DIN EN IEC 62056-8-4

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Datenkommunikation der elektrischen Energiemessung – DLMS/COSEM – Teil 8-4: Kommunikationsprofile für Schmalband-OFDM-PLC-PRIME-Nachbarschaftsnetzwerke (IEC 62056-8-4:2018); Englische Fassung EN IEC 62056-8-4:2019

Electricity metering data exchange –
the DLMS/COSEM suite –
Part 8-4: Communication profiles for narrow-band OFDM PLC PRIME neighbourhood networks
(IEC 62056-8-4:2018);
English version EN IEC 62056-8-4:2019

Échange des données de comptage de l'électricité –
la suite DLMS/COSEM –
Partie 8-4: Profils de communication pour réseaux de voisinage OFDM PLC PRIME à bande étroite
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Anwendungsbeginn

Anwendungsbeginn für die von CENELEC am 2019-01-17 angenommene Europäische Norm als DIN-Norm ist 2020-05-01.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN EN 62056-8-4:2018-03.

Für dieses Dokument ist das nationale Arbeitsgremium K 461 „Messeinrichtungen und -systeme für Elektrizität“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE (www.dke.de) zuständig.

Die enthaltene IEC-Publikation wurde vom TC 13 „Electrical energy measurement and control“ erarbeitet.

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Der Zusammenhang der zitierten Dokumente mit den entsprechenden deutschen Dokumenten ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

Das Präsidium des DIN hat mit Präsidialbeschluss 1/2004 festgelegt, dass DIN-Normen, deren Inhalt sich auf internationale Arbeitsergebnisse der Informationsverarbeitung gründet, unter bestimmten Bedingungen allein in englischer Sprache veröffentlicht werden dürfen. Diese Bedingungen sind für die vorliegende Norm erfüllt.

Da sich die Benutzer der vorliegenden Norm der englischen Sprache als Fachsprache bedienen, wird die Englische Fassung der EN IEC 62056-8-4 veröffentlicht. Zu deren Abschnitt 1, der den Anwendungsbereich festlegt, Abschnitt 3, der die Begriffe und Abkürzungen festlegt und Abschnitt 4, der die betroffenen Kommunikationsumgebungen festlegt, wurde eine Übersetzung angefertigt und als informativer Nationaler Anhang NA der vorliegenden Norm hinzugefügt. Für die meisten der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Das Original-Dokument enthält Bilder in Farbe, die in der Papierversion in einer Graustufen-Darstellung wiedergegeben werden. Elektronische Versionen dieses Dokuments enthalten die Bilder in der originalen Farbdarstellung.

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Nationaler Anhang NA
(informativ)

Auszugsweise Übersetzung

Reihenfolge und Inhalt der folgenden Abschnitte sind identisch mit denen in den jeweiligen Abschnitten der Englischen Fassung.

1 Anwendungsbereich

Dieser Teil von IEC 62056 legt DLMS/COSEM-Kommunikationsprofile für Schmalband-OFDM-PRIME-Nachbarschaftsnetzwerke mit Trägerfrequenzübertragung auf Hochspannungsleitungen unter Verwendung der in Recommendation ITU-T G.9904:2012 festgelegten Modulation fest.

Es werden drei Kommunikationsprofile festgelegt:

- ein Profil, das die LLC-Schicht nach IEC 61334-4-32 verwendet;
- ein Profil, das TCP-UDP/IPv4 verwendet;
- ein Profil, das TCP-UDP/IPv6 verwendet.

3 Begriffe und Abkürzungen

3.1 Begriffe

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

ISO und IEC stellen terminologische Datenbanken für die Verwendung in der Normung unter den folgenden Adressen bereit:

– IEC Electropedia: verfügbar unter http://www.electropedia.org/

– ISO Online Browsing Platform: verfügbar unter http://www.iso.org/obp

ANMERKUNG Siehe auch Recommendation ITU-T G.9904:2012.

3.1.1
Basisknoten
Masterknoten, der die Ressourcen eines Teilnetzes steuert und verwaltet

3.1.2
Registrierung
Prozess, durch den ein Dienstknoten als Teilnehmer des Teilnetzes akzeptiert und ihm eine LNID zugewiesen wird

3.1.3
Dienstknoten
jeder Knoten eines Teilnetzes, der kein Basisknoten ist

3.1.4
Registrierungsaufhebung
Prozess, durch den ein Dienstknoten ein Teilnetz verlässt

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3.2 Abkürzungen

Abkürzungen	Übersetzung	Englischer Begriff
AA	Anwendungsassoziation	(en: Application Association)
AARE	A-Associate-Antwort	(en: Application Association Response)
AARQ	A-Associate-Anforderung	(en: Application Association Request)
ACSE	Anwendungssteuerungs-Dienstelement	(en: Application Control Service Element)
AL	Anwendungsschicht	(en: Application Layer)
AP	Anwendungsprozess	(en: Application Process)
APDU	Protokolldateneinheit der Anwendungsschicht	(en: Application Protocol Data Unit)
ARQ	automatische Wiederholungsanfrage	(en: Automatic Repeat Request)
CL	Konvergenzschicht	(en: Convergence Layer)
.cnf	Bestätigungs-Dienstprimitiv	(en: Confirm service primitive)
COSEM	Begleitspezifikation für die Energiemessung	(en: Companion Specification for Energy Metering)
CPCS	gemeinsamer Teil der Konvergenzteilschicht	(en: Common Part Convergence Sublayer)
CSMA/CA	Carrier Sense Multiple Access mit Kollisionsvermeidung	(en: Carrier Sense Multiple Access – Collision Avoidance)
D8PSK	differentielle Achtphasenumtastung	(en: Differential Eight-Phase Shift Keying)
DBPSK	differentielle binäre Phasenumtastung	(en: Differential Binary Phase Shift Keying)
DGW	Standardgateway	(en: Default Gateway)
DHCP	dynamisches Konfigurations-Protokoll	(en: Dynamic Host Configuration Protocol)
DLMS	Device Language Message Specification	(en: Device Language Message Specification)
DQPSK	differentielle Quadraturphasenumtastung	(en: Differential Quaternary Phase Shift Keying)
EUI-48	Erweiterte eindeutige Kennung mit einer Länge von 48 Bit	(en: 48-bit Extended Unique Identifier)
FU	Firmware-Upgrade	(en: Firmware Upgrade)
FW	Firmware	(en: Firmware)
IANA	Internet Assigned Numbers Authority	(en: Internet Assigned Numbers Authority)
IGMP	Internet-Gruppenmanagementprotokoll	(en: Internet Group Management Protocol)
.ind	Anzeige-Dienstprimitiv	(en: Indication service primitive)
IP	Internetprotokoll	(en: Internet Protocol)
IPv4	Internetprotokoll, Version 4	(en: Internet Protocol, version 4)
IPv6	Internetprotokoll, Version 6	(en: Internet Protocol, version 6)

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LCID	lokale Verbindungskennung	(en: Local Connection Identifier)
LD	logisches Gerät	(en: Logical Device)
LLC	logische Verknüpfungssteuerung (Teilschicht)	(en: Logical Link Control (sub-layer))
LNID	lokale Knotenkennung	(en: Local Node Identifier)
MAC	Steuerung für Mediumzugriff, MAC-Teilschicht-Einheit	(en: Medium Access Control, MAC sublayer entity
MLME	MAC-Schicht-Managementeinheit	(en: MAC Layer Management Entity)
MPDU	MAC-Protokolldateneinheit	(en: MAC Protocol Data Unit)
NAT	Netzwerkadressübersetzung	(en: Network Address Translation)
NHC	Kompression des nächsten Headers	(en: Next Header Compression)
NL	Rauschpegel	(en: Noise Level)
OBIS	Objektidentifikationssystem	(en: Object Identification System)
OFDM	orthogonales Frequenzmultiplexverfahren	(en: Orthogonal Frequency Division Multiplexing)
OSI	Kommunikation offener Systeme	(en: Open System Interconnection)
PHY	Einheit der Bitübertragungsschicht	(en: Physical Layer entity)
PLC	Kommunikation über Energieleitungen	(en: Power Line Communication)
PIB	PLC-Informationsdatenbank	(en: PLC Information Base)
PLME	Managementeinheit der Bitübertragungsschicht	(en: Physical Layer Management Entity)
PPDU	Protokolldateneinheit der Bitübertragungsschicht	(en: PHY Protocol Data Unit)
.req	Anforderungs-Dienstprimitiv	(en: Request service primitive)
RFC	Request for Comment	(en: Request For Comment)
.rsp	Antwort-Dienstprimitiv	(en: Response service primitive)
SDU	Dienstdateneinheit	(en: Service Data Unit)
SID	Schalterkennung	(en: Switch Identifier)
SNA	Teilnetzadresse	(en: Subnetwork Address)
SNR	Signal-Rausch-Verhältnis	(en: Signal-to-Noise Ratio)
SSCS	dienstspezifische Konvergenzteilschicht	(en: Service Specific Convergence Sublayer)
TCP	Übertragungssteuerungsprotokoll	(en: Transmission Control Protocol)
TOS	Dienstart	(en: Type Of Service)
UDP	Benutzer-Datagramm-Protokoll	(en: User Datagram Protocol)
xDLMS_ASE	erweitertes DLMS-Anwendungsdienstelement	(en: extended DLMS Application Service Element)
ZCT	Nulldurchgangs-Zeitpunkt	(en: Zero Crossing Time)

4 Betroffene Kommunikationsumgebungen

Die DLMS/COSEM-Kommunikationsprofile für Schmalband-OFDM-PLC-PRIME-Nachbarschaftsnetzwerke sind für den Datenfernaustausch in Nachbarschaftsnetzwerken (en: neighbourhood network; NN) zwischen Nachbarschaftsnetzwerk-Zugangspunkten (en: neighbourhood network access point; NNAP) und Zugangspunkten zum lokalen Netzwerk (en: local network access point; LNAP) oder Endgeräten mit OFDM-PLC-

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Technik über das Niederspannungs-Elektrizitätsverteilungsnetz als Kommunikationsmedium vorgesehen. Die funktionale Referenzarchitektur ist in Bild 1 dargestellt.

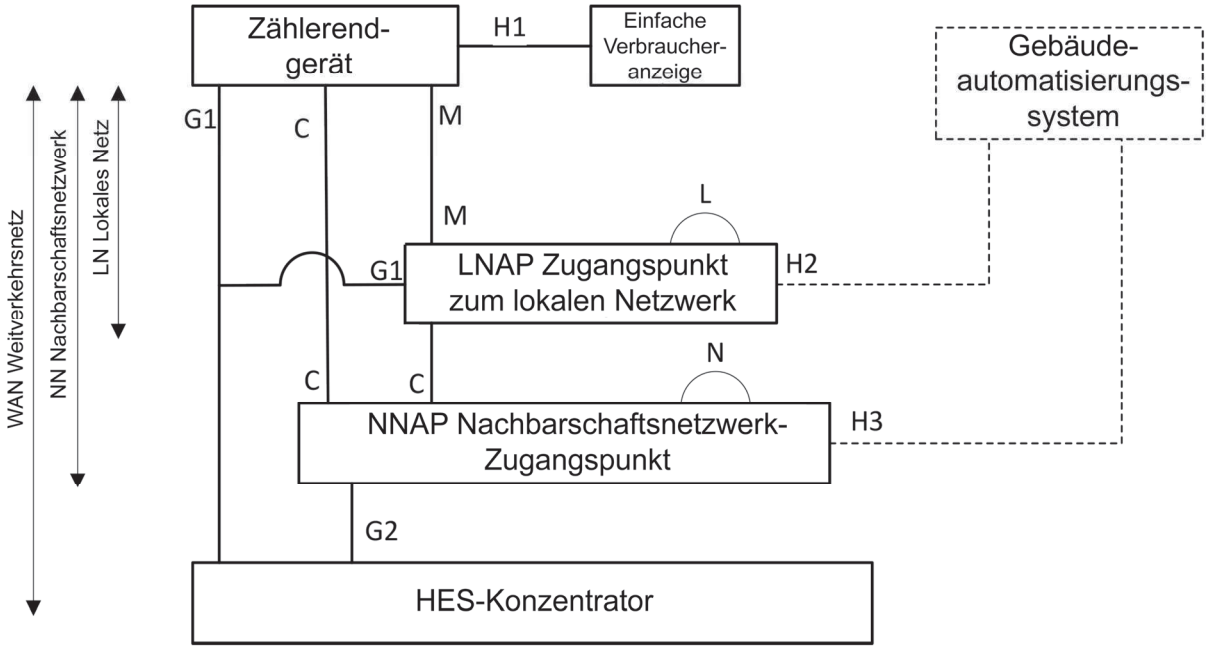


Bild 1 – Kommunikationsarchitektur

Die Endgeräte – üblicherweise Elektrizitätszähler – sind mit Anwendungsfunktionen und Kommunikationsfunktionen ausgestattet. Sie dürfen entweder direkt über die Schnittstelle C mit dem NNAP oder über eine Schnittstelle M mit einem LNAP verbunden werden, wobei der LNAP über die Schnittstelle C mit dem NNAP verbunden wird. Die LNAP-Funktion darf in die Messfunktionen integriert sein.

Ein NNAP umfasst Gatewayfunktionen und darf Konzentratorfunktionen übernehmen. In Aufwärtsrichtung ist er über geeignete Kommunikationsmedien und -protokolle mit dem Zähler-Konzentrator (en: head end system; HES) verbunden.

Endgeräte und LNAPs dürfen mit verschiedenen NNAPs kommunizieren, jedoch nicht zeitgleich mit mehreren NNAPs. Aus Sicht der PLC-Kommunikation fungiert der NNAP als Basisknoten, während Endgeräte und LNAPs als Dienstknoten fungieren.

NNAPs und auch LNAPs dürfen miteinander kommunizieren, dies fällt jedoch nicht in den Anwendungsbereich dieses Dokuments, welches nur die Schnittstelle C behandelt.

Wenn der NNAP Konzentratorfunktionen übernimmt, fungiert er als DLMS/COSEM-Client. Wenn der NNAP nur die Gatewayfunktion übernimmt, so fällt die Rolle des DLMS/COSEM-Clients dem HES zu. Die Endgeräte oder die LNAPs übernehmen die Rolle von DLMS/COSEM-Servern.

Auch eine gemischte Architektur ist möglich, sowohl der HES als auch der NNAP können also als Client fungieren.

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NORME EUROPÉENNE

EUROPÄISCHE NORM

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English Version

Electricity metering data exchange - the DLMS/COSEM suite - Part 8-4: Communication profiles for narrow-band OFDM PLC PRIME neighbourhood networks (IEC 62056-8-4:2018)

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Datenkommunikation der elektrischen Energiemessung - DLMS/COSEM - Teil 8-4: Kommunikationsprofile für Schmalband-OFDM-PLC-PRIME-Nachbarschaftsnetzwerke (IEC 62056-8-4:2018)

This European Standard was approved by CENELEC on 2019-01-17. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the respons bility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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European foreword

The text of document 13/1749/CDV, future edition 1 of IEC 62056-8-4, prepared by IEC/TC 13 "Electrical energy measurement and control" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62056-8-4:2019.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2019-10-17
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2022-01-17

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 62056-8-4:2018 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 61334-4-1:1996	NOTE	Harmonized as EN 61334-4-1:1996 (not modified)

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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 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)	EN 61334-4-32	1996
IEC 61334-4-511	2000	Distribution automation using distribution line carrier systems – Part 4-511: Data communication protocols – Systems management – CIASE protocol	EN 61334-4-511	2000
IEC 62056-1-0	–	Electricity metering data exchange – The DLMS/COSEM suite – Part 1-0: Smart metering standardisation framework	EN 62056-1-0	-
IEC/TS 62056-1-1	–	Electricity metering data exchange – The DLMS/COSEM suite – Part 1-1: Template for DLMS/COSEM communication profile standards	-	-
IEC 62056-4-7	2015	Electricity metering data exchange – The DLMS/COSEM suite – Part 4-7: DLMS/COSEM transport layer for IP networks	EN 62056-4-7	2016
IEC 62056-5-3	2017	Electricity metering data exchange – The DLMS/COSEM suite – Part 5-3: DLMS/COSEM application layer	EN 62056-5-3	2017
IEC 62056-6-1	–	Electricity metering data exchange – The DLMS/COSEM suite – Part 6-1: Object Identification System (OBIS)	EN 62056-6-1	-
IEC 62056-6-2	2017	Electricity metering data exchange – The DLMS/COSEM suite – Part 6-2: COSEM interface classes	EN IEC 62056-6-2	2018
IEC 62056-9-7	2013	Electricity metering data exchange – The DLMS/COSEM suite – Part 9-7: Communication profile for TCP-UDP/IP networks	EN 62056-9-7	2013

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ITU-T G.9904	2012	SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS – Access networks – In premises networks – Narrow-band orthogonal frequency division multiplexing power line communication transceivers for PRIME networks	–	–
STD 0005	–	Internet Protocol	–	–
STD 0006	–	User Datagram Protocol	–	–
STD 0007	–	Transmission Control Protocol	–	–
RFC 1144	–	Compressing TCP/IP Headers for Low-Speed Serial Links	–	–
RFC 2460	–	Internet Protocol, Version 6 (IPv6) Specification	–	–
RFC 2464	–	Transmission of IPv6 Packets over Ethernet Networks	–	–
RFC 3315	–	Dynamic Host Configuration Protocol for IPv6 (DHCPv6)	–	–
RFC 4291	–	IP Version 6 Addressing Architecture	–	–
RFC 4862	–	IPv6 Stateless Address Autoconfiguration	–	–
RFC 6282	–	Compression Format for IPv6 Datagrams over IEEE 802.15.4-Based Networks	–	–

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INTRODUCTION

As defined in IEC 62056-1-0, the IEC 62056 DLMS/COSEM suite provides specific communication profile standards for communication media relevant for smart metering.

Such communication profile standards specify how the COSEM data model and the DLMS/COSEM application layer can be used on the lower, communication media-specific protocol layers.

Communication profile standards refer to communication standards that are part of the IEC 62056 DLMS/COSEM suite or to any other open communication standard.

This International Standard specifies DLMS/COSEM communication profiles using Recommendation ITU-T G.9904:2012 *Narrow-band orthogonal frequency division multiplexing power line communication transceivers for PRIME networks*. It applies for devices installed on the neighbourhood network.

It follows the rules defined in IEC 62056-5-3:2017, Annex A, and in IEC 62056-1-0 and the IEC TS 62056-1-1 recommendations for its structure.

The communication profile specified in this document is based on the results of the European OPEN Meter project, Topic Energy 2008.7.1.1, Project no.: 226369, www.openmeter.com, and has been prepared by the PRIME Alliance Technical Working Group, www.prime-alliance.org.

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1 Scope

This part of IEC 62056 specifies DLMS/COSEM communication profiles for narrow-band OFDM power line carrier PRIME neighbourhood networks using the modulation as specified in Recommendation ITU-T G.9904:2012.

Three communication profiles are specified:

- a profile using the IEC 61334-4-32 LLC layer;
- a profile using TCP-UDP/IPv4;
- a profile using TCP-UDP/IPv6.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 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 61334-4-511:2000, *Distribution automation using distribution line carrier systems – Part 4-511: Data communication protocols – Systems management – CIASE protocol*

IEC 62056-1-0, *Electricity metering data exchange – The DLMS/COSEM suite – Part 1-0: Smart metering standardization framework*

IEC TS 62056-1-1, *Electricity metering data exchange – The DLMS/COSEM suite – Part 1-1: Template for DLMS/COSEM communication profile standards*

IEC 62056-4-7:2015, *Electricity metering data exchange – The DLMS/COSEM suite – Part 4-7: DLMS/COSEM transport layer for IP networks*

IEC 62056-5-3:2017, *Electricity metering data exchange – The DLMS/COSEM suite – Part 5-3: DLMS/COSEM application layer*

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

IEC 62056-6-2:2017, *Electricity metering data exchange – The DLMS/COSEM suite – Part 6-2: COSEM interface classes*

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

Recommendation ITU-T G.9904:2012, *Series G: Transmission systems and media, digital systems and networks Access networks – In premises networks. Narrowband orthogonal frequency division multiplexing power line communication transceivers for PRIME networks*

STD0005 – Internet Protocol
Author: J. Postel
Date: September 1981
Also: RFC0791, RFC0792, RFC0919, RFC0922, RFC0950, RFC1112

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Available from: http://www.ietf.org/rfc/rfc0791.txt

STD0006 – User Datagram Protocol
Author: J. Postel
Date: 28 August 1980
Also: RFC 768
Available from: http://www.ietf.org/rfc/rfc0768.txt

STD0007 – Transmission Control Protocol
Author: J. Postel
Date: September 1981
Available from: http://www.ietf.org/rfc/rfc0793.txt

RFC 1144, Compressing TCP/IP Headers for Low Speed serial Link
Author: V. Jabobson
Date: February 1990
Available from https://tools.ietf.org/rfc/rfc1144.txt

RFC 2460, Internet Protocol, Version 6 (IPv6) Specification
Authors: S. Deering, Cisco, R. Hinden Nokia
Date: December 1998
Available from: http://www.ietf.org/rfc/rfc2460.txt

RFC 2464, Transmission of IPv6 Packets over Ethernet Networks
Authors M. Crawford Fermilab
Date: December 1998
Available from: http://www.ietf.org/rfc/rfc2464.txt

RFC 3315, Dynamic Host Configuration Protocol for IPv6 (DHCPv6)
Authors R. Droms, E J. Bound, B. Volz, T. Lemon, C. Perkins, M. Carney
Date: July 2003
Available from: www.ietf.org/rfc/rfc3315.txt

RFC 4291, IP Version 6 Addressing Architecture
Authors R. Hinden Nokia, S. Deering Cisco Systems
Date: February 2006.
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RFC 4862, IPv6 Stateless Address Configuration
Authors S. Thomson, Cisco, T. Narten IBM, T. Jinmei, Toshiba
Date: September 2007.
Available from: www.ietf.org/rfc/rfc4862.txt

RFC 6282, Compression Format for IPv6 Datagrams over IEEE 802.15.4–Based Networks
Authors J. Hui, Ed. Arch Rock Corporation P. Thubert Cisco
Date: September 2011.
Available from: http://www.ietf.org/rfc/rfc6282.txt

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

NOTE See also Recommendation ITU-T G.9904:2012.

3.1.1
base node
master node which controls and manages the resources of a subnetwork

3.1.2
registration
process by which a service node is accepted as member of the subnetwork and allocated with an LNID

3.1.3
service node
any one node of a subnetwork which is not a base node

3.1.4
unregistration
process by which a service node leaves a subnetwork

3.2 Abbreviated terms

Abbreviation	Meaning
AA	Application Association
AARE	Application Association Response
AARQ	Application Association Request
ACSE	Application Control Service Element
AL	Application Layer
AP	Application Process
APDU	Application Protocol Data Unit
ARQ	Automatic Repeat Request
CL	Convergence Layer
.cnf	Confirm service primitive
COSEM	Companion Specification for Energy Metering
CPCS	Common Part Convergence Sublayer
CSMA/CA	Carrier Sense Multiple Access – Collision Avoidance
D8PSK	Differential Eight-Phase Shift Keying
DBPSK	Differential Binary Phase Shift Keying
DGW	Default Gateway
DHCP	Dynamic Host Configuration Protocol
DLMS	Device Language Message Specification
DQPSK	Differential Quaternary Phase Shift Keying
EUI-48	48-bit Extended Unique Identifier
FU	Firmware Upgrade
FW	Firmware

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Abbreviation	Meaning
IANA	Internet Assigned Numbers Authority
IGMP	Internet Group Management Protocol
.ind	Indication service primitive
IP	Internet Protocol
IPv4	Internet Protocol, version 4
IPv6	Internet Protocol version 6
LCID	Local Connection Identifier
LD	Logical Device
LLC	Logical Link Control (sub-layer)
LNID	Local Node Identifier
MAC	Medium Access Control, MAC sublayer entity
MLME	MAC Layer Management Entity
MPDU	MAC Protocol Data Unit
NAT	Network Address Translation
NHC	Next Header Compression
NL	Noise Level
OBIS	OBject Identification System
OFDM	Orthogonal Frequency Division Multiplexing
OSI	Open System Interconnection
PHY	Physical Layer entity
PLC	Power Line Communication
PIB	PLC Information Base
PLME	Physical Layer Management Entity
PPDU	PHY Protocol Data Unit
.req	Request service primitive
RFC	Request For Comment
.rsp	Response service primitive
SDU	Service Data Unit
SID	Switch Identifier
SNA	Subnetwork Address
SNR	Signal-to-Noise Ratio
SSCS	Service Specific Convergence Sublayer
TCP	Transmission Control Protocol
TOS	Type Of Service
UDP	User Datagram Protocol
xDLMS_ASE	extended DLMS Application Service Element
ZCT	Zero Crossing Time

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4 Targeted communication environments

The DLMS/COSEM communication profiles for narrow-band OFDM PLC PRIME neighbourhood networks are intended for remote data exchange on Neighbourhood Networks (NN) between Neighbourhood Network Access Points (NNAPs) and Local Network Access Points (LNAPs) or End Devices using OFDM PLC technology over the low voltage electricity distribution network as a communication medium. The functional reference architecture is shown Figure 1.

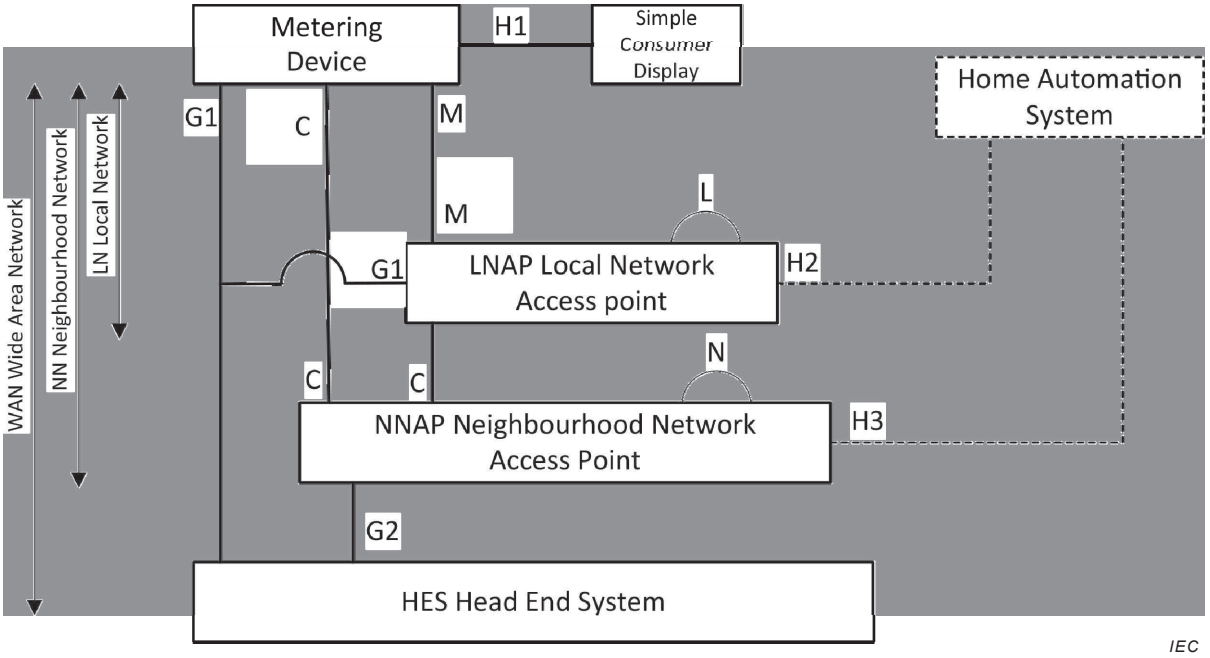


Figure 1 – Communication architecture

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 base node while end devices and LNAPs act as service nodes.

NNAPs and similarly LNAPs may communicate to each other, but this is out of the scope of this document, 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.

A mixed architecture is also possible, i.e. both the HES and the NNAP can act as a client.

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5 Use of the communication layers for this profile

5.1 Information related to the use of the standard specifying the lower layers

Recommendation ITU-T G.9904:2012 defines PHY and MAC layers for power line communication using OFDM. At the top of the MAC layer it defines also a number of Convergence layers, the purpose of which is to match the lower protocol layers with the higher protocol layers.

This document makes use of the entire part of the PHY and MAC layers. Additionally, it defines – in 5.5 – the use of the respective Convergence layers.

5.2 The structure of the communication profiles

5.2.1 Overview

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

- the DLMS/COSEM Application layer as specified in IEC 62056-5-3 covering the Application, Presentation and Session functionalities;
- the LLC sublayer as specified in IEC 61334-4-32, used with the DLMS/COSEM 61334-4-32 profile over PRIME networks;
- the DLMS/COSEM transport layer for IP networks as specified in IEC 62056-4-7:2015 used with the DLMS/COSEM TCP-UDP/IPv4 and TCP-UDP/IPv6 profiles over PRIME networks;
- the PRIME MAC layer, the CPCS and the corresponding SSCS, according to the selected profile (IEC 61334-4-32, TCP-UDP/IPv4 or TCP-UDP/IPv6);
- the PRIME Physical layer.

Following this reference model, three distinct profiles can be identified, all of them using the PRIME PHY, MAC layers as lower layers and the Common Part Convergence Sublayer on one hand, and the DLMS/COSEM Application layer specified in IEC 62056-5-3 and the COSEM object model specified in IEC 62056-6-1 and IEC 62056-6-2 on the other hand. Lower layers – meaning PHY and MAC – are based on the principles of IEEE 802.15.4.

NOTE The COSEM interface classes for setting up and managing data exchange over narrow-band OFDM PLC PRIME network are specified in IEC 62056-6-2.

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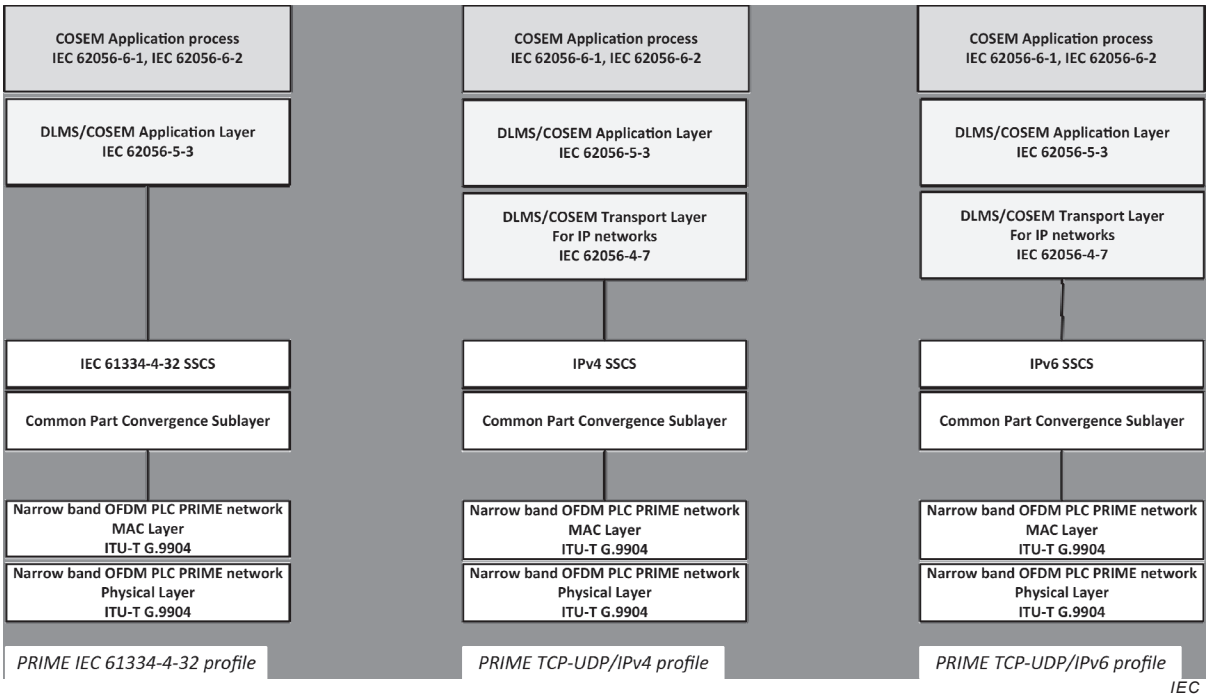


Figure 2 – OFDM PLC PRIME communication profile architectures

5.2.2 The IEC 61334-4-32 profile

The IEC 61334-4-32 profile uses the PRIME IEC 61334-4-32 SSCS making the necessary adaptation between the PRIME PHY and MAC layers and the DLMS/COSEM application layer.

5.2.3 The TCP-UDP/IPv4 profile

The TCP-UDP/IPv4 profile uses the PRIME IPv4 SSCS making the necessary adaptation between the PRIME PHY and MAC layers and the IPv4 layer, supporting the DLMS/COSEM transport layer and application layer.

5.2.4 The TCP-UDP/IPv6 profile

The TCP-UDP/IPv6 profile uses the PRIME IPv6 SSCS making the necessary adaptation between the PRIME PHY and MAC layers and the IPv6 layer, supporting the DLMS/COSEM transport layer and application layer.

5.3 Lower protocol layers and their use

5.3.1 General

All three profiles specified in this document share the same PHY and MAC layers.

5.3.2 Physical layer

5.3.2.1 General

This layer provides the interface between the equipment and the physical transmission medium that is the electricity distribution network. It transmits and receives MPDUs between neighbour nodes.

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5.3.2.2 PRIME PHY data plane services

PHY DATA services are generated / used by the MAC layer entity whenever data – PPDUs – have to be transmitted to / received from (a) peer MAC entity(ies) using the PHY transmission procedures. See Recommendation ITU-T G.9904:2012, 7.10.2.

5.3.2.3 PRIME PHY control plane services

PRIME PHY control plane services are used to control the physical layer by the MAC layer. See Recommendation ITU-T G.9904:2012, 7.10.3. They are the following:

- PHY_AGC: allows the MAC layer entity to set or get the Automatic Gain Mode of the PHY;
- PHY_TIMER: allows the MAC layer entity to get the time at which the transmission has to be started;
- PHY_CD: allows the MAC layer entity to look for the carrier detect signal, in order to detect if the physical medium is free;
- PHY_NL: allows the MAC layer entity to get the floor noise level value present on the power line;
- PHY_SNR: allows the MAC layer entity to get the value of the signal-to-noise ratio, in order to find the appropriate degree of robustness needed for data exchange;
- PHY_ZCT: allows the MAC layer entity to get the zero crossing time of the mains and the time between the last transmission or reception and the zero crossing of the mains.

5.3.2.4 PRIME PHY management plane services

PRIME PHY management plane services are used to manage the physical layer by the MAC layer. See Recommendation ITU-T G.9904:2012, 7.10.4. They are the following:

- PLME_RESET: allows the MAC layer entity to request the PHY layer to reset its present functional state. As a result of this primitive, the PHY should reset all internal states and flush all buffers to clear any queued receive or transmit data;
- PLME_SLEEP: allows the MAC layer entity to request the PHY layer to suspend its present activities including all reception functions. The PHY layer should complete any pending transmission before entering into a sleep state;
- PLME_RESUME: allows the MAC layer entity to request the PHY layer to resume its suspended activities. As a result of this primitive, the PHY layer should start its normal transmission and reception functions;
- PLME_TESTMODE: allows the MAC layer entity to put the PHY layer into some non-default functional modes. Specific functional mode out of the various possible modes is provided as an input parameter. Following the reception of this primitive, the PHY layer should complete any pending transmissions in its buffer before entering the test mode requested;
- PLME_GET: allows the MAC layer entity to query information about a given attribute of the PRIME Information Base.

5.3.3 MAC layer

5.3.3.1 Overview – main features and functions

A subnetwork can be seen as a tree structure with two types of nodes, the base node and service nodes. The base node is at the root of the tree and acts as the master node that provides the subnetwork with connectivity. There is one and only one base node in a subnetwork. Any other subnetwork node is a service node. Service nodes are either leaves or branch points (switches) of the tree structure.

The base node is initially the subnetwork itself and all other nodes should follow a registration process to enrol themselves on the subnetwork.

Service nodes start in a “Disconnected” state and they try to find a base node or a switch node to register themselves to the subnetwork. After this, they become leaves of the tree.

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Service nodes may change their state dynamically from “Terminal” functions to “Switch” functions and vice-versa. These changes occur on the basis of certain pre-defined events on the network. Service nodes in “Switch” state become branch points of the tree, capable of switching their neighbours’ data to propagate connectivity.

The three functional states of service nodes are:

- **Disconnected:** all nodes are in this state initially or after a restart. In this state, a node is not capable to participate in the network. The primary function of a service node in this state is to search for an operational network in its proximity and try to register itself on it;
- **Terminal**: In this state a service node is part of the network and is capable of communicating its traffic by establishing connections, but it is not capable of switching the traffic of any other node; and finally:
- **Switch:** In this state a service node is capable of performing all “Terminal” functions. Additionally, it is capable of forwarding data to and from other devices on the subnetwork.

The events and associated processes that trigger changes from one functional state to another are registration, unregistration, promotion and demotion.

Other functions of the MAC layer are:

- address resolution and broadcast and multicast addressing;
- CSMA/CA algorithm implementation;
- promoting service nodes from “Terminal” state to “Switch” state or demoting them from the “Switch” state to “Terminal” state;
- establishing direct connections from one service node to another;
- packet aggregation;
- security functions, such as encryption and security keys management;
- PHY robustness management in order to select the best modulation schema for a given situation;
- ARQ mechanism.

5.3.3.2 Services used by base node and service nodes

The MAC connection and data services used by base nodes and service nodes are the following (see Recommendation ITU-T G.9904:2012, 8.5.2 and 8.5.4:

- MAC_ESTABLISH: is used to manage the connection establishment at MAC layer;
- MAC_RELEASE: is used to release a connection at MAC layer;
- MAC_JOIN: is used to join to a broadcast or multicast connection and allow the reception of such packets;
- MAC_LEAVE: is used to leave a broadcast or multicast connection;
- MAC_DATA: is used to send and receiving unicast, multicast or broadcast data.

5.3.3.3 Management services

The MAC management services (see Recommendation ITU-T G.9904:2012, 8.5.5) are the following:

- MLME_REGISTER: is used to perform registration and to indicate when registration has been performed;
- MLME_UNREGISTER: is used to perform unregistration and to indicate when it has been performed;
- MLME_PROMOTE: is used to perform promotion of service nodes from the “Terminal“ state to “Switch” state and to indicate when it has been performed;
- MLME_DEMOTE: is used to perform demotion of service nodes in the “Switch“ state to “Terminal” state and to indicate when it has been performed;

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- MLME_RESET: is used to reset the MAC into a known “good” status. After the reset the MAC is in the disconnected functional state;
- MLME_GET: is used to retrieve individual values from the MAC such as statistics;
- MLME_LIST_GET: is used to retrieve a list of values from the MAC;
- MLME_SET: is used to set configuration values in the MAC.

5.4 Service mapping and convergence layers

5.4.1 Overview

NOTE 1 The following description is based on Recommendation ITU-T G.9904:2012, 9.1.

The convergence layer is divided into two sublayers:

The Common Part Convergence Sublayer (CPCS) provides a set of generic services. The use of CPCS services is optional in that a SSCS will configure into its protocol stack those services which are required from the CPCS and omit services that are not required. In the present specification, the CPCS provides the following services to the different SSCSs: segmentation and reassembly.

The Service Specific Convergence Sublayer (SSCS) contains services that are specific to a given communication profile. There are four SSCSs specified to connect the MAC layer to the upper layer:

- the IEC 61334-4-32 SSCS, see 5.4.2;
- the IPv4 SSCS, see 5.4.3;
- the IPv6 SSCS, see 5.4.4;
- the Null Convergence Sublayer.

NOTE 2 The Null Convergence Sublayer is outside the scope of this document. Information can be found in Recommendation ITU-T G.9904:2012, Clause 9.

5.4.2 The IEC 61334-4-32 LLC SSCS

5.4.2.1 General

The IEC 61334-4-32 LLC convergence sublayer (SSCS) provides convergence functions for the communication profile using IEC 61334-4-32 LLC services. Implementations conforming to this SSCS shall offer all LLC services specified in this document. Additionally, the PRIME IEC 61334-4-32 SSCS shall provide services that help the mapping of the connection-less LLC protocol into the connection-oriented nature of PRIME MAC, meaning that before data exchange can take place, a connection has to be established. See Recommendation ITU-T G.9904:2012, 9.5.2.

Main features:

- a service node can only exchange data with the base node and not with other service nodes;
- each IEC 61334-4-32 SSCS session establishes a dedicated PRIME MAC connection for exchanging unicast data with the base node;
- the service node SSCS session is responsible for initiating this connection to the base node. The base node SSCS cannot initiate a connection to a service node;
- each IEC 61334-4-32 SSCS listens to a PRIME broadcast MAC connection dedicated to the transfer of IEC 61334-4-32 broadcast data from the base node to the service nodes. This broadcast connection is used when the base node application process using the IEC 61334-4-32 communication profile makes a transmission request with the destination address used for broadcast or when the broadcast SAP functions are used. When there are multiple SSCS sessions within a service Node, one PRIME broadcast MAC connection is shared by all the SSCS sessions.

The IEC 61334-4-32 SSCS services are shown in Figure 3 and specified in 5.4.2.2.

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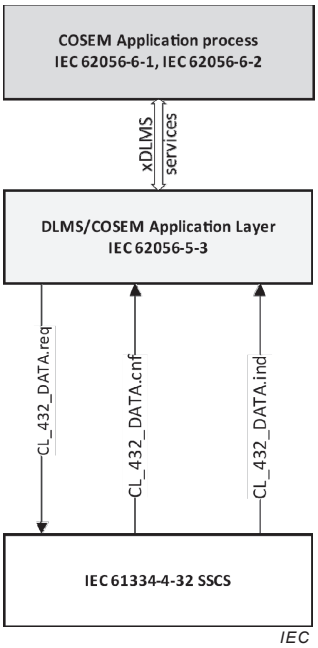


Figure 3 – IEC 61334-4-32 SSCS services

5.4.2.2 CL_432_DATA services

5.4.2.2.1 General

IEC 61334-4-32 specifies the following LLC layer data services:

- DL_Data services;
- DL_Broadcast services;
- DL_Reply services; and
- DL_Update_Reply services.

In the DLMS/COSEM PRIME IEC 61334-4-32 profile, only the DL_Data services are used. They are mapped to CL_432_DATA services. All other services are also mapped into CL_432_DATA services as defined below.

5.4.2.2.2 CL_432_DATA services

For DL_Data data services, refer to IEC 61334-4-32. In this document, DL_Data services are mapped into CL_432_DATA services.

xDLMS LN services are shown as an example here. PRIME does not impose any limitation on using any of the xDLMS services.

Figure 4 shows an example of the use of the CL_432_Data services.

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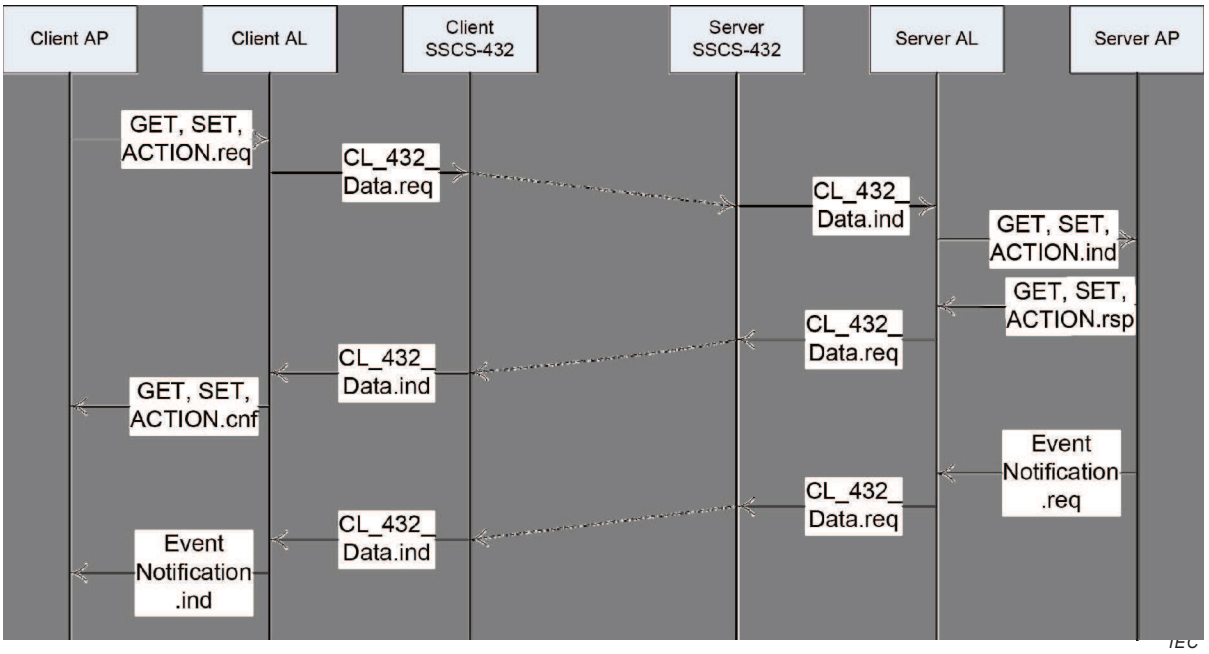


Figure 4 – MSC for Data services in the case of logical name referencing

5.4.2.2.3 DL_Broadcast services

The DL_Broadcast.request service specified in IEC 61334-4-32 is not used in this profile. Instead, the CL_432_DATA.request primitive is used with a broadcast address as destination address.

5.4.2.2.4 DL_Reply and DL_Update_Reply services

In IEC 61334-4-32, the DL_Reply and Update_Reply services are used for unsolicited service management. In the DLMS/COSEM PRIME IEC 61334-4-32 profile, these services are replaced by CL_432_DATA services at the SSCS level.

5.4.3 The IPv4 SSCS

5.4.3.1 Data services

5.4.3.1.1 General

The following primitives are used for sending and receiving IPv4 packets.

5.4.3.1.2 CL_IPv4_DATA.request

NOTE For details, see Recommendation ITU-T G.9904:2012, 9.4.8.5.2.

Function

This primitive is passed from the IPv4 layer to the IPv4 SSCS. It contains one IPv4 packet to be sent.

Service parameters

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