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Izmenjava podatkov pri merjenju električne energije - Niz DLMS/COSEM - 8-7. del: PLC-profil z adaptivnim spektrom z več nosilnimi frekvencami za omrežja CX1

Electricity metering data exchange - The DLMS/COSEM suite - Part 8-7: The adaptive multi-carrier spread-spectrum PLC profile for CX1 networks

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Electricity metering data exchange - The DLMS/COSEM suite - Part 8-7: AMC-SS PLC communication profile for neighbourhood networks

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European Committee for Electrotechnical Standardization
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Europäisches Komitee für Elektrotechnische Normung

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Foreword

This document (CLC/TS 52056-8-7:2015) has been prepared by CLC/TC 13 "Electrical energy measurement and control".

The following date is fixed:

- latest date by which the existence of this document has to be announced at national level (doa) 2015-07-24

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1 Scope

This Technical Specification specifies the DLMS/COSEM communication profile using a compatibly-extendable form (CX1) of Adaptive Multi-Carrier Spread-Spectrum (AMC-SS) PLC for neighbourhood networks. Its structure is in line with the DLMS/COSEM framework as described in EN 62056-1-0[GK1].

The transport layer, the application layer and the data model are as specified in the EN 62056 DLMS/COSEM suite.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CLC/TS 50590:2015, *Electricity metering data exchange - Lower layer PLC profile using Adaptive Multi-Carrier Spread-Spectrum for CX1 networks*

EN 61334-4-32:1996, *Distribution automation using distribution line carrier systems – Part 4 : Data communication protocols – Section 32: Data link layer – Logical link control (LLC) (IEC 61334-4-32:1996)*

EN 61334-4-1:1996, *Distribution automation using distribution line carrier systems – Part 4 : Data communication protocols – Section 1: Reference model of the communication system (IEC 61334-4-1:1996)*

EN 62056-5-3, *Electricity metering data exchange – The DLMS/COSEM suite – Part 5-3: DLMS/COSEM application layer (IEC 62056-5-3)*

EN 62056-6-1, *Electricity metering data exchange – The DLMS/COSEM suite – Part 61: OBIS Object identification system (IEC 62056-6-1)*

EN 62056-6-2, *Electricity metering data exchange – The DLMS/COSEM suite – Part 62: Interface classes (IEC 62056-6-2)*

FprEN 62056-4-7:2014, *Electricity metering data exchange - The DLMS/COSEM suite – Part 4-7: DLMS/COSEM transport layer for IP networks (IEC 62056-4-7:201X, 13/1570/CDV)*

EN 62056-9-7:2013, *Electricity metering data exchange – The DLMS/COSEM Suite – Part 9-7: Communication profile for TCP-UDP/IP networks (IEC 62056-9-7:2013)*

RFC 2507 - IP Header Compression. Authors: M. Degermark, B. Nordgren, S. Pink. February 1999. Available from http://tools.ietf.org/html/rfc2507

Ipv4 TOS Byte and Ipv6 Traffic Class Octet http://www.iana.org/assignments/ipv4-tos-byte/ipv4-tos-byte.xml

3 Abbreviations

.cnf	.confirm (primitive)
.ind	.indication (primitive)
.req	.request (primitive)
.res	.response (primitive)
ACSE	Association Control Service Element
AL	Application Layer
AMC-SS	Adaptive Multi-Carrier Spread Spectrum
AP	Application Process
A-PDU	Application Protocol Data Unit
ASE	Application Service Element
CENELEC	European Committee for Electrotechnical Standardization
CIN	Channel Identification Number
CL	Convergence Sub-Layer
COSEM	Companion Specification for Energy Metering
CRC	Cyclic Redundancy Check
CX1	Compatibly Extendable form of AMC-SS PLC
D8PSK	Differential Eight-Phase Shift Keying
DBLMAX	Maximum Data Block Length
DBPSK	Differential Binary Phase Shift Keying
DID	Device Identifier
DL	Data Link
DLL	Data Link Layer (layer 2)
DLMS	Device Language Message Specification
DLS	Data Link Service
DP	Data Priority
DPSK	Differential Phase Shift Keying
DQPSK	Differential Quaternary Phase Shift Keying
DSAP	Destination Service Access Point
FEC	Forward Error Correction
HES	(Metering) Head End System
Hz	Hertz
IEC	International Electrotechnical Commission
IP	Internet Protocol
IPv4	Internet Protocol, version 4
IPv6	Internet Protocol, version 6
kHz	kilo Hertz
LA	Link Address
LCN	Link Channel Number
LLC	Logical Link Control (sub-layer)
L-SAP	Data Link Layer Service Access Point
LNAP	Local Network Access Point

MAC	Medium Access Control (sub-layer)
MPDU	MAC Protocol Data Unit
N_NIN	Network Identification Number of a network node
NIN	Network Identification Number
NN	Neighbourhood Network
NNAP	Neighbourhood Network Access Point
OBIS	OBject Identification System
OSI	Open System Interconnection
PDU	Protocol Data Unit
PHY	Physical
PLC	Power-Line Communications
PPDU	PHY Protocol Data Unit
SAP	Service Access Point
SDU	Service Data Unit
SSAP	Source Service Access Point
TCP	Transmission Control Protocol
xDLMS_ASE	extended DLMS Application Service Element

4 Targeted communication environments

The *DLMS/COSEM PLC AMC-SS communication profile* is intended for remote data exchange on Neighbourhood Networks (NN) between *Neighbourhood Network Access Points* (NNAP) and *Local Network Access Points* (LNAPs) or *End Devices* using AMC-SS technology over the low voltage electricity distribution network as a communication medium at the C interface. The functional reference architecture is shown in Figure 1.

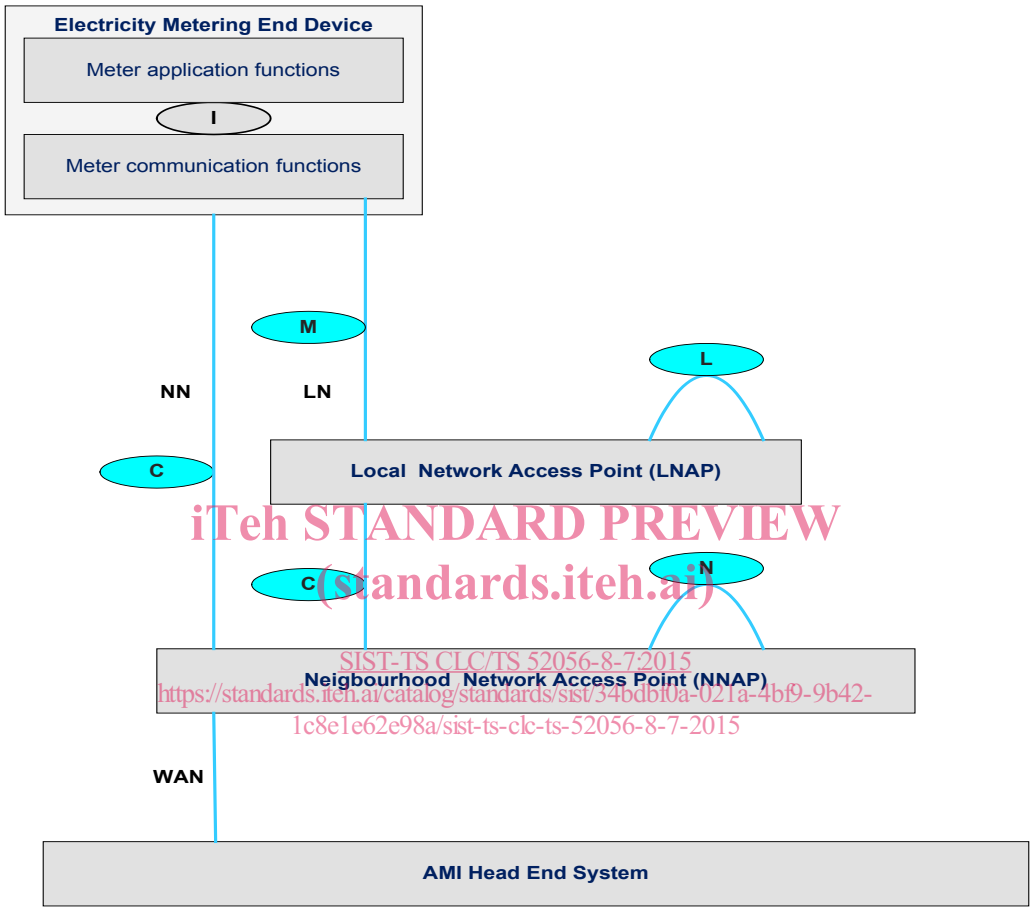

Figure 1 – Communication architecture

End devices – typically electricity meters – comprise application functions and communication functions. They may be connected directly to the NNAP via the C interface, or to an LNAP via an M interface, while the LNAP is connected to the NNAP via the C interface. The LNAP function may be co-located with the metering functions.

A NNAP comprises gateway functions and it may comprise concentrator functions. Upstream, it is connected to the Metering Head End System (HES) using suitable communication media and protocols.

End devices and LNAPs may communicate to different NNAPs, but to one NNAP only at a time. From the PLC communication point of view, the NNAP acts as the master node while end devices and LNAPs act as slave nodes.

NNAPs and similarly LNAPs may communicate to each other, but this is out of the scope of this specification, which covers the C interface only.

When the NNAP has concentrator functions, it acts as a DLMS/COSEM client. When the NNAP has gateway functionality only, then the HES plays the role of a DLMS/COSEM client. The end devices or the LNAPs play the role of DLMS/COSEM servers.

5 Reference model

The proposed protocol stacks use the following OSI layers as shown in Figure 2.

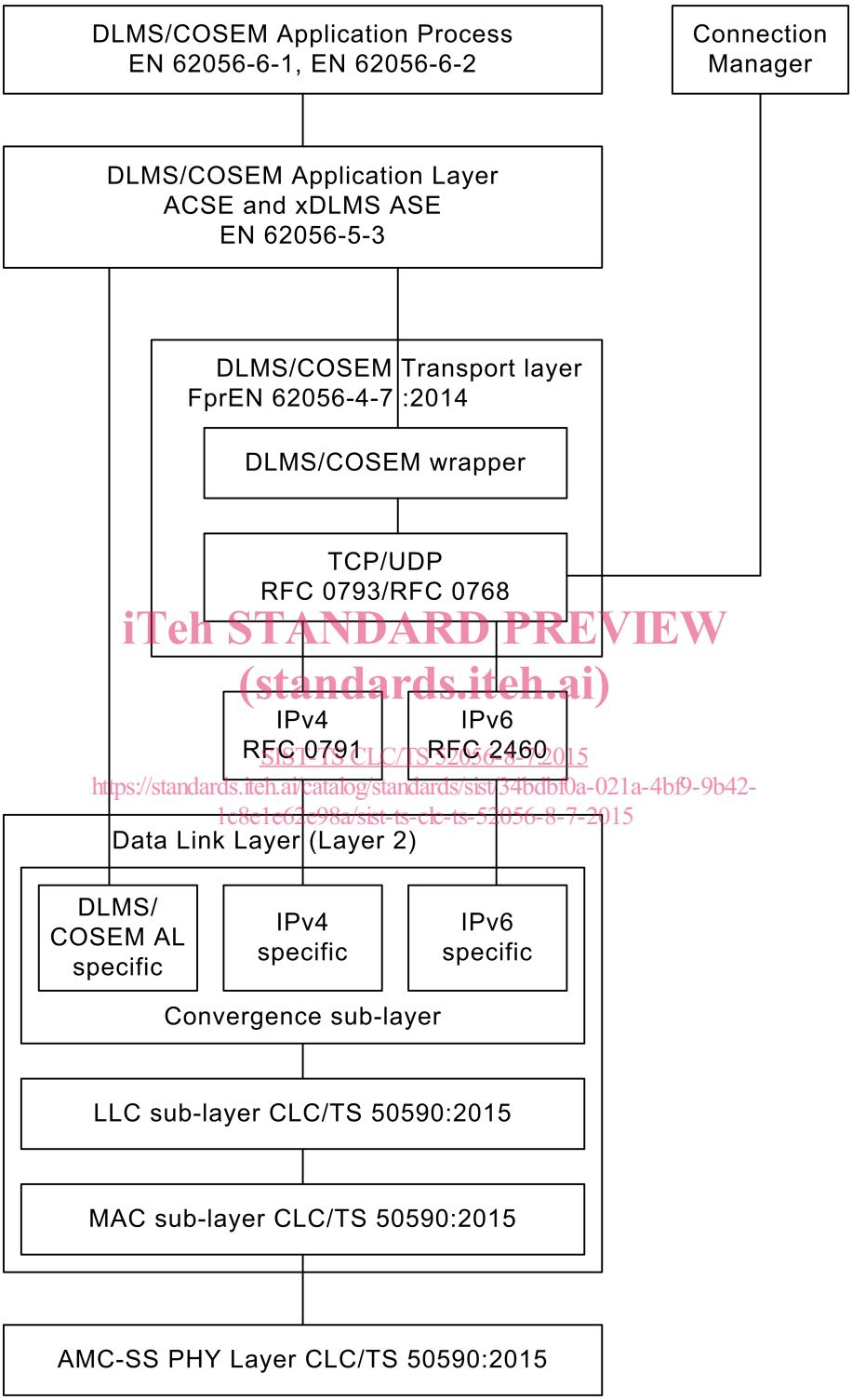

Figure 2 – DLMS/COSEM AMC-SS PLC architecture

The protocol layer are:

- the DLMS/COSEM data model as specified in EN 62056-6-1 and EN 62056-6-2;
- the DLMS/COSEM Application layer as specified in EN 62056-5-3 covering the Application, Presentation and Session functionalities;

- the DLMS/COSEM transport layer as specified in FprEN 62056-4-7:2014, used with the DLMS/COSEM TCP-UDP/IPv4 or TCP-UDP/IPv6 profile over AMC-SS, if IP transport is used;
- the IPv4 or the IPv6 network layer, if IP transport is used;
- the AMC-SS Data link layer, which consists of the Convergence, LLC and MAC sub-layers;
- the AMC-SS Physical layer.

NOTE The Physical layer and data link layer service primitives are specified in CLC/TS 50590[GK2].

6 Physical Layer (PHY)

6.1 Overview – main features and functions

This layer provides the interface between the equipment and the physical transmission medium that is the low-voltage distribution network. It transmits and receives MPDUs between neighbour nodes. The AMC-SS PHY uses a fast frequency-hopping spread spectrum technique combined with Differential Phase Shift Keying (DPSK) and forward error-correcting coding. Three differential modulation schemes are used: DBPSK, DQPSK and D8PSK. The system operates in the CENELEC A-band. This band covers the frequency range from 3 kHz up to 95 kHz. Frequencies in this band shall only be used for applications for monitoring or controlling the low-voltage distribution network, including energy usage of connected equipment and premises. A typical example of an application in this band would be metering communications.

This technique provides the following advantages:

- Robustness against time-frequency-selective fading;
- Robustness against pulse and narrowband interference, pulsating non-gaussian noise and combinations of them;
- Robustness against unwanted intermodulation effects;
- Low linearity requirements for the analogue front end;
- High power efficiency as a result of low peak to average ratio of the transmitted signal;
- Good electromagnetic compatibility between neighbouring systems.

The physical layer of AMC-SS is defined in Clause 5 of CLC/TS 50590:2015. The parameters of the physical layer are preconfigured.

6.2 PHY layer services

PHY services are generated by the MAC layer entity whenever data is to be transmitted to a peer MAC entity or entities, and passed to the PHY entity to request the sending of a PPDU to one or more remote PHY using the PHY transmission procedures. The primitives which are used between the MAC layer and the PHY layer are shown in Figure 3.

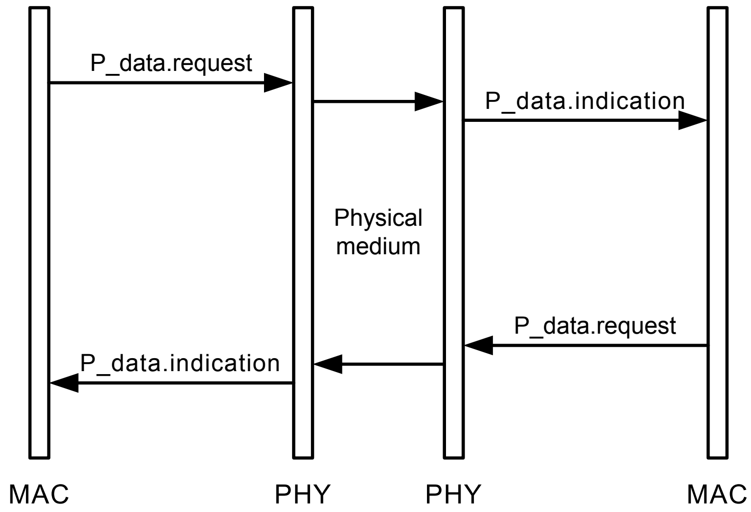

Figure 3 – Primitives between layer 2 and layer 1

The data, received from the MAC layer, is FEC-encoded. The encoded bit-sequence is segmented, interleaved, differentially encoded and mapped to the symbols and carrier frequencies.

7 Data Link Layer

7.1 Functions and structure

The Data Link Layer of AMC-SS provides a point to multi-point and point to point communication on the low voltage distribution network between a master node and one or more slave nodes. It contains three sub-layers:

- the Medium Access Control sub-layer;
- the Logical Link Control sub-layer;
- the Convergence sub-layer.

The structure of the Data Link Layer is shown in Figure 4.

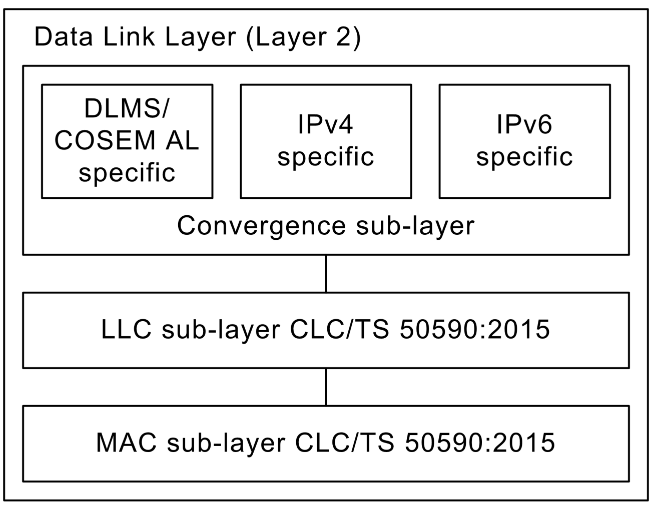

Figure 4 – Structure of Data Link Layer

Layer 2 services are used by the higher layer entity whenever data is to be transmitted to a peer entity or entities, and passed to the layer 2 entity to request the sending of a MPDU to one or more remote entities. The transmission of data is initiated with a CL_data.request primitive or CL_IPv4_data.request primitive (in the case of IPv4) or CL_IPv6_data.request primitive (in the case of IPv6). The success or failure of the transmission is locally indicated