN configuration frame (which the border router originates). Once the border router has transitioned to a new key index (likely due to the expiration of an older key), the border router shall not reuse that key index until the associated key material has been replaced.

7.5.2 *CCM* Nonce and Frame Counter*

The FAN uses AES-CCM* to secure frames. An input to the AES-CCM* calculation is the CCM* nonce, which is composed of the source address of the transmitter, the transmitter's frame counter for the specific key used, and the security level. The source address used in the nonce shall be in the octet order described in Annex C of IEEE Std. 802.15.4™ - 2020. To ensure replay protection, the CCM* nonce and therefore the frame counter value shall not be used more than once with a specific Key.

A node shall maintain a frame counter for each Key. The frame counter shall be set to 0 before the first use of the Key and shall be incremented with each unique transmission secured using the Key. If the frame counter saturates, the associated key shall not be further used.

7.6 Channel Access

Nodes shall operate in non-beacon mode.

Unslotted CSMA-CA and CCA Mode 1 shall be implemented (as described in IEEE Std. 802.15.4™-2020 sections **6.2.5.1** and 10.2.8 respectively).

The following channel access mechanisms shall be employed:

Octets: 2			1	Variable
Bit: 0-6	**7-14**	**15**		
Length	Element ID = 0 × 2A	Type = 0	WH-IE Sub ID	WH-IE Content

FIG. 7 HEADER IE FRAME FORMAT

Octets: 2			Variable	Variable	Variable
Bit: 0-10	**11-14**	**15**			
Length	Group ID = 0 × 04	Type = 1	First Nested Sub IE	Second Nested Sub IE	…

FIG. 8 PAYLOAD IE FRAME FORMAT

a) *Asynchronous Frame Transmissions*
   1) CSMA/CA shall not be used before asynchronous frame transmissions.
   2) CCA Mode 1 may be used before asynchronous frame transmissions. If CCA indicates a channel is busy, then the channel shall be skipped and the next channel in the frame transmission sequence attempted.

b) *Frame Transmissions*
   1) Upper layer to indicate details on weather CCA to be used or not before transmission of specific frame.

c) CSMA/CA and/or CCA shall not be used before acknowledgement frame transmissions.

d) *Broadcast Frame Transmissions*
   1) CSMA/CA shall be used with CCA mode 1 for all broadcast transmissions.

7.7 Frame Exchange Patterns

The following terms are used to describe the data exchange patterns supported by the FAN MAC.

7.7.1 *Received Frame*

A frame shall be considered "received" if the frame CRC is valid and (only when included in the frame) the frame destination address matches the EUI-64 of the receiving node. If secured, the security integrity check field of a received frame shall be validated as a prerequisite to any further processing by the MAC.

Following the transmission of a frame (assuming a single radio), a node shall adhere to the following priority channel listening scheme:

If the node had transmitted a frame requesting an ACK, the node shall continue to listen for the continuation of the ACK on the same channel as the transmission.

8 MARKING

8.1 Marking

The LMCP device shall be marked with the following information:

a) Manufacturer's name;
b) Operating frequency;
c) Modulation;
d) Data rate supported; and
e) Country of manufacture.

In case if the marking is not possible due to the size of the device or any other constraints, the marking shall be done on the package.

8.2 Standard Mark

The device may also be marked with the following additional information:

a) Address of the manufacturer; and
b) Trademark/trade name.

8.3 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

ANNEX A (PHY PICS)

(*Clause* 5)

The features and functionalities used in Physical layer shall be as given in **A-1** and **A-2**.

A-1 PLP CAPABILITIES

The requirement for the PLP is described below in Table 7.

Table 7 PHY Packet

(*Clause* A-1)

Item Number	Item Description	Reference	Support
PLP 1	Transmission of PPDU packets	11 of IEEE Std. 802.15.4™ - 2020	M
PLP 2	Reception of PPDU packets	11 of IEEE Std. 802.15.4™ - 2020	M
PLP3	PSDU size	11.2 of IEEE Std. 802.15.4™ - 2020	M

A-2 RF CAPABILITIES

The requirements for the PHY RF capabilities are described below in Table 8.

Table 8 Radio Frequency (RF)

(*Clause* A-2)

Item Number	Item Description	Reference	Support
RF 1	SUN PHYs		
RF 1.1	SUN-FSK	Clause 5	M
RF 1.3	Transmit and receive using CSM	10.1 of IEEE Std. 802.15.4™ - 2020	M
RF 2	SUN PHY operating modes		
RF 2.1	Operating mode #1 and #2 for the frequency bands 866 MHz in Table 3	Clause 5.3	M
RF 2.2	Operating mode #3 for the frequency bands 866 MHz in Table 3	Clause 5.3	O
RF 3	SUN-FSK Options		
RF 3.1	SUN-FSK FEC	19.3.5 of IEEE Std. 802.15.4™ - 2020	O
RF 3.2	SUN-FSK interleaving	19.3.6 of IEEE Std. 802.15.4™ - 2020	O
RF 3.3	SUN-FSK data whitening	19.4 of IEEE Std. 802.15.4™ - 2020	M
RF 3.4	FCS Length support for 4-octet	7.2.11 of IEEE Std. 802.15.4™ - 2020	M

ANNEX B (MAC PICS)

(*Clause* 7)

B-1 The details of the features and functionalities used in Media Access layer shall be as given below in Table 9.

Table 9 MAC Frames

(*Clause* B-1)

Item Number	Item Description	Reference	Support
MF 1	Data	7.3.2 of IEEE Std. 802.15.4™ - 2020	M
MF 2	Enhanced Acknowledgment	7.3.3 of IEEE Std. 802.15.4™ - 2020	M
MF 3	IEs	7.4 of IEEE Std. 802.15.4™ - 2020	M
MF 3.1	Header IE	7.4.2 of IEEE Std. 802.15.4™ - 2020	M
MF 3.2	Payload IE	7.4.3 of IEEE Std. 802.15.4™ - 2020	M

ANNEX C

(*Foreword*)

COMMITTEE COMPOSITION

Smart infrastructure Sectional Committee, LITD 28

Organization	*Representative(s)*
Indian Institute of Science, Bengaluru	Prof Bharadwaj Amrutur (***Chairman***)
Amravati Smart City Development Corporation Limited, Mumbai	Shri Siddharth Ganesh
ARM, Noida	Shri Kumaar Guhan
Centre for Development of Telematics, New Delhi	Shri Aurindam Bhattacharya Shrimati Anupama Chopra (*Alternate*)
Criterion Network Labs, Bengaluru	Shri Jayaprakash Kumar Shri Krishna Kumar Lohati (*Alternate*)
Cyan Connode Private Limited, Bengaluru	Shri Deepak Nimare Shri Manish Widhani (*Alternate*)
E-Goverments Foundation, Bengaluru	Shri Krishnakumar Thiagarajan
Ericsson India Private Limited, Gurugram	Shri Sendil Kumar Devar
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European Project SESEI	Shri Dinesh Chand Sharma
Hawlett Packard Enterprise	Shri R. Devarajan
IEEE India, Bengaluru	Shri Srikanth Chandrasekaran Shri Munir Mohammed (*Alternate*)
India Smart Grid Forum, New Delhi	Shri Reji Kumar Pillai Shrimati Parul (*Alternate*)
Indian Institute of Science, Bengaluru	Shri Vasanth Rajaraman
Intel India Technology Private Limited, Bengaluru	Shri C. Subramanian Shri Anantha Narayanan (*Alternate* I) Shri Sidhartha Mohanty (*Alternate* II)
Ministry of Housing and Urban Affairs, New Delhi	Shri Kunal Kumar
MoHUA Smart Cities Handholding team	Shri Padam Vijay
Narnix Technolabs Private Limited, New Delhi	Shri N. Kishor Narang
National Smart Grid Mission, Ministry of Power, Gurugram	Shri Mr Arun Misra Shri Gyan Prakash (*Alternate* I) Shrimati Kumud Wadhwa (*Alternate* II)
PHYTEC Embedded Private Limited, Bengaluru	Shri B. Vallab Rao (Vasu)
Pune Smart City, Pune	Shri Manojit Bose
Qualcomm India Private Limited, Bengaluru	Dr Vinosh Babu James Dr Punit Rathod (*Alternate*)

Organization	*Representative(s)*
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Schneider Electric's industrial software business-AVEVA, Mumbai	Shri Gourav Kumar Hada Shrimati Sangeeta Garg (*Alternate*)
Secure Meters Limited, Gurugram	Shri Anil Mehta Shri Puneet khurana (*Alternate* I) Shri Kaustubh Patil (*Alternate* II) Shri Uttam Kotdiya (*Alternate* III)
Shrama Technologies Private Limited	Shri Amarjeet Kumar
Siemens Limited, Mumbai	Shri Ravi Madipadga Shri Pradeep Kapoor (*Alternate* I) Shri Vikram Gandotra (*Alternate* II) Shri Manoj Belgaonkar (*Alternate* III)
Standardization Testing and Quality Certification (STQC)	Shrimati Lipika Kaushik
System Level Solutions (India) Private Limited, Anand	Shri Dipen Parmar Shri Foram Modi (*Alternate*)
Tata Consultancy Services Limited, Mumbai	Shri Ramesh Balaji Shri Debashis Mitra (*Alternate*)
Tejas Networks Limited, Bengaluru	Dr Kanwar Jit Singh
Telecommunication Engineering Center, Department of Telecommunications, New Delhi	Shri Rajeev Kumar Tyagi Shri Sushil Kumar (*Alternate* I) Shri Uttam Chand (*Alternate* II)
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Shri Manikandan K.
Scientist 'D' (Electronics and IT), BIS

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