

© Copyright SEK. Reproduction in any form without permission is prohibited.

Kommunikationsnät och system för kraftföretagsautomation – Del 7-420: Grundläggande kommunikationsstruktur – Logiska noder för decentraliserad elförsörjning

*Communication networks and systems for power utility automation –
Part 7-420: Basic communication structure –
Distributed energy resources logical nodes*

Som svensk standard gäller europastandarden EN 61850-7-420:2009. Den svenska standarden innehåller den officiella engelska språkversionen av EN 61850-7-420:2009.

Nationellt förord

Europastandarden EN 61850-7-420:2009

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 61850-7-420, First edition, 2009 - Communication networks and systems for power utility automation - Part 7-420: Basic communication structure - Distributed energy resources logical nodes**

utarbetad inom International Electrotechnical Commission, IEC.

ICS 33.200

Denna standard är fastställd av SEK Svensk Elstandard, som också kan lämna upplysningar om **sakinnehållet** i standarden.
Postadress: SEK, Box 1284, 164 29 KISTA
Telefon: 08 - 444 14 00. Telefax: 08 - 444 14 30
E-post: sek@elstandard.se. Internet: www.elstandard.se

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a säkerhet, prestanda, dokumentation, utförande och skötsel av elprodukter, elanläggningar och metoder. Genom att utforma sådana standarder blir säkerhetskraven tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

SEK Svensk Elstandard

Box 1284
164 29 Kista
Tel 08-444 14 00
www.elstandard.se

**Communication networks and systems for power utility automation -
Part 7-420: Basic communication structure -
Distributed energy resources logical nodes
(IEC 61850-7-420:2009)**

Systèmes et réseaux de communication
pour l'automatisation des services
de distribution d'énergie -
Partie 7-420: Structure
de communication de base -
Nœuds logiques de ressources
d'énergie distribuées
(CEI 61850-7-420:2009)

Kommunikationsnetze und -systeme
für die Automatisierung
in der elektrischen Energieversorgung -
Teil 7-420: Grundlegende
Kommunikationsstruktur -
Logische Knoten für die
dezentrale Energieversorgung
(IEC 61850-7-420:2009)

This European Standard was approved by CENELEC on 2009-05-01. 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 Central Secretariat 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 responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 57/981/FDIS, future edition 1 of IEC 61850-7-420, prepared by IEC TC 57, Power systems management and associated information exchange, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61850-7-420 on 2009-05-01.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2010-02-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2012-05-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61850-7-420:2009 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60364-7-712	NOTE Harmonized as HD 60364-7-712:2005 (not modified).
IEC 60870-5-101	NOTE Harmonized as EN 60870-5-101:2003 (not modified).
IEC 60870-5-104	NOTE Harmonized as EN 60870-5-104:2006 (not modified).
IEC 61800-4	NOTE Harmonized as EN 61800-4:2003 (not modified).
IEC 61850	NOTE Harmonized in EN 61850 series (not modified).
IEC 61850-6	NOTE Harmonized as EN 61850-6:2004 (not modified).
IEC 61850-7-1	NOTE Harmonized as EN 61850-7-1:2003 (not modified).
IEC 61850-8	NOTE Harmonized in EN 61850-8 series (not modified).
IEC 61850-9	NOTE Harmonized in EN 61850-9 series (not modified).
IEC 61850-10	NOTE Harmonized as EN 61850-10:2005 (not modified).
IEC 61968	NOTE Harmonized in EN 61968 series (not modified).
IEC 61970-301	NOTE Harmonized as EN 61970-301:2004 (not modified).
IEC 62056	NOTE Harmonized in EN 62056 series (not modified).
ISO/IEC 7498-1	NOTE Harmonized as EN ISO/IEC 7498-1:1995 (not modified).

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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 When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61850-7-2	2003	Communication networks and systems in substations - Part 7-2: Basic communication structure for substation and feeder equipment - Abstract communication service interface (ACSI)	EN 61850-7-2	2003
IEC 61850-7-3	2003	Communication networks and systems in substations - Part 7-3: Basic communication structure for substation and feeder equipment - Common data classes	EN 61850-7-3	2003
IEC 61850-7-4	2003	Communication networks and systems in substations - Part 7-4: Basic communication structure for substation and feeder equipment - Compatible logical node classes and data classes	EN 61850-7-4	2003
IEC 61850-7-410	⁻¹⁾	Communication networks and systems for power utility automation - Part 7-410: Hydroelectric power plants - Communication for monitoring and control	EN 61850-7-410	2007 ²⁾
ISO 4217	⁻¹⁾	Codes for the representation of currencies and funds	-	-

¹⁾ Undated reference.

²⁾ Valid edition at date of issue.

CONTENTS

INTRODUCTION.....	9
1 Scope.....	12
2 Normative references	12
3 Terms, definitions and abbreviations	13
3.1 Terms and definitions	13
3.2 DER abbreviated terms	18
4 Conformance.....	20
5 Logical nodes for DER management systems.....	20
5.1 Overview of information modelling (informative)	20
5.1.1 Data information modelling constructs	20
5.1.2 Logical devices concepts.....	21
5.1.3 Logical nodes structure	22
5.1.4 Naming structure	22
5.1.5 Interpretation of logical node tables.....	23
5.1.6 System logical nodes LN Group: L (informative)	24
5.1.7 Overview of DER management system LNs	27
5.2 Logical nodes for the DER plant ECP logical device	29
5.2.1 DER plant electrical connection point (ECP) logical device (informative).....	29
5.2.2 LN: DER plant corporate characteristics at the ECP Name: DCRP.....	31
5.2.3 LN: Operational characteristics at ECP Name: DOPR.....	31
5.2.4 LN: DER operational authority at the ECP Name: DOPA.....	32
5.2.5 LN: Operating mode at ECP Name: DOPM	33
5.2.6 LN: Status information at the ECP Name: DPST	34
5.2.7 LN: DER economic dispatch parameters Name: DCCT	35
5.2.8 LN: DER energy and/or ancillary services schedule control Name: DSCC.....	36
5.2.9 LN: DER energy and/or ancillary services schedule Name: DSCH	37
5.3 Logical nodes for the DER unit controller logical device	38
5.3.1 DER device controller logical device (informative)	38
5.3.2 LN: DER controller characteristics Name: DRCT.....	38
5.3.3 LN: DER controller status Name: DRCS	39
5.3.4 LN: DER supervisory control Name: DRCC.....	40
6 Logical nodes for DER generation systems.....	42
6.1 Logical nodes for DER generation logical device	42
6.1.1 DER generator logical device (informative)	42
6.1.2 LN: DER unit generator Name: DGEN	42
6.1.3 LN: DER generator ratings Name: DRAT	44
6.1.4 LN: DER advanced generator ratings Name: DRAZ	45
6.1.5 LN: Generator cost Name: DCST.....	46
6.2 Logical nodes for DER excitation logical device.....	47
6.2.1 DER excitation logical device (informative)	47
6.2.2 LN: Excitation ratings Name: DREX.....	47
6.2.3 LN: Excitation Name: DEXC	48
6.3 Logical nodes for DER speed/frequency controller	49

6.3.1	Speed/frequency logical device (informative).....	49
6.3.2	LN: Speed/Frequency controller Name: DSFC	49
6.4	Logical nodes for DER inverter/converter logical device	50
6.4.1	Inverter/converter logical device (informative).....	50
6.4.2	LN: Rectifier Name: ZRCT	51
6.4.3	LN: Inverter Name: ZINV	53
7	Logical nodes for specific types of DER.....	55
7.1	Logical nodes for reciprocating engine logical device	55
7.1.1	Reciprocating engine description (informative)	55
7.1.2	Reciprocating engine logical device (informative)	55
7.1.3	LN: Reciprocating engine Name: DCIP	56
7.2	Logical nodes for fuel cell logical device.....	57
7.2.1	Fuel cell description (informative).....	57
7.2.2	Fuel cell logical device (informative).....	59
7.2.3	LN: Fuel cell controller Name: DFCL.....	60
7.2.4	LN: Fuel cell stack Name: DSTK.....	61
7.2.5	LN: Fuel processing module Name: DFPM.....	62
7.3	Logical nodes for photovoltaic system (PV) logical device	63
7.3.1	Photovoltaic system description (informative)	63
7.3.2	Photovoltaics system logical device (informative)	65
7.3.3	LN: Photovoltaics module ratings Name: DPVM.....	67
7.3.4	LN: Photovoltaics array characteristics Name: DPVA.....	68
7.3.5	LN: Photovoltaics array controller Name: DPVC	69
7.3.6	LN: Tracking controller Name: DTRC.....	70
7.4	Logical nodes for combined heat and power (CHP) logical device	72
7.4.1	Combined heat and power description (informative).....	72
7.4.2	Combined heat and power logical device (informative)	75
7.4.3	LN: CHP system controller Name: DCHC.....	76
7.4.4	LN: Thermal storage Name: DCTS	77
7.4.5	LN: Boiler Name: DCHB	78
8	Logical nodes for auxiliary systems	78
8.1	Logical nodes for fuel system logical device	78
8.1.1	Fuel system logical device (informative)	78
8.1.2	LN: Fuel characteristics Name: MFUL.....	80
8.1.3	LN: Fuel delivery system Name: DFLV.....	80
8.2	Logical nodes for battery system logical device	81
8.2.1	Battery system logical device (informative)	81
8.2.2	LN: Battery systems Name: ZBAT.....	82
8.2.3	LN: Battery charger Name: ZBTC	83
8.3	Logical node for fuse device.....	84
8.3.1	Fuse logical device (informative)	84
8.3.2	LN: Fuse Name: XFUS	84
8.4	Logical node for sequencer	85
8.4.1	Sequencer logical device.....	85
8.4.2	LN: Sequencer Name: FSEQ	85
8.5	Logical nodes for physical measurements	86
8.5.1	Physical measurements (informative)	86
8.5.2	LN: Temperature measurements Name: STMP	86

8.5.3	LN: Pressure measurements Name: MPRS.....	87
8.5.4	LN: Heat measured values Name: MHET.....	87
8.5.5	LN: Flow measurements Name: MFLW.....	88
8.5.6	LN: Vibration conditions Name: SVBR.....	90
8.5.7	LN: Emissions measurements Name: MENV.....	90
8.5.8	LN: Meteorological conditions Name: MMET.....	91
8.6	Logical nodes for metering.....	91
8.6.1	Electric metering (informative).....	91
9	DER common data classes (CDC).....	92
9.1	Array CDCs.....	92
9.1.1	E-Array (ERY) enumerated common data class specification.....	92
9.1.2	V-Array (VRY) visible string common data class specification.....	92
9.2	Schedule CDCs.....	93
9.2.1	Absolute time schedule (SCA) settings common data class specification.....	93
9.2.2	Relative time schedule (SCR) settings common data class specification.....	94
	Annex A (informative) Glossary.....	96
	Bibliography.....	98

	Figure 1 – Example of a communications configuration for a DER plant.....	10
	Figure 2 – IEC 61850 modelling and connections with CIM and other IEC TC 57 models.....	11
	Figure 3 – Information model hierarchy.....	21
	Figure 4 – Example of relationship of logical device, logical nodes, data objects, and common data classes.....	22
	Figure 5 – Overview: Conceptual organization of DER logical devices and logical nodes.....	28
	Figure 6 – Illustration of electrical connection points (ECP) in a DER plant.....	29
	Figure 7 – Inverter / converter configuration.....	50
	Figure 8 – Example of a reciprocating engine system (e.g. Diesel Gen-Set).....	55
	Figure 9 – Example of LNs in a reciprocating engine system.....	56
	Figure 10 – Fuel cell – Hydrogen/oxygen proton-exchange membrane fuel cell (PEM).....	58
	Figure 11 – PEM fuel cell operation.....	58
	Figure 12 – Example of LNs used in a fuel cell system.....	59
	Figure 13 – Example: One line diagram of an interconnected PV system.....	64
	Figure 14 – Schematic diagram of a large PV installation with two arrays of several sub-arrays.....	65
	Figure 15 – Example of LNs associated with a photovoltaics system.....	66
	Figure 16 – Two examples of CHP configurations.....	73
	Figure 17 – CHP unit includes both domestic hot water and heating loops.....	74
	Figure 18 – CHP unit includes domestic hot water with hybrid storage.....	74
	Figure 19 – CHP unit includes domestic hot water without hybrid storage.....	74
	Figure 20 – Example of LNs associated with a combined heat and power (CHP) system.....	75

Table 1 – Interpretation of logical node tables.....	23
Table 2 – LPHD class	25
Table 3 – Common LN class	26
Table 4 – LLN0 class	27
Table 5 – DER plant corporate characteristics at the ECP, LN (DCRP)	31
Table 6 – Operational characteristics at the ECP, LN (DOPR)	32
Table 7 – DER operational authority at the ECP, LN (DOPA)	33
Table 8 – Operating mode at the ECP, LN (DOPM).....	34
Table 9 – Status at the ECP, LN (DPST).....	35
Table 10 – DER Economic dispatch parameters, LN (DCCT)	35
Table 11 – DER energy schedule control, LN (DSCC).....	36
Table 12 – DER Energy and ancillary services schedule, LN (DSCH)	37
Table 13 – DER controller characteristics, LN DRCT	38
Table 14 – DER controller status, LN DRCS	39
Table 15 – DER supervisory control, LN DRCC.....	40
Table 16 – DER unit generator, LN (DGEN)	42
Table 17 – DER Basic Generator ratings, LN (DRAT).....	44
Table 18 – DER advanced generator ratings, LN (DRAZ).....	46
Table 19 – Generator cost, LN DCST	47
Table 20 – Excitation ratings, LN (DREX)	47
Table 21 – Excitation, LN (DEXC).....	48
Table 22 – Speed/frequency controller, LN (DSFC).....	49
Table 23 – Rectifier, LN (ZRCT).....	51
Table 24 – Inverter, LN (ZINV).....	53
Table 25 – Reciprocating engine, LN (DCIP).....	57
Table 26 – Fuel cell controller, LN (DFCL)	60
Table 27 – Fuel cell stack, LN (DSTK)	61
Table 28 – Fuel cell processing module, LN (DFPM).....	62
Table 29 – Photovoltaic module characteristics, LN (DPVM)	67
Table 30 – Photovoltaic array characteristics, LN (DPVA)	68
Table 31 – Photovoltaic array controller, LN (DPVC).....	69
Table 32 – Tracking controller, LN (DTRC)	70
Table 33 – CHP system controller, LN (DCHC)	76
Table 34 – CHP thermal storage, LN (DCTS).....	77
Table 35 – CHP Boiler System, LN (DCHB)	78
Table 36 – Fuel types	79
Table 37 – Fuel characteristics, LN (MFUL)	80
Table 38 – Fuel systems, LN (DFLV)	81
Table 39 – Battery systems, LN (ZBAT)	82
Table 40 – Battery charger, LN (ZBTC).....	83
Table 41 – Fuse, LN (XFUS).....	84
Table 42 – Sequencer, LN (FSEQ).....	85
Table 43 – Temperature measurements, LN (STMP).....	86

Table 44 – Pressure measurements, LN (MPRS)	87
Table 45 – Heat measurement, LN (MHET).....	88
Table 46 – Flow measurement, LN (MFLW)	89
Table 47 – Vibration conditions, LN (SVBR).....	90
Table 48 – Emissions measurements, LN (MENV)	91
Table 49 – E-Array (ERY) common data class specification	92
Table 50 – V-Array (VRY) common data class specification	92
Table 51 – Schedule (SCA) common data class specification	93
Table 52 – Schedule (SCR) common data class specification	94

INTRODUCTION

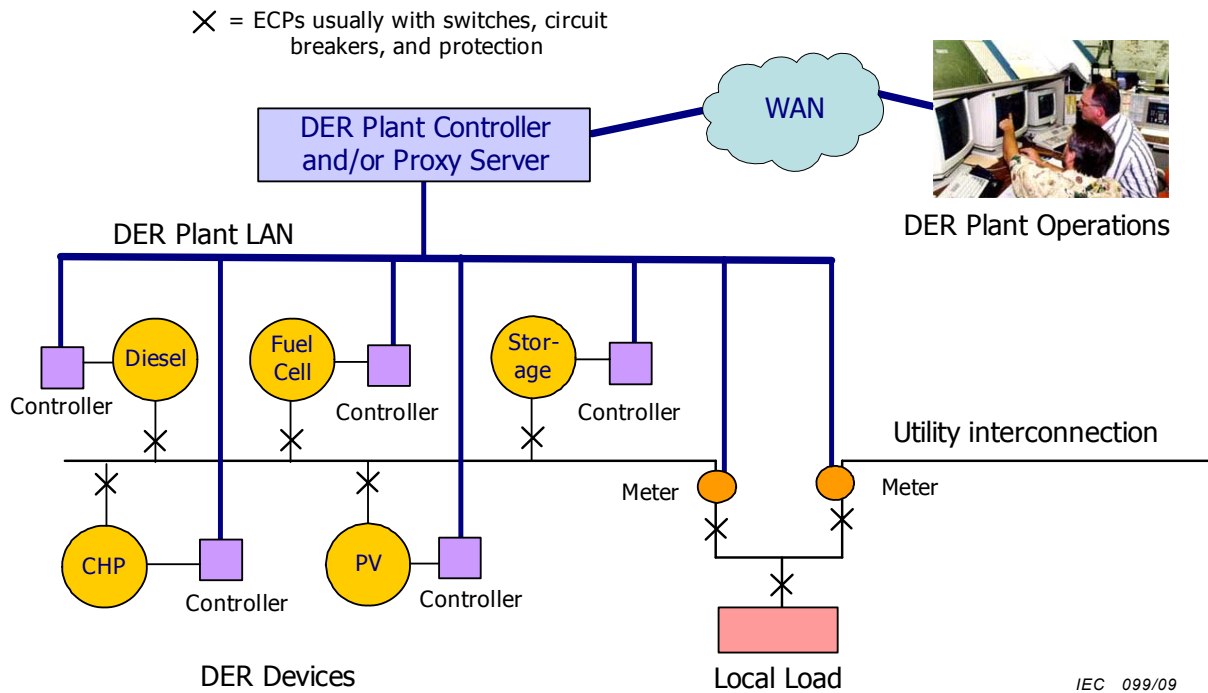
Increasing numbers of DER (distributed energy resources) systems are being interconnected to electric power systems throughout the world. As DER technology evolves and as the impact of dispersed generation on distribution power systems becomes a growing challenge - and opportunity, nations worldwide are recognizing the economic, social, and environmental benefits of integrating DER technology within their electric infrastructure.

The manufacturers of DER devices are facing the age-old issues of what communication standards and protocols to provide to their customers for monitoring and controlling DER devices, in particular when they are interconnected with the electric utility system. In the past, DER manufacturers developed their own proprietary communication technology. However, as utilities, aggregators, and other energy service providers start to manage DER devices which are interconnected with the utility power system, they are finding that coping with these different communication technologies present major technical difficulties, implementation costs, and maintenance costs. Therefore, utilities and DER manufacturers recognize the growing need to have one international standard that defines the communication and control interfaces for all DER devices. Such standards, along with associated guidelines and uniform procedures would simplify implementation, reduce installation costs, reduce maintenance costs, and improve reliability of power system operations.

The logical nodes in this document are intended for use with DER, but may also be applicable to central-station generation installations that are comprised of groupings of multiple units of the same types of energy conversion systems that are represented by the DER logical nodes in this document. This applicability to central-station generation is strongest for photovoltaics and fuel cells, due to their modular nature.

Communications for DER plants involve not only local communications between DER units and the plant management system, but also between the DER plant and the operators or aggregators who manage the DER plant as a virtual source of energy and/or ancillary services. This is illustrated in Figure 1.

Example of a Communications Configuration for a DER Plant



Key

- CHP combined heat and power
- WAN wide area network
- DER distributed energy resources
- PV photovoltaics
- LAN local area network

Figure 1 – Example of a communications configuration for a DER plant

In basic terms, “communications” can be separated into four parts:

- information modelling (the types of data to be exchanged – nouns),
- services modelling (the read, write, or other actions to take on the data – verbs),
- communication protocols (mapping the noun and verb models to actual bits and bytes),
- telecommunication media (fibre optics, radio systems, wireless systems, and other physical equipment).

This document addresses only the IEC 61850 information modelling for DER. Other IEC 61850 documents address the services modelling (IEC 61850-7-2) and the mapping to communication protocols (IEC 61850-8-x). In addition, a systems configuration language (SCL) for DER (IEC 61850-6-x) would address the configuration of DER plants.

The general technology for information modelling has developed to become well-established as the most effective method for managing information exchanges. In particular, the IEC 61850-7-x information models for the exchange of information within substations have become International Standard. Many of the components of this standard can be reused for information models of other types of devices.

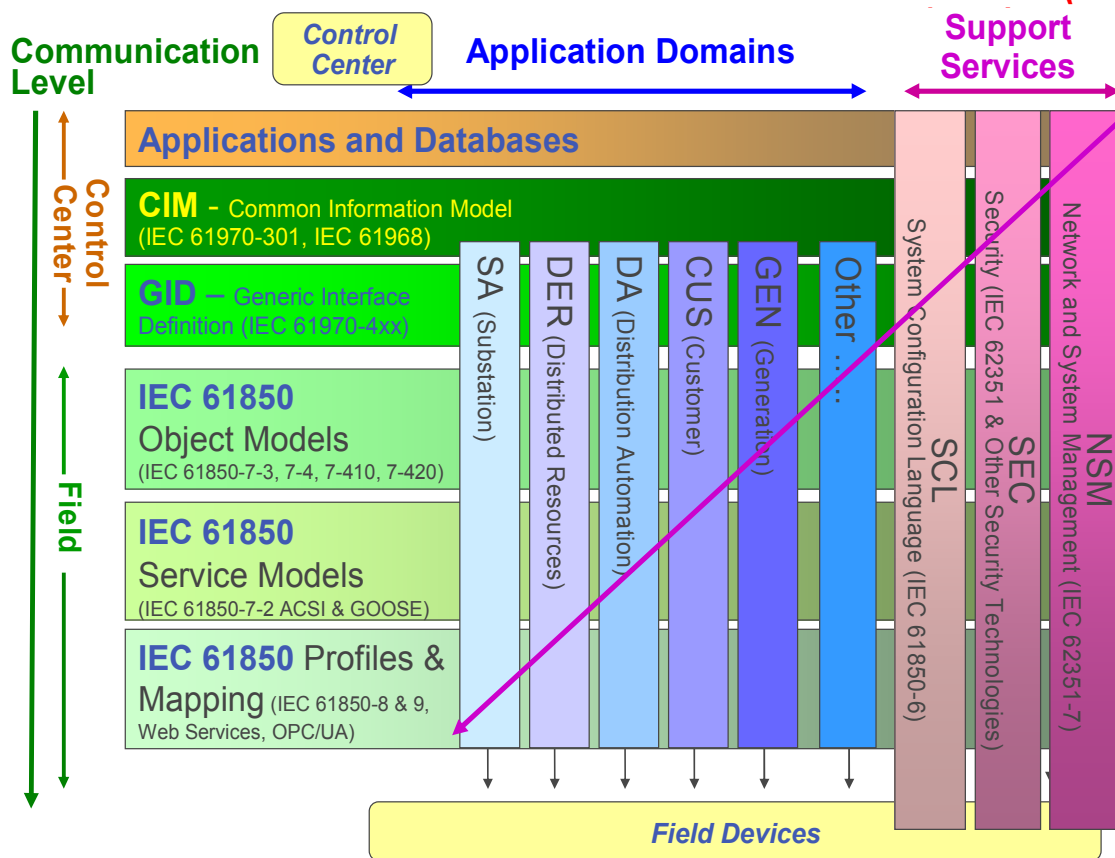
In addition to the IEC 61850 standards, IEC TC 57 has developed the common information model (CIM) that models the relationships among power system elements and other

information elements so that these relationships can be communicated across systems. Although this standard does not address these CIM relationships for DER, it is fully compatible with the CIM concepts.

The interrelationship between IEC TC 57 modelling standards is illustrated in Figure 2. This illustration shows as horizontal layers the three components to an information exchange model for retrieving data from the field, namely, the communication protocol profiles, the service models, and the information models. Above these layers is the information model of utility-specific data, termed the common information model (CIM), as well as all the applications and databases needed in utility operations. Vertically, different information models are shown:

- substation automation (IEC 61850-7-4),
- large hydro plants (IEC 61850-7-410),
- distributed energy resources (DER) (IEC 61850-7-420),
- distribution automation (under development),
- advanced metering infrastructure (as pertinent to utility operations) (pending).

IEC 61850 Models and the Common Information Model (CIM)



IEC 100/09

Figure 2 – IEC 61850 modelling and connections with CIM and other IEC TC 57 models

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-420: Basic communication structure – Distributed energy resources logical nodes

1 Scope

This International Standard defines the IEC 61850 information models to be used in the exchange of information with distributed energy resources (DER), which comprise dispersed generation devices and dispersed storage devices, including reciprocating engines, fuel cells, microturbines, photovoltaics, combined heat and power, and energy storage.

The IEC 61850 DER information model standard utilizes existing IEC 61850-7-4 logical nodes where possible, but also defines DER-specific logical nodes where needed.

2 Normative references

The following referenced documents are indispensable for the application 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 61850-7-2:2003, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substations and feeder equipment – Abstract communication service interface (ACSI)* ¹⁾

IEC 61850-7-3:2003, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substations and feeder equipment – Common data classes* ¹⁾

IEC 61850-7-4:2003, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substations and feeder equipment – Compatible logical node classes and data classes* ¹⁾

IEC 61850-7-410, *Communication networks and systems for power utility automation – Part 7-410: Hydroelectric power plants – Communication for monitoring and control*

ISO 4217, *Codes for the representation of currencies and funds*

¹⁾ A new edition of this document is in preparation.