

DIN EN 61850-7-1

ICS 33.040.40

Ersatz für
DIN EN 61850-7-1:2012-04
Siehe Anwendungsbeginn

**Kommunikationsnetze und -systeme für die Automatisierung in der
elektrischen Energieversorgung –
Teil 7-1: Grundlegende Kommunikationsstruktur –
Grundsätze und Modelle
(IEC 61850-7-1:2011 + A1:2020);
Englische Fassung EN 61850-7-1:2011 + A1:2020**

Communication networks and systems for power utility automation –
Part 7-1: Basic communication structure –
Principles and models
(IEC 61850-7-1:2011 + A1:2020);
English version EN 61850-7-1:2011 + A1:2020

Réseaux et systèmes de communication pour l'automatisation des systèmes électriques –
Partie 7-1: Structure de communication de base –
Principes et modèles
(IEC 61850-7-1:2011 + A1:2020);
Version anglaise EN 61850-7-1:2011 + A1:2020

Gesamtumfang 200 Seiten

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE

Anwendungsbeginn

Anwendungsbeginn für die von CENELEC am 2011-08-19 angenommene Europäische Norm und die am 2020-10-05 angenommene Änderung A1 als DIN-Norm ist 2022-12-01.

Für DIN EN 61850-7-1:2012-04 besteht eine Übergangsfrist bis 2023-10-05.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN EN 61850-7-1/A1:2019-05.

Für dieses Dokument ist das nationale Arbeitsgremium DKE/K 952 „Netzleittechnik“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE (www.dke.de) zuständig.

Aktuelle Informationen zu diesem Dokument können über die Internetseiten von DKE (www.dke.de) und DIN (www.din.de) durch eine Suche nach der Dokumentennummer aufgerufen werden.

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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.

Diese Norm ist die Übernahme der konsolidierten Edition 2.1 von IEC 61850-7-1:2011 + A1:2020. Durch das Amendment sind sehr umfangreiche Änderungen fast jeden Abschnittes durchgeführt worden. Deshalb wurde auf die Kennzeichnung der einzelnen Änderungen verzichtet.

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 61870-7-1 veröffentlicht. Zu deren Abschnitt 1, der den Anwendungsbereich festlegt und Abschnitt 3, der die Begriffe 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.

Änderungen

Gegenüber DIN EN 61850-7-1:2012-04 wurden folgende Änderungen vorgenommen:

- a) das Modell für statistische und historische statistische Daten;
- b) die Konzepte von Proxies, Gateways, LD-Hierarchie und LN-Inputs;
- c) das Modell für die Zeitsynchronisierung;
- d) die Konzepte hinter verschiedenen Prüfeinrichtungen;
- e) die erweiterte Protokollierungsfunktion;
- f) der Gebrauch von Zahlen zur Datenerweiterung;
- g) der Gebrauch von Namensräumen;
- h) der Modus und das Verhalten eines logischen Knotens;
- i) der Gebrauch von Bereichs- und Totbandwerten;
- j) der Zugang zu Steuerungsvorgängen und anderen;
- k) enthält Klarstellungen und Korrekturen zur zweiten Ausgabe der IEC 61850-7-1, 55 basierend auf den Themen = {828, 874, 948, 1060, 1072, 1129, 1151, 1196, 1251, 1268, 1312, 1396, 1437, 1468, 1491};
- l) Neufassung des Unterabschnitts 8.2.3 über Gateways und Proxys;
- m) Neufassung der vollständigen Abschnitte 13 und 14 über Namensräume und Regeln für die Erweiterung von Objektklassen;
- n) Hinzufügen von drei neuen normativen Anhängen für LGOS/LSVS-Engineering (G), GOOSE/SMV-Abonnementkonfiguration (H) und Beispielen für Anwendungsfälle zur Verdeutlichung der gemeinsamen Regeln von Abschnitt 14 (J);
- o) führt im informativen Anhang I das Konzept der Entkopplung von Domain-Namensräumen und Basis-Namensräumen in Ausgabe 3 dieses Dokuments ein.

Frühere Ausgaben

DIN EN 61850-7-1: 2004-12, 2012-04

Nationaler Anhang NA (informativ)

Auszugsweise Übersetzung

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

Einleitung

Dieser Teil der Normenreihe IEC 61850 bietet einen Überblick über die Architektur für die Kommunikation und Interaktion zwischen Systemen für die Automatisierung von elektrischen Energieversorgungen, wie z. B. Schutzeinrichtungen, Leistungsschaltern, Transformatoren, Stations-Hosts usw.

Dieses Dokument ist Teil einer Reihe von Spezifikationen, die eine mehrschichtige Kommunikationsarchitektur für die Automatisierung von elektrischen Energieversorgungen beschreiben. Diese Architektur wurde gewählt, um abstrakte Definitionen von Klassen (die hierarchische Informationsmodelle darstellen) und Diensten bereitzustellen, so dass die Spezifikationen unabhängig von bestimmten Protokollstapeln, Implementierungen und Betriebssystemen sind.

Das Ziel der Normenreihe IEC 61850 ist es, die Interoperabilität zwischen IEDs verschiedener Zulieferer herzustellen, genauer gesagt zwischen Funktionen, die von Systemen zur Automatisierung von elektrischen Energieversorgungen ausgeführt werden sollen, sich aber in Geräten (physischen Einrichtungen) verschiedener Zulieferer befinden. Interoperable Funktionen können Funktionen sein, die Schnittstellen zum Prozess darstellen (z. B. Leistungsschalter) oder Funktionen der Stationsautomatisierung wie z. B. Schutzfunktionen. In diesem Teil der Normenreihe IEC 61850 werden Beispiele von Funktionen zur Beschreibung der in der Normenreihe IEC 61850 angewandten Konzepte und Methoden genutzt.

In diesem Teil von IEC 61850 werden die Zusammenhänge zwischen anderen Teilen der Normenreihe IEC 61850 beschrieben. Zuletzt wird in diesem Teil beschrieben, wie Interoperabilität erreicht wird.

ANMERKUNG Austauschbarkeit ist die Fähigkeit, ein Gerät desselben Zulieferers oder verschiedener Zulieferer zu ersetzen, das dieselbe Kommunikationsschnittstelle verwendet und mindestens dieselbe Funktionalität bietet, ohne dass dies Auswirkungen auf das übrige System hat. Wenn Unterschiede in der Funktionalität akzeptiert werden, kann der Austausch auch einige Änderungen an anderer Stelle im System erfordern. Austauschbarkeit impliziert eine Standardisierung von Funktionen und, im engeren Sinne von Geräten, die nicht in den Anwendungsbereich dieser Norm fallen. Die Austauschbarkeit liegt außerhalb des Anwendungsbereichs, wird jedoch nach dieser Norm zur Interoperabilität unterstützt.

Dieser Teil der Normenreihe IEC 61850 ist für alle betroffenen Parteien der genormten Kommunikation und genormten Systeme in der Versorgungsindustrie vorgesehen. Er enthält einen Überblick über und eine Einführung in IEC 61850-7-4, IEC 61850-7-3, IEC 61850-7-2, IEC 61850-6 und IEC 61850-8-1.

1 Anwendungsbereich

In diesem Teil der Normenreihe IEC 61850 werden die Modellierungsmethoden, Kommunikationsprinzipien und Informationsmodelle vorgestellt, die in den verschiedenen Teilen der Normenreihe IEC 61850-7-x verwendet werden. Der Zweck dieses Teils der Normenreihe IEC 61850 besteht darin – aus konzeptioneller Sicht – eine Hilfe zum Verständnis der grundlegenden Modellierungskonzepte und Beschreibungsmethoden bereitzustellen für:

- stationsspezifische Informationsmodelle für Automatisierungssysteme von elektrischen Energieversorgungen,
- Gerätefunktionen, die für Automatisierungszwecke der elektrischen Energieversorgung genutzt werden, und
- Kommunikationssysteme zur Bereitstellung der Interoperabilität innerhalb von Energieversorgungseinrichtungen.

Darüber hinaus enthält dieser Teil der Normenreihe IEC 61850 Erläuterungen und detaillierte Anforderungen in Bezug auf den Zusammenhang zwischen IEC 61850-7-4, IEC 61850-7-3, IEC 61850-7-2 und IEC 61850-5. In diesem Teil wird erklärt, wie die abstrakten Dienste und Modelle der Normenreihe IEC 61850-7-x auf konkrete Kommunikationsprotokolle abgebildet werden, wie sie in IEC 61850-8-1 definiert sind.

Die Konzepte und Modelle, die in diesem Teil der Normenreihe IEC 61850 bereitgestellt werden, dürfen unter anderem auch zur Beschreibung von Informationsmodellen und Funktionen verwendet werden für:

- Wasserkraftwerke,
- Informationsaustausch von Station zu Station,
- Informationsaustausch für verteilte Automatisierung,
- Informationsaustausch von Station zu Kontrollzentrum,
- Informationsaustausch für die Messung,
- Zustandsüberwachung und Diagnose sowie
- Informationsaustauschs mit technischen Systemen für die Gerätekonfiguration.

ANMERKUNG 1 In diesem Teil der IEC 61850 werden Beispiele und Auszüge aus anderen Teilen der Normenreihe IEC 61850 verwendet. Diese Auszüge werden zur Erläuterung von Konzepten und Methoden verwendet. Diese Beispiele und Auszüge sind in diesem Teil der IEC 61850 informativ.

ANMERKUNG 2 In den Beispielen in diesem Teil werden Namen von Klassen verwendet, (z. B. XCBR für eine Klasse eines logischen Knotens), die in IEC 61850-7-4, IEC 61850-7-3 definiert sind, und Dienstnamen, die in IEC 61850-7-2 definiert sind. Die normativen Namen sind nur in IEC 61850-7-4, IEC 61850-7-3 und IEC 61850-7-2 definiert.

ANMERKUNG 3 In diesem Teil der IEC 61850 wird keine umfassende Anleitung bereitgestellt. Es wird empfohlen, diesen Teil zuerst zu lesen – gemeinsam mit IEC 61850-7-4, IEC 61850-7-3 und IEC 61850-7-2. Zusätzlich wird empfohlen, auch IEC 61850-1 und IEC 61850-5 zu lesen.

ANMERKUNG 4 In diesem Teil der IEC 61850 werden keine Implementierungsfragen diskutiert.

3 Begriffe

Für die Anwendung dieses Dokuments gelten die Begriffe nach IEC 61850-2 und 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>

3.1

Information

en **information**

Kenntnis über Objekte wie Sachverhalte, Ereignisse, Gegenstände, Vorgänge oder Vorstellungen (einschließlich Begriffen), die in einem gegebenen Zusammenhang eine bestimmte Bedeutung haben

[QUELLE: IEC 60050-101:1998, 101-12-01]

3.2

Informationsmodell

en **information model**

Kenntnis über die Funktionen der elektrischen Energieversorgung und die Geräte, in denen diese Funktionen implementiert sind

Diese Kenntnis wird mit Hilfe der Normenreihe IEC 61850 sichtbar und zugänglich gemacht. Das Modell beschreibt auf abstrakte Weise eine kommunikationsorientierte Darstellung einer realen Funktion oder eines Geräts.

3.3

Modell

en **model**

eine Darstellung eines Aspekts der Realität

Zweck der Erstellung eines Modells ist es, besser zu verstehen, zu beschreiben oder vorherzusagen, wie etwas in der Realität funktioniert, indem eine vereinfachte Darstellung einer bestimmten Einheit oder eines bestimmten Phänomens untersucht wird. Der Schwerpunkt des in der IEC 61850-7-x definierten Modells liegt auf den Kommunikationseigenschaften der modellierten Daten und Funktionen.

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

**EN 61850-7-1:2011-10
+ A1:2020-10**

ICS 33.200

Supersedes EN 61850-7-1:2003

English version

**Communication networks and systems for power utility automation –
Part 7-1: Basic communication structure – Principles and models
(IEC 61850-7-1:2011 + A1:2020)**

Réseaux et systèmes de communication pour
l'automatisation des systèmes électriques – Partie 7-1:
Structure de communication de base – Principes et modèles
(IEC 61850-7-1:2011 + A1:2020)

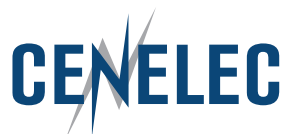
Kommunikationsnetze und -systeme für die Automatisierung in
der elektrischen Energieversorgung – Teil 7-1: Grundlegende
Kommunikationsstruktur – Grundsätze und Modelle
(IEC 61850-7-1:2011 + A1:2020)

This European Standard was approved by CENELEC on 2011-08-19 and A1 on 2020-10-05. 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 responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Foreword

The text of document 57/1121/FDIS, future edition 2 of IEC 61850-7-1, prepared by IEC TC 57, Power systems management and associated information exchange, was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61850-7-1:2011.

This document supersedes EN 61850-7-1:2003.

Compared to EN 61850-7-1:2003, EN 61850-7-1:2011 introduces:

- the model for statistical and historical statistical data,
- the concepts of proxies, gateways, LD hierarchy and LN inputs,
- the model for time synchronisation,
- the concepts behind different testing facilities,
- the extended logging function.

EN 61850-7-1:2011 also clarifies the following points:

- the use of numbers for data extension,
- the use of name spaces,
- the mode and behaviour of a logical node,
- the use of range and deadbanded values,
- the access to control actions and others.

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) | 2012-05-19 |
| – latest date by which the national standards conflicting with the document have to be withdrawn | (dow) | 2014-08-19 |

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

Endorsement notice

The text of the International Standard IEC 61850-7-1:2011 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 61346-1 | NOTE | Harmonized as EN 61346-1. |
| IEC 61346-2 | NOTE | Harmonized as EN 61346-2. |
| IEC 61400 series | NOTE | Harmonized in EN 61400 series (not modified). |

European foreword to Amendment A1

The text of document 57/2201/FDIS, future IEC 61850-7-1/A1, prepared by IEC/TC 57 "Power systems management and associated information exchange" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61850-7-1:2011/A1:2020.

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) 2021-07-05
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2023-10-05

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This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association.

Endorsement notice

The text of the International Standard IEC 61850-7-1:2011/A1:2020 was approved by CENELEC as a European Standard without any modification.

Remove the following reference:

IEC 61400 series NOTE Harmonized in EN 61400 series.

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.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC/TS 61850-2	–	Communication networks and systems in substations - Part 2: Glossary	-	–
IEC 61850-3	–	Communication networks and systems in substations - Part 3: General requirements	EN 61850-3	–
IEC 61850-4	–	Communication networks and systems for power utility automation - Part 4: System and project management	EN 61850-4	–
IEC 61850-5	–	Communication networks and systems in substations - Part 5: Communication requirements for functions and device models	EN 61850-5	–
IEC 61850-6	–	Communication networks and systems for power utility automation - Part 6: Configuration description language for communication in electrical substations related to IEDs	EN 61850-6	–
IEC 61850-7-2	–	Communication networks and systems for power utility automation - Part 7-2: Basic information and communication structure - Abstract communication service interface (ACSI)	EN 61850-7-2	–
IEC 61850-7-3	–	Communication networks and systems for power utility automation - Part 7-3: Basic communication structure - Common data classes	EN 61850-7-3	–
IEC 61850-7-4	–	Communication networks and systems for power utility automation - Part 7-4: Basic communication structure - Compatible logical node classes and data object classes	EN 61850-7-4	–

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61850-8-1	–	Communication networks and systems for power utility automation - Part 8-1: Specific Communication Service Mapping (SCSM) - Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3	EN 61850-8-1	–
IEC 61850-9-2	–	Communication networks and systems in substations - Part 9-2: Specific Communication Service Mapping (SCSM) - Sampled values over ISO/IEC 8802-3	EN 61850-9-2	–
IEC 61850-10	–	Communication networks and systems in substations - Part 10: Conformance testing	EN 61850-10	–
ISO/IEC 8802-3	–	Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications	–	–
ISO/IEC 8825	Series	Information technology - ASN.1 encoding rules	–	–
ISO 9506-1	–	Industrial automation systems - Manufacturing Message Specification - Part 1: Service definition	–	–
ISO 9506-2	–	Industrial automation systems - Manufacturing Message Specification - Part 2: Protocol specification	–	–

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INTRODUCTION

This part of the IEC 61850 series provides an overview of the architecture for communication and interactions between systems for power utility automation such as protection devices, breakers, transformers, substation hosts etc.

This document is part of a set of specifications which details a layered communication architecture for power utility automation. This architecture has been chosen to provide abstract definitions of classes (representing hierarchical information models) and services such that the specifications are independent of specific protocol stacks, implementations, and operating systems.

The goal of the IEC 61850 series is to provide interoperability between the IEDs from different suppliers or, more precisely, between functions to be performed by systems for power utility automation but residing in equipment (physical devices) from different suppliers. Interoperable functions may be those functions that represent interfaces to the process (for example, circuit breakers) or substation automation functions such as protection functions. This part of the IEC 61850 series uses simple examples of functions to describe the concepts and methods applied in the IEC 61850 series.

This part of the IEC 61850 series describes the relationships between other parts of the IEC 61850 series. Finally this part defines how interoperability is reached.

NOTE Interchangeability is the ability to replace a device from the same vendor, or from different vendors, utilising the same communication interface and as a minimum, providing the same functionality, with no impact on the rest of the system. If differences in functionality are accepted, the exchange may also require some changes somewhere else in the system. Interchangeability implies a standardisation of functions and, in a strong sense, of devices which are outside the scope of this standard. Interchangeability is outside the scope, but it will be supported following this standard for interoperability.

This part of the IEC 61850 series is intended for all stakeholders of standardised communication and standardised systems in the utility industry. It provides an overview of and an introduction to IEC 61850-7-4, IEC 61850-7-3, IEC 61850-7-2, IEC 61850-6, and IEC 61850-8-1.

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-1: Basic communication structure – Principles and models

1 Scope

This part of the IEC 61850 series introduces the modelling methods, communication principles, and information models that are used in the various parts of the IEC 61850-7-x series. The purpose of this part of the IEC 61850 series is to provide – from a conceptual point of view – assistance to understand the basic modelling concepts and description methods for:

- substation-specific information models for power utility automation systems,
- device functions used for power utility automation purposes, and
- communication systems to provide interoperability within power utility facilities.

Furthermore, this part of the IEC 61850 series provides explanations and provides detailed requirements relating to the relation between IEC 61850-7-4, IEC 61850-7-3, IEC 61850-7-2 and IEC 61850-5. This part explains how the abstract services and models of the IEC 61850-7-x series are mapped to concrete communication protocols as defined in IEC 61850-8-1.

The concepts and models provided in this part of the IEC 61850 series may also be applied to describe, among others, information models and functions for:

- hydroelectric power plants,
- substation to substation information exchange,
- information exchange for distributed automation,
- substation to control centre information exchange,
- information exchange for metering,
- condition monitoring and diagnosis, and
- information exchange with engineering systems for device configuration.

NOTE 1 This part of IEC 61850 uses examples and excerpts from other parts of the IEC 61850 series. These excerpts are used to explain concepts and methods. These examples and excerpts are informative in this part of IEC 61850.

NOTE 2 Examples in this part use names of classes (e.g. XCBR for a class of a logical node) defined in IEC 61850-7-4, IEC 61850-7-3, and service names defined in IEC 61850-7-2. The normative names are defined in IEC 61850-7-4, IEC 61850-7-3, and IEC 61850-7-2 only.

NOTE 3 This part of IEC 61850 does not provide a comprehensive tutorial. It is recommended that this part be read first – in conjunction with IEC 61850-7-4, IEC 61850-7-3, and IEC 61850-7-2. In addition, it is recommended that IEC 61850-1 and IEC 61850-5 also be read.

NOTE 4 This part of IEC 61850 does not discuss implementation issues.

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 61850-2, *Communication networks and systems in substations – Part 2: Glossary*

IEC 61850-3, *Communication networks and systems in substations – Part 3: General requirements*

IEC 61850-4, *Communication networks and systems for power utility automation – Part 4: System and project management*

IEC 61850-5, *Communication networks and systems in substations – Part 5: Communication requirements for functions and device models*

IEC 61850-6, *Communication networks and systems for power utility automation – Part 6: Configuration description language for communication in electrical substations related to IEDs*

IEC 61850-7-2, *Communication networks and systems for power utility automation – Part 7-2: Basic information and communication structure – Abstract communication service interface (ACSI)*

IEC 61850-7-3, *Communication networks and systems for power utility automation – Part 7-3: Basic communication structure – Common data classes*

IEC 61850-7-4, *Communication networks and systems for power utility automation – Part 7-4: Basic communication structure – Compatible logical node classes and data object classes*

IEC 61850-8-1, *Communication networks and systems for power utility automation – Part 8-1: Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3*

IEC 61850-9-2, *Communication networks and systems in substations – Part 9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3*

IEC 61850-10, *Communication networks and systems in substations – Part 10: Conformance testing*

ISO/IEC 8802-3, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO/IEC 8825 (all parts), *Information technology – ASN.1 encoding rules*

ISO 9506-1, *Industrial automation systems – Manufacturing Message Specification – Part 1: Service definition*

ISO 9506-2, *Industrial automation systems – Manufacturing Message Specification – Part 2: Protocol specification*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61850-2 as well as the following apply.

3.1 information

knowledge concerning objects, such as facts, events, things, processes, or ideas, including concepts, that within a certain context has a particular meaning

[IEC 60050-101:1998, 101-12-01]

3.2 information model

knowledge concerning power utility functions and devices in which the functions are implemented

This knowledge is made visible and accessible through the means of the IEC 61850 series. The model describes in an abstract way a communication-oriented representation of a real function or device.

3.3

model

a representation of some aspect of reality

The purpose of creating a model is to help understand, describe, or predict how things work in the real world by exploring a simplified representation of a particular entity or phenomenon. The focus of the model defined in IEC 61850-7-x is on the communication features of the data and functions modelled.

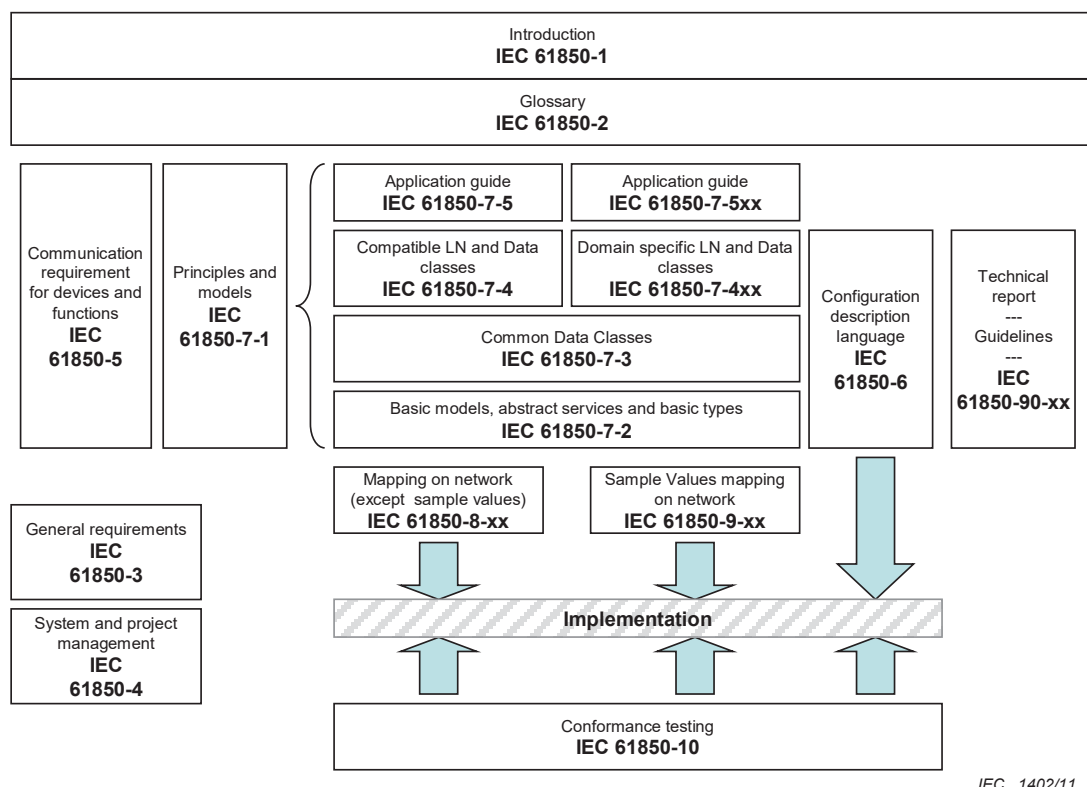
4 Abbreviated terms

ACSI	Abstract communication service interface
ASN.1	Abstract syntax notation one
API	Application program interface
CDC	Common data class
CT	Current transformer
DST	Daylight saving time
GOOSE	Generic oriented object system event
IED	Intelligent electronic device
LD	Logical device
LN	Logical node
LLN0	Logical node zero
LPHD	Logical node physical device
MICS	Model implementation conformance statement
MMS	Manufacturing message specification
PHD	Physical device
PICOM	Piece of communication
PICS	Protocol implementation conformance statement
SAS	Substation automation system
SCSM	Specific communication service mapping
SICS	SCL implementation conformance statement
SoE	Sequence of events
SMV	Sample values
UCAIug	UCA international users group
UTC	Universal time coordinated
VMD	Virtual manufacturing device
VT	Voltage transformer
XML	extended markup language

5 Overview of the IEC 61850 series concepts

5.1 Objective

IEC 61850-7-4, IEC 61850-7-3, IEC 61850-7-2, IEC 61850-6, and IEC 61850-8-1 are closely related. This subclause provides an overview of these parts and it describes how they are interwoven. The modelling and implementation methods applied in the different parts of the standard and their relation are shown in Figure 1.



IEC 1402/11

Figure 1 – Relations between modelling and mapping parts of the IEC 61850 series

Each part defines a specific aspect of a substation IED:

- IEC 61850-1 gives an introduction and overview of the IEC 61850 series,
- IEC 61850-2 contains the glossary of specific terminology and definitions used in the context of power utility automation systems within the various parts of the standard,
- IEC 61850-3 specifies the general requirements of the communication network with regard to the quality requirements, environmental conditions and auxiliary services,
- IEC 61850-4 pertains to the system and project management with respect to the engineering process, the life cycle of the SAS and the quality assurance from the development stage to the discontinuation and decommissioning of the SAS.
- IEC 61850-5 specifies the communication requirements of the functions being performed in systems for power utility automation and to device models. All known functions and their communication requirements are identified,
- this part of IEC 61850 defines the basic principles and modelling methods,
- IEC 61850-6 specifies a file format for describing communication related IED (intelligent electronic device) configurations and IED parameters, communication system configurations, switchyard (function) structures, and the relations between them. The main purpose of the format is to exchange IED capability descriptions, and system level descriptions between engineering tools of different manufacturers in a compatible way. The defined language is called substation configuration description language (SCL). Mapping specific extensions or usage rules may be required in the appropriate parts.

- IEC 61850-7-5 defines the usage of information models for substation automation applications. It gives clear examples on how to apply LNs and data defined in IEC 61850-7-4 for different substation applications. The examples cover applications from monitoring function to protection blocking schemes. Other domain specific application guides which are within the scope of IEC technical committee 57 are defined in the IEC 61850-7-5xx series¹. Examples are hydropower and distributed energy resources domains,
- IEC 61850-7-4 defines specific information models for substation automation functions (for example, breaker with status of breaker position, settings for a protection function, etc.) – what is modelled and could be exchanged. Other domain specific information models within the scope of IEC technical committee 57 are defined in the 61850-7-4xx series,
- IEC 61850-7-3 has a list of commonly used information (for example, for double point control, 3-phase measurand value, etc.) – what the common basic information is,
- IEC 61850-7-2 provides the services to exchange information for the different kinds of functions (for example, control, report, get and set, etc.) – how to exchange information,
- IEC 61850-8-1 defines the concrete means to communicate the information between IEDs (for example, the application layer, the encoding, etc.) – how to serialise the information during the exchange,
- IEC 61850-9-2, and particularly the subset 9-2LE described in the “Implementation Guideline for Digital Interface to Instrument Transformers using IEC 61850-9-2” by the UCAIug, defines the concrete means to communicate sampled values between sensors and IEDs,
- IEC 61850-10 defines the methods and abstract cases for conformance testing of devices and engineering tools as well as the metrics to be measured within devices according to the requirements defined in IEC 61850-5,
- there may be object classes defined for various other application domains outside the scope of IEC technical committee 57. They are relevant to Figure 1 only if they are built according to the approach of the IEC 61850 series.

5.2 Topology and communication functions of substation automation systems

As shown by the topology in Figure 2, one focus of the IEC 61850 series is the support of substation automation functions by the communication of (numbers in brackets refer to the figure):

- sampled value exchange for CTs and VTs (1),
- fast exchange of I/O data for protection and control (2),
- control signals (3),
- trip signals (4),
- engineering and configuration (5),
- monitoring and supervision (6),
- control-center communication (7),
- time-synchronisation,
- etc.

Support for other functions such as metering, condition monitoring, and asset management is provided as well.

Many functions are implemented in intelligent electronic devices (IED). Several functions may be implemented in a single IED or one function may be implemented in one IED and another function may be hosted by another IED. IEDs (i.e., the functions residing in IEDs) communicate with functions in other IEDs by the information

¹ IEC 61850-7-4xx, -7-5xx, -8-xx, -9-xx and -90-xx are series of documents whose scope is similar. For example, IEC 61850-7-4 deals with data object classes used for substations while IEC 61850-7-410 deals with data object classes used for hydroelectric power plants. IEC 61850-90-xx series is reserved for technical reports or guidelines.

exchange mechanisms of this standard. Therefore, functions distributed over more than one IED may be also implemented.

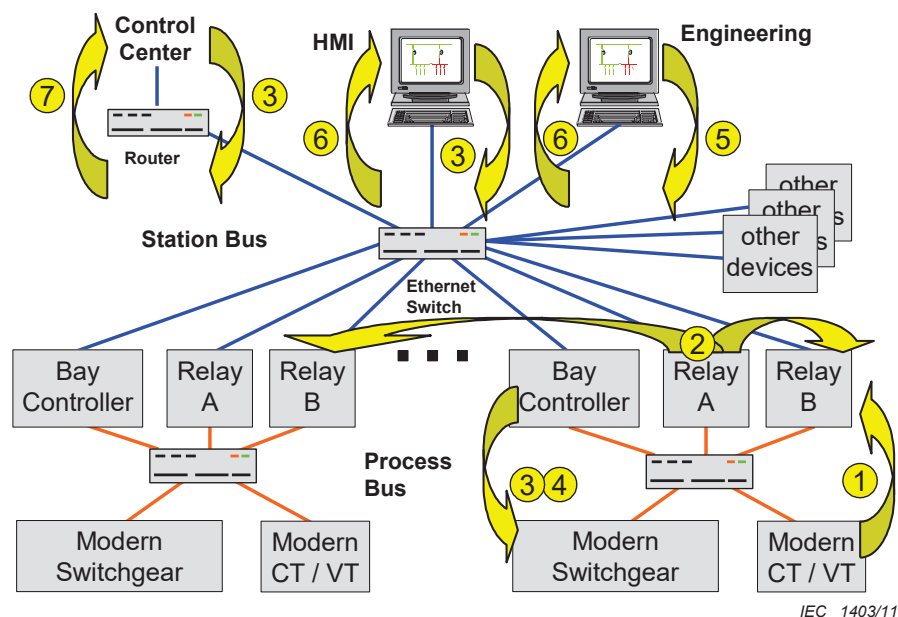
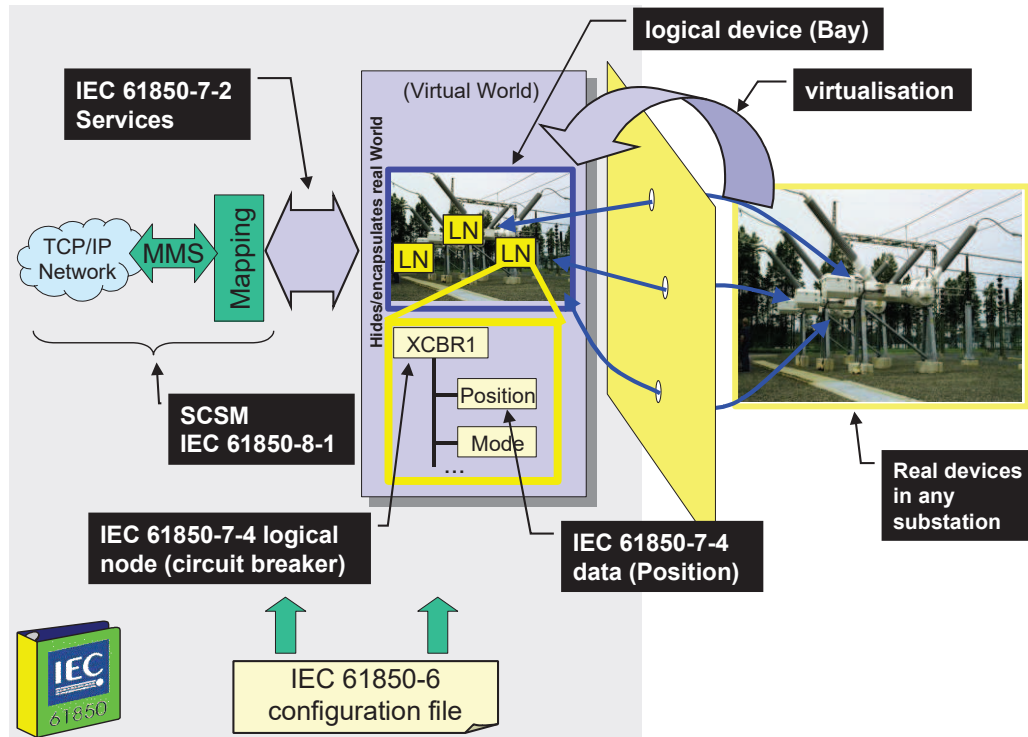


Figure 2 – Sample substation automation topology

5.3 The information models of substation automation systems

The information exchange mechanisms rely primarily on well-defined information models. These information models and the modelling methods are at the core of the IEC 61850 series. The IEC 61850 series uses the approach to model the common information found in real devices as depicted in Figure 3. All information made available to be exchanged with other devices is defined in the standard. The model provides for systems for power utility automation an image of the analogue world (power system process, switchgear).

NOTE 1 “The common information” in the context of the IEC 61850 series means that the stakeholders of power utility automation systems (users and vendors) have agreed that the information defined in the IEC 61850 series is widely accepted and required for the open exchange of information between any kind of substation IEDs.



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Figure 3 – Modelling approach (conceptual)

Implementations to reach interoperability have to be based on common understanding of definitions. Therefore, the parts describing the data model contain mandatory semantic tables which have to be considered very carefully.

The IEC 61850 series defines the information and information exchange in a way that it is independent of a concrete implementation (i.e., it uses abstract models). The standard also uses the concept of virtualisation. Virtualisation provides a view of those aspects of a real device that are of interest for the information exchange with other devices. Only those details that are required to provide interoperability of devices are defined in the IEC 61850 series.

As described in IEC 61850-5, the approach of the standard is to decompose the application functions into the smallest entities, which are used to exchange information. The granularity is given by a reasonable distributed allocation of these entities to dedicated devices (IED). These entities are called logical nodes (for example, a virtual representation of a circuit breaker class, with the standardised class name XCBR). The logical nodes are modelled and defined from the conceptual application point of view in IEC 61850-5. Several logical nodes build a logical device (for example, a representation of a Bay unit). A logical device is always implemented in one IED; therefore logical devices do not contain logical nodes from different IEDs².

Real devices on the right-hand side of Figure 3 are modelled as a virtual model in the middle of the figure. The logical nodes defined in the logical device (for example, bay) correspond to well-known functions in the real devices. In this example, the logical node XCBR represents a specific circuit breaker of the bay to the right.

NOTE 2 The logical nodes of this example may be implemented in one or several IEDs as appropriate. If the logical nodes are implemented in different IEDs, they need exchange information over a network. Information exchange inside a logical node is outside the scope of the IEC 61850 series.

² There is one exception: the proxy/gateway application. For details, refer to 8.2.3 Gateways and proxies.

Based on their functionality, a logical node contains a list of data (for example, position) with dedicated data attributes. The data have a structure and a well-defined semantic (meaning in the context of systems for power utility automation or, e.g. more specifically, of substation automation systems). The information represented by the data and their attributes are exchanged by the services according to the well-defined rules and the requested performance as described in IEC 61850-5. The services are implemented by a specific and concrete communication means (SCSM, for example, using MMS, TCP/IP, and Ethernet among others).

The logical nodes and the data contained in the logical device are crucial for the description and information exchange for substation automation systems to reach interoperability.

The logical devices, the logical nodes and the data they contain need to be configured. The main reason for the configuration is to select the appropriate logical nodes and data from the standard and to assign the instance-specific values, for example, concrete references between instances of the logical nodes (their data) and the exchange mechanisms, and initial values for process data.

5.4 Applications modelled by logical nodes defined in IEC 61850-7-4

Table 1 lists all groups of logical nodes defined in IEC 61850-7-4. Over one hundred logical nodes covering the most common applications of substation and feeder equipment are defined. While the definition of information models for protection and protection related applications is important because of the high impact of protection for safe and reliable operation of the power system, the covered applications include many other functions like monitoring, measurement, control and power quality.

Table 1 – LN groups

Group indicator	Logical node groups
A	Automatic control
C	Supervisory control
D	DER (Distributed Energy Resources)
F	Functional blocks
G	Generic function references
H	Hydro power
I	Interfacing and archiving
K	Mechanical and non-electrical primary equipment
L	System functions
M	Metering and measurement
P	Protection functions
Q	Power quality events detection related
R	Protection related functions
S	Supervision and monitoring
T	Instrument transformer and sensors
W	Wind power
X	Switchgear
Y	Power transformer and related functions
Z	Further (power system) equipment

IEC 61850 has well-defined rules to define additional logical nodes and data, for example for additional functions within substations or for other application domains such as wind power plants. For details on the extension rules, see Clauses 13 and 14 of this document.

The following excerpt of the logical nodes has been included to provide an example of what kind of real applications the logical nodes represent:

- distance protection;
- differential protection;
- overcurrent;
- undervoltage;
- directional over power;
- volts per Hz relay;
- transient earth fault;
- directional element;
- harmonic restraint;
- protection scheme;
- zero speed or underspeed;
- measurement;
- metering;
- sequence and imbalance;
- harmonics and interharmonics;
- differential measurements;
- switch control;
- circuit breaker;
- circuit switch;
- and others.

Most logical nodes provide information that can be categorised as depicted in Figure 4. The semantic of a logical node is represented by data and data attributes. Logical nodes may provide a few or up to 30 data. Data may contain a few or even more than 20 data attributes. Logical nodes may contain more than 100 individual information (points) organised in a hierarchical structure.

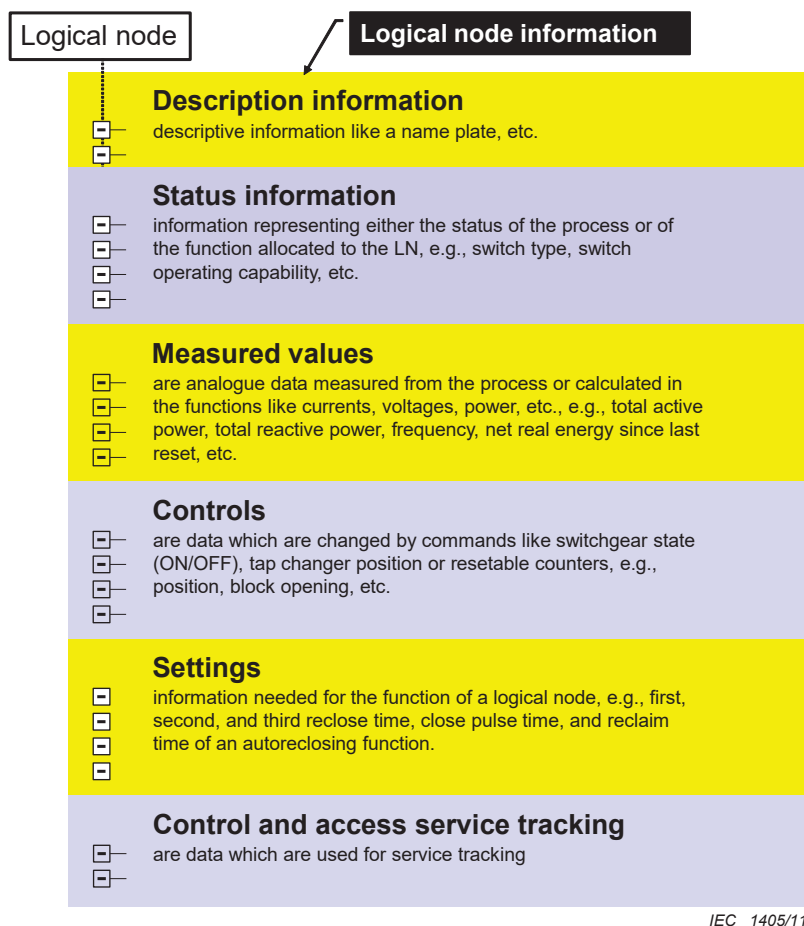


Figure 4 – Logical node information categories

IEDs are built up by composing logical nodes as depicted in Figure 5. The logical nodes are the building blocks of substation IEDs, for example, circuit breaker (XCBR) and others. In the example for each phase, one instance of XCBR is used.

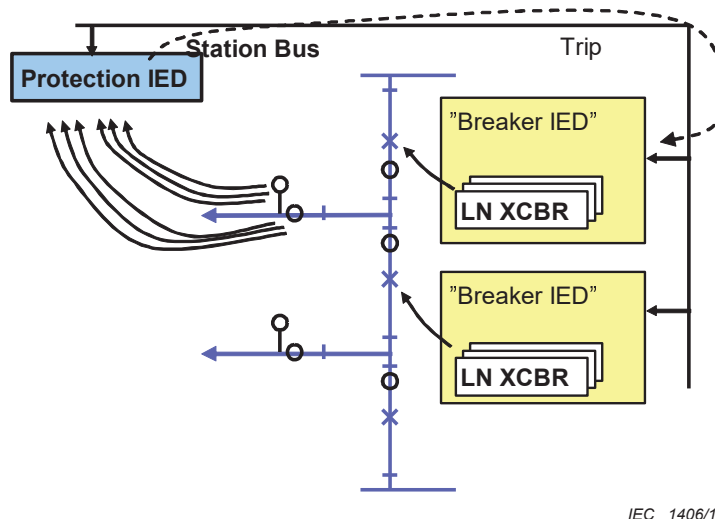


Figure 5 – Build-up of devices (principle)

In Figure 5, the protection IED receives the values for the voltage and current from conventional VT and CT. The protection functions in the protection device may detect a fault and issue or send a trip signal via the station bus. The standard supports also IEDs for digitizing VTs and CTs sending voltage and current as samples to the protection over a serial link. The output of conventional VTs and CTs may also be converted at the source to samples and transmitted over this serial link.

The logical nodes are used to build up substation IEDs.

5.5 The semantic is attached to data

The mean number of specific data provided by logical nodes defined in IEC 61850-7-4 is approximately 20. Each of the data (for example, position of a circuit breaker) comprises several details (the data attributes). The position (named "Pos") of a circuit breaker is defined in the logical node XCBR (see Figure 6). The position is defined as data. The category of the position in the logical node is "controls" – the position can be controlled via a control service.

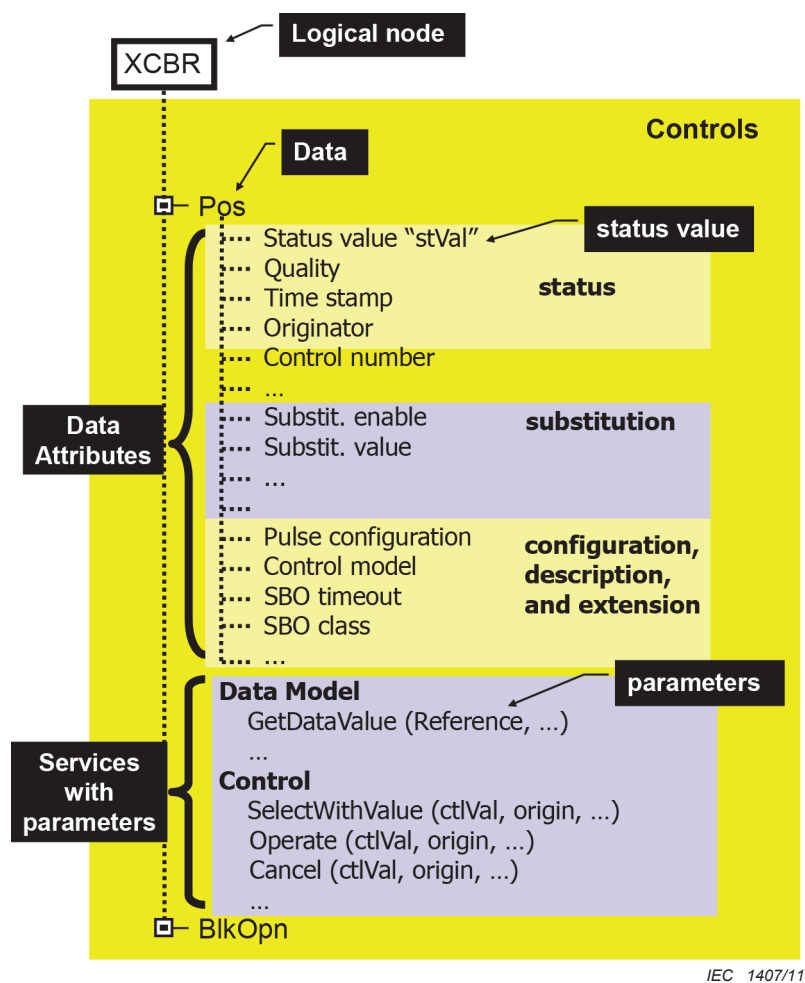


Figure 6 – Position information depicted as a tree (conceptual)

The position Pos is more than just a simple "point" in the sense of simple RTU protocols. It is made up of several data attributes. The data attributes are categorised as follows:

- status (or measured/metered values, or settings),
- control mirror,
- substitution and blocked,
- configuration, description and extension.

The data example Pos has approximately 20 data attributes accessible through different services. The data attribute Pos.stVal represents the position of the real breaker (could be in intermediate-state, off, on, or bad-state).

The position Pos can be controlled by use of control services and the associated service parameters. It is important to understand that these service parameters are not part of the data model: they do not represent data attributes. They only “live” the time of the command execution.

The position also has information about the originator that issued the command and the control number (given by the originator in the request). Furthermore, the position contains the cause diagnosis of a negative control response. The quality and time stamp information indicate the current validity of the status value and the time of the last change of the status value.

The current values for stVal, the quality and the time stamp (associated with the stVal) can be read, reported or logged in a buffer of the IED.

The values for stVal and quality can be remotely substituted. The substituted values take effect immediately after enabling substitution.

Several data attributes are defined for the configuration of the control behaviour, for example, pulse configuration (single pulse or persistent pulses, on/off-duration, and number of pulses) or control model (direct, select-before-operate, etc.).

Data attributes are defined primarily by an attribute name and an attribute type:

Attribute name	Attribute type	FC	TrgOp	(Value/value range) Description	PresCond
stVal	DpStatusKind	ST	dchg	Status value of the controllable data object.	M
ctlModel	CtlModelKind	CF	dchg	Control model as defined in IEC 61850-7-2 that reflects the behaviour of the controllable data object.	M

Additional information provides further details (one could say provides meta-data) on:

- the services allowed: functional constraint -> FC=SV means that specific services shall be applied only (for example SV refers to the substitution service),
- the trigger conditions that cause a report to be sent: TrgOp=dchg means that a change in the value of that attribute causes a report,
- the value or value range,
- the presence conditions, e.g. mandatory (M) or optional (O). These conditions specify presence of elements in a given context (one LN, or one CDC, or one data attribute type, or one data object for dataNs) and are specified in IEC 61850-7-2.

The data attribute names are standardised (i.e., they are reserved) names that have a specific semantic in the context of the IEC 61850 series. The semantic of all data attribute names is defined in IEC 61850-7-3.

The names of the data and data attributes carry the crucial semantic of a substation IED.

The position information Pos as shown in Figure 6 has many data attributes that can be found in many other switching-specific applications. The prime characteristic of the position is the data attribute stVal (status value) which represents four states: intermediate-state | off | on | bad-state. These four states (represented usually with two bits) are commonly known as “double point” information. The whole set of all the data attributes defined for the data Pos (position) is called a “common data class” (CDC). The name of the common data class of the double point information is DPC (controllable double point).

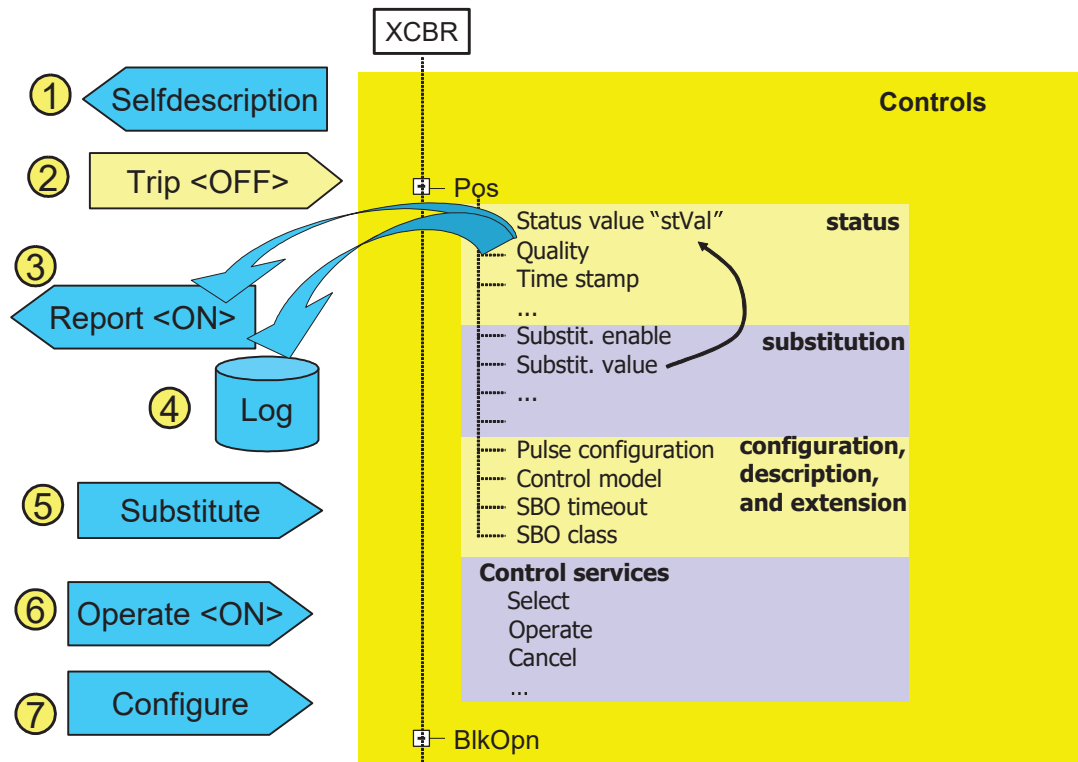
Common data classes provide a useful means to reduce the size of data definitions (in the standard). The data definition does not need to list all the attributes but needs to just reference the common data class. Common data classes are also very useful to keep the definitions of data attributes consistent. A change in the double point control CDC specific data attributes only needs to be made in a single place – in the DPC definition of IEC 61850-7-3.

IEC 61850-7-3 defines common data classes for a wide range of well-known applications. The core common data classes are classified into the following groups:

- status information,
- measurand information,
- controllable status information,
- controllable analogue information,
- status settings,
- analogue settings,
- description information, and
- Service tracking.

5.6 The services to exchange information

The logical nodes, data, data attributes and service parameters are defined mainly to specify the information required to perform an application, and for the exchange of information between IEDs. The information exchange is defined by means of services. An excerpt of the services is displayed in Figure 7.



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NOTE The circles with the numbers (1) to (7) refer to the list below.

Figure 7 – Service excerpt

The operate service manipulates the control specific service parameters of a circuit breaker position (open or close the breaker). The report services inform another device that the position of the circuit breaker has been changed. The substitute service forces a specific data attribute to be set to a value independent of the process.

The categories of services (defined in IEC 61850-7-2) are as follows:

- retrieving the self-description of a device, see (1) in Figure 7,
- fast and reliable peer-to-peer exchange of status information (tripping or blocking of functions or devices), see (2) in Figure 7,
- reporting of any set of data (data attributes), SoE – cyclic and event triggered, see (3) in Figure 7,
- logging and retrieving of any set of data (data attributes) – cyclic and event, see (4) in Figure 7,
- substitution, see (5) in Figure 7,
- handling and setting of parameter setting groups,
- transmission of sampled values from sensors,
- time synchronisation,
- file transfer,
- control devices (operate service), see (6) in Figure 7, and
- online configuration, see (7) in Figure 7.

Many services operate directly on the attributes of the information model (i.e., on the data attributes of data contained in logical nodes). The pulse configuration of the data attribute Pos of a specific circuit breaker can be set directly by a client to a new value. Directly means that the service operates on the request of the client without specific constraints of the IED.

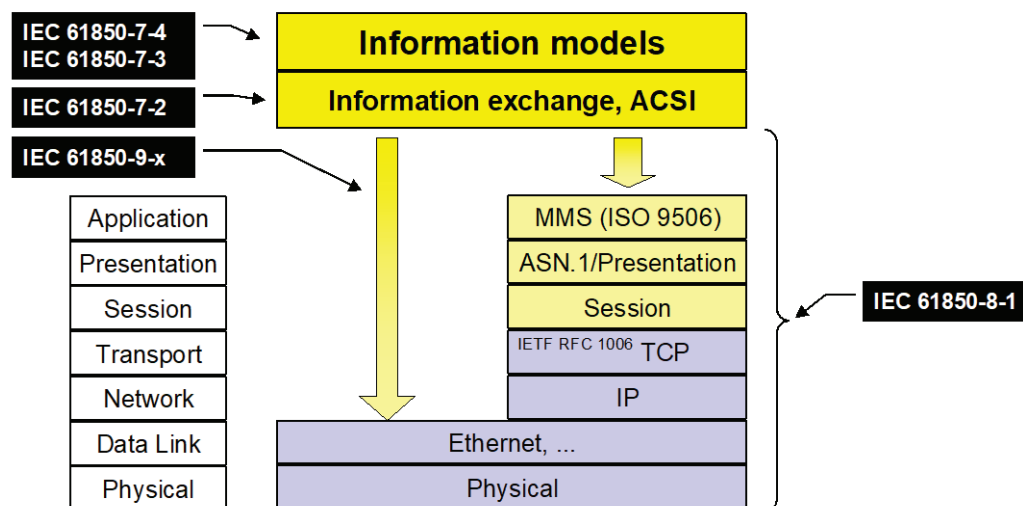
Other services provide a more complex behaviour which is dependent on the state of some specific state machine. A control request may be required to follow a state machine associated with the data attribute, for example, select-before-operate.

There are also several application-specific communication services that provide a comprehensive behaviour model which partially act autonomously. The reporting service model describes an operating-sequence in which the IED acts automatically on certain trigger conditions defined in the information model (for example, report on data-change of a status value) or conditions defined in the reporting service model (for example, report on a periodical event).

5.7 Services mapped to concrete communication protocols

The services defined in IEC 61850-7-2 are called abstract services. Abstract means that only those aspects that are required to describe the required actions on the receiving and sending side of a service request are defined in IEC 61850-7-2. They are based on the functional requirements in IEC 61850-5. The semantic of the service models with their attributes and the semantic of the services that operate on these attributes (including the parameters that are carried with the service requests and responses) are defined in IEC 61850-7-2.

The specific syntax (format) and especially the encoding of the messages that carry the service parameters of a service and how these are passed through a network are defined in a specific communication service mapping (SCSM). One SCSM – IEC 61850-8-1 – is the mapping of the services to MMS (ISO 9506-1 and ISO 9506-2) and other provisions like TCP/IP and Ethernet (see Figure 8), another is IEC 61850-9-2 – the direct mapping on Ethernet.



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Figure 8 – Example of communication mapping

Additional mappings to other communication stacks are possible. However, to not jeopardize interoperability, the number of accepted mappings in the standard shall be a minimum. The main purpose of this flexibility is to be able to follow over time the evolution in communication technology. The ACSI is independent of the mappings.

5.8 The configuration of the automation system

IEC 61850-6 specifies a file format for describing communication related IED configurations and IED parameters, communication system configurations, switchyard (function) structures, and the relations between them. The main purpose of this format is to exchange IED capability descriptions, and SA system descriptions between IED engineering tools and the system engineering tool(s) of different manufacturers in a compatible way.

The defined language is called substation configuration description language (SCL). The configuration language is based on the extensible markup language (XML) version 1.0.

To support the intended engineering process, the SCL is capable to describe:

- a) a system specification in terms of the single line diagram, and allocation of logical nodes to parts and equipment of the single line to indicate the needed functionality,
- b) pre-configured IEDs with:
 - the logical node, datasets and report control block definitions,
 - the supported services: GOOSE, sampled values, logging, file handling,
- c) pre-configured IEDs with no semantic or a pre-configured semantic for a process part of a certain structure, for example a double busbar GIS line feeder,
- d) complete process configuration with all IEDs bound to individual process functions and primary equipment, enhanced by the access point connections and possible access paths in subnetworks for all possible clients,
- e) as item d) above, but additionally with all predefined associations and client server connections between logical nodes on data level. This is needed if an IED is not capable of dynamically building associations or reporting connections (either on the client or on the server side).

The scope of SCL is focussed on these purposes:

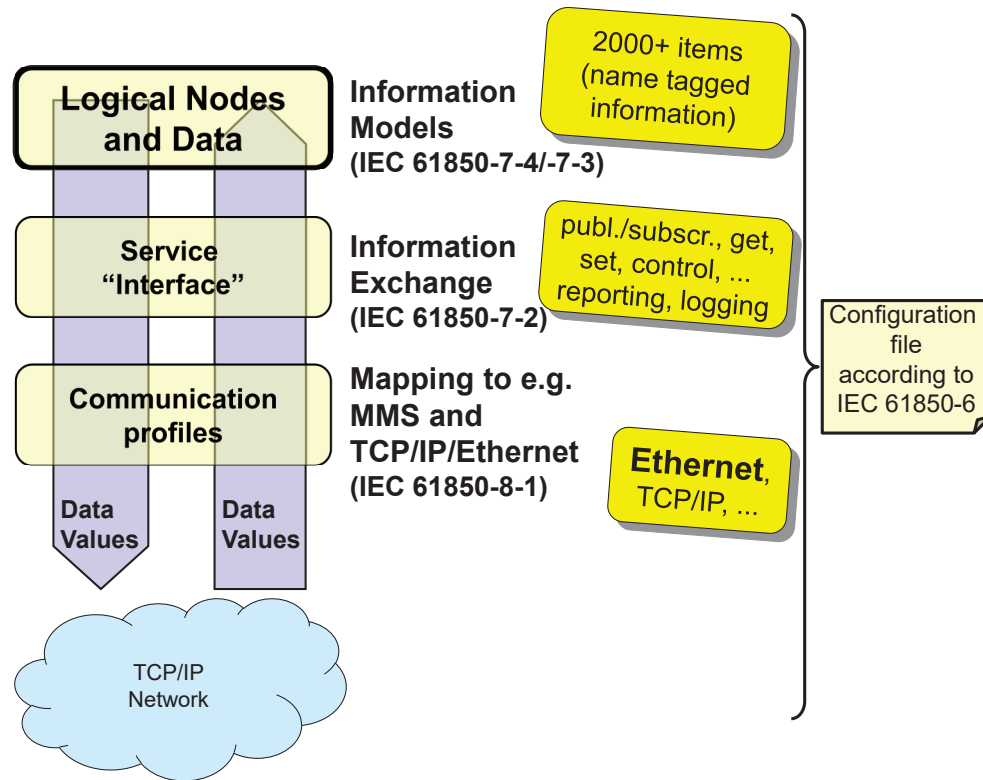
- 1) SAS functional specification (point a) above),
- 2) IED capability description (points b) and c) above), and
- 3) SA system description (points d) and e) above).

These purposes shall support in a standardised way system design, communication engineering and the description of the readily engineered system communication for the device engineering tools.

5.9 Summary

Figure 9 exhibits a summary of Clause 5. The four main building blocks are

- the substation automation system specific information models,
- the information exchange methods,
- the mapping to concrete communication protocols, and
- the configuration of a substation IED.



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Figure 9 – Summary

These four building blocks are to a high degree independent of each other. The information is separated from the presentation and from the information exchange services. The information exchange services are separated from the concrete communication profiles. It means that the information models can easily be extended, by definition of new logical nodes and new data according to specific and flexible rules, as required by another application domain. In the same way, different communication stacks may be used following the state-of-the-art in communication technology. But to keep interoperability simple, one stack only should be selected at one time. For the selection, see IEC 61850-8-x and IEC 61850-9-x.

Clause 6 provides a more detailed view of the four building blocks.

6 Modelling approach of the IEC 61850 series

6.1 Decomposition of application functions and information

As described in IEC 61850-5, the general approach of the IEC 61850 series is to decompose application functions into the smallest entities, which are then used to communicate. The granularity is given by a reasonable distributed allocation of these entities to dedicated devices (IED). The entities are called logical nodes. The requirements for logical nodes are defined – from an application point of view – in IEC 61850-5.

Based on their functionality, these logical nodes comprise data with dedicated data attributes. The information represented by the data and the data attributes are exchanged by dedicated services according to well-defined rules and the performance requested as required in IEC 61850-5.

The decomposition process (to get the most common logical nodes) and the composition process (to build up devices using logical nodes) are depicted in Figure 10. The data classes contained in logical nodes have been defined to support the most common applications in an understandable and commonly accepted way.

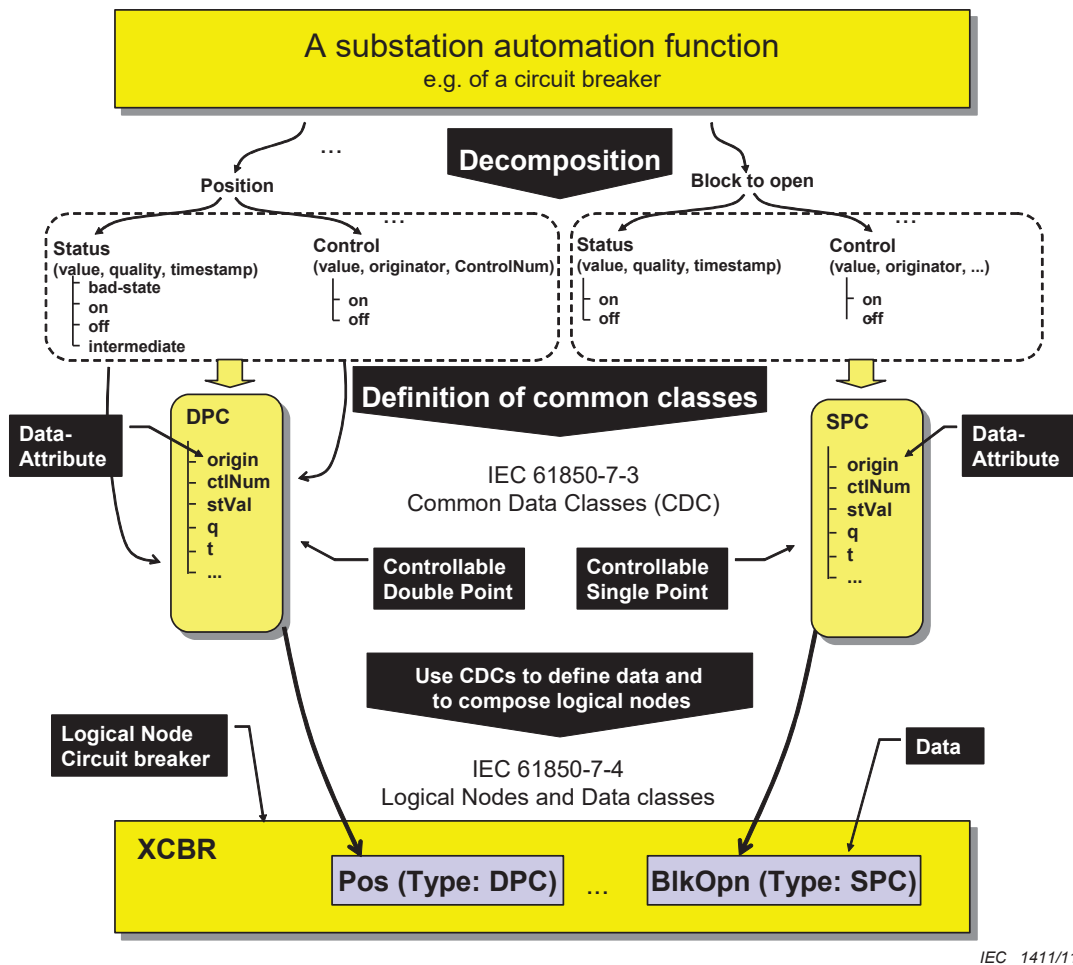


Figure 10 – Decomposition and composition process (conceptual)

A small part of a function (an excerpt of a circuit breaker model) has been selected as an example to explain the decomposition process. The circuit breaker has, among many other attributes, a position which can be controlled and monitored and the capability to prevent the switch being opened (for example, by an operator in service situations, block to open). The position comprises some information that represents the status of the position providing the value of the status (on, off, intermediate, bad state), the quality of the value (good, etc.), and the timestamp of the time of the last change of the position. In addition, the function provides the capability to control the switch: Control value (on, off). To keep track of who controlled the switch, the originator stores the information about the entity that issued the last control command. A control number stores the sequence number of the last control command.

The information grouped under the position (status, etc.) represents a very common group of a four-state value that can be reused many times. Similarly, the “block to open” groups information of a two-state value. These groups are called common data classes (CDC):

- four-state reusable class is defined as controllable double point (DPC), and
- two-state reusable class is defined as controllable single point (SPC).

IEC 61850-7-3 defines many common data classes for status, measurands, controllable status, controllable analogue, status settings, and analogue settings.

6.2 Creating information models by stepwise composition

IEC 61850-7-5xx series, IEC 61850-7-4xx series, IEC 61850-7-3, and IEC 61850-7-2 define how to model the information and communication in power utility applications according to the requirements defined in IEC 61850-5. The modelling uses the logical nodes (and their data that represent a huge amount of semantical definitions) primarily as building blocks to compose the visible information of a power utility automation system. The models are used for description of the information produced and consumed by applications and for the exchange of information with other IEDs.

The logical nodes and data classes introduced in IEC 61850-5 are refined and precisely defined in the IEC 61850-7-4xx series. They have been defined in a joint effort of domain experts of the various power utility application domains and modelling experts. The logical nodes and their data are defined with regard to content (semantic) and form (syntax). The approach uses object oriented methods.

NOTE 1 The logical node classes and data classes modelled and defined in IEC 61850-7-4 meet the requirements listed in IEC 61850-5.

In the next step, the common data classes are used to define the (power utility domain-specific) data classes, see lower half of Figure 10. These data classes (defined in IEC 61850-7-4) are specialised common data classes, for example, the data class Pos (a specialisation of DPC) inherits all data attributes of the corresponding common data class DPC, i.e., the stVal, q, t, etc. The semantic of the class Pos is defined at the end of IEC 61850-7-4.

A logical node groups several data classes to build up a specific functionality. The logical node XCBR represents the common information of a real circuit breaker. The XCBR can be reused to describe the common information of circuit breakers of various makes and types.

IEC 61850-7-4 defines several tens of logical nodes making use of hundreds of data names. The logical node XCBR comprises over 15 data classes. An incomplete description of the logical node XCBR is given in Table 2.

Table 2 – Logical node class XCBR (conceptual)

Descriptions
External equipment name plate
Name plate of the logical node
Controls
Switch position (see below for details)
Block opening
Block closing
Charger motor enabled
Control authority at station level. Switches between station and higher level.
...
Status information
Mode
Behaviour
Health
External equipment health
Operation counter
Local operation (Indicates the switchover between local and remote operation; local = TRUE, remote =FALSE)
Circuit breaker operating capability
Point on wave switching capability
Circuit breaker operating capability when fully charged
...

NOTE 2 IEC 61850-7-4 defines a standardised name for each item such as Pos for the switch position. Additionally, the tables for logical nodes contain the common data class to be used for the corresponding data class. Finally, the tables define if the data class in the table is mandatory or optional. These details are explained later in this part.

The content of the marked “switch position” (name = Pos) is introduced in Figure 11.

IEC 61850-7-x series use tables for the definition of the logical node classes and data classes (see IEC 61850-7-4), the common data classes (see IEC 61850-7-3) and service models (see IEC 61850-7-2). Data classes and data attributes form a hierarchical structure as depicted in Figure 11. The data attributes of the data class Pos are functionally grouped (status, substitution, configuration, etc.).

The data attributes have a standardized name and a standardized type. On the right-hand side the corresponding references (object reference) are shown. These references are used to provide the path information to identify the information in the tree.

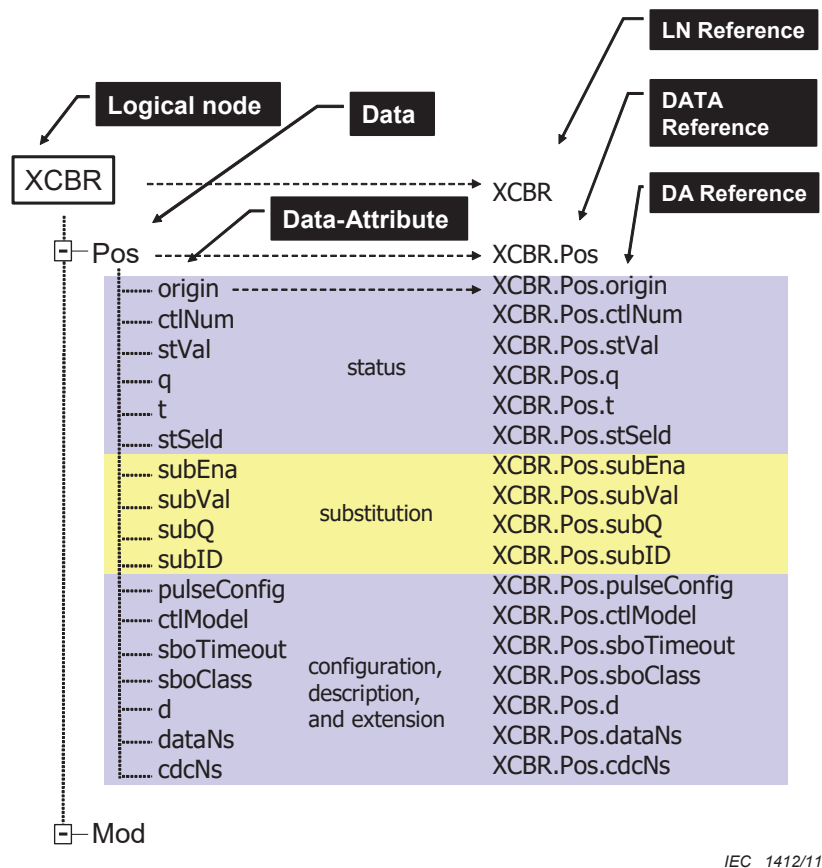


Figure 11 – XCBR1 information depicted as a tree

XCBR is the root at the level of logical nodes. The object reference XCBR references the complete tree below. XCBR contains data, for example, Pos and Mode. The data Pos (position) is precisely defined in IEC 61850-7-4 (see excerpt of the description):

Description of data

Data object name	Explanation
...	...
Pos	(controllable) Circuit breaker/switch position.
...	...

The content of the position Pos is a list of some 20 data attributes and 7 controllable parameters. The attributes are derived from the common data class DPC (double point control). The data attributes defined in the DPC are partly mandatory and others are optional. Only those data attributes that are required for a specific application are inherited by a data object. For example, if the position does not require the support of substitution, then the data attributes subEna, subVal, subQ, and subID are not required in the data object Pos.

The information exchange services that access the data attributes make use of the hierarchical tree. The data attribute XCBR.PosctlModel defines the type of control service which is supported. The status information could be referenced as a member (XCBR.Pos.stVal) of a data set named "AlarmXCBR". The data set could be referenced by a reporting control block named "Alarm". The report control block could be configured to send a report to a specific computer each time a circuit breaker changes its state (from open to close or from close to open).

6.3 Example of an IED composition

Figure 12 shows examples of different logical nodes being parts of IEDs. The logical nodes involved are PTOC (time overcurrent protection), PDIS (distance protection), PTRC (trip conditioning) and XCBR (circuit breaker). Case 1 shows a protection device with two functions, which are hardwired with the circuit breaker. Case 2 shows a protection device with two functions where the trip is communicated via a trip message over a network to the circuit breaker LN. Case 3 shows the two protection functions in dedicated devices, which may operate both in a fault and where the trips are transmitted as trip messages via the network independently to the circuit breaker LN (XCBR).

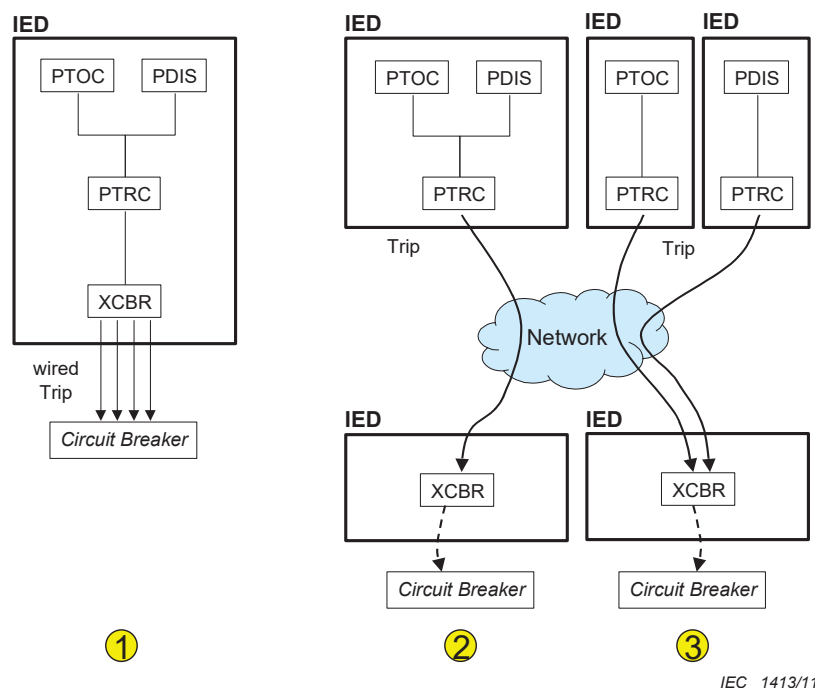


Figure 12 – Example of IED composition

In cases 2 and 3, the IED that hosts the XCBR LNs may be integrated in the real circuit breaker device or hardwired with it as in case 1, but this is outside the scope of the IEC 61850 series. The real breaker is represented for the substation automation system according to the IEC 61850 series by the XCBR LNs.

The IED composition is very flexible to meet current and future needs.

6.4 Information exchange models

6.4.1 General

The information contained in the hierarchical models of IEC 61850-7-4 can be communicated using services defined in IEC 61850-7-2. The information exchange methods (depicted in Figure 12) fall mainly into three categories:

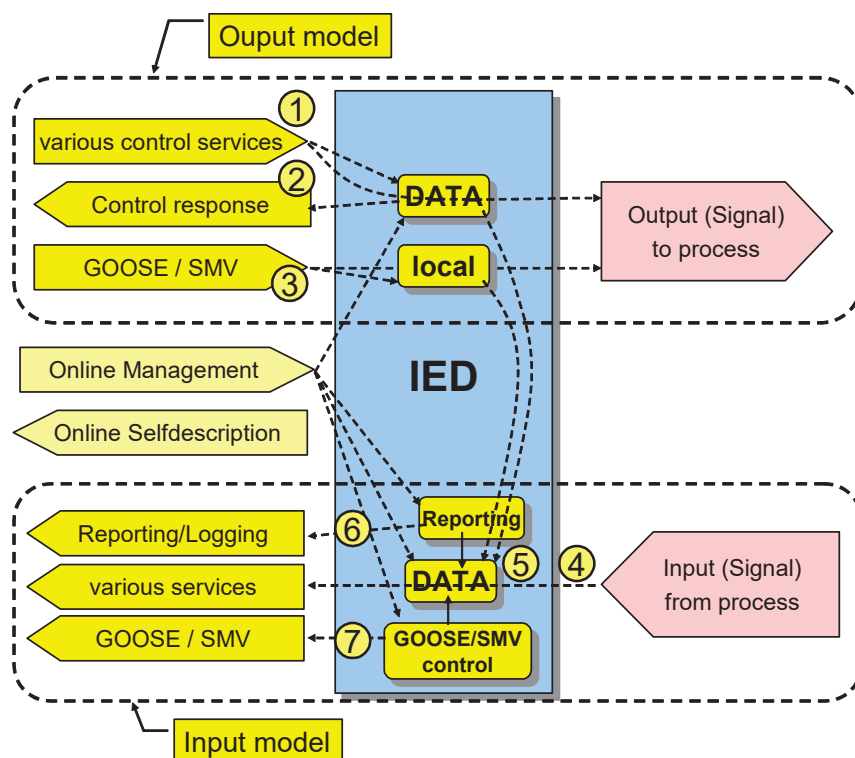
- the output model,
- the input model, and
- the model for online management and self-description.

Several services are defined for each model. The services operate on data, data attributes, and other attributes usually contained in logical nodes.

NOTE 1 Services operate actually on instances of data. To increase the readability, the term “instance of” has been omitted in most places throughout this part of IEC 61850.

Services for the output model may have an impact on an internal process only, may produce an output signal to the process via a process interface, or may change a state value of a data attribute triggering a report. If the process interface is an IED in conformance with the IEC 61850 series, this service will produce an output signal to the process directly.

NOTE 2 The terms “input” and “output” are relative to the direction from the IED to the process (output) and from the process to the IED (input).



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The numbers in the circles in this figure are used in 6.4.2, 6.4.3 and related figures as references for the description.

Figure 13 – Output and input model (principle)

Several services are defined for the input model. The services communicating input information may carry information directly from the process interface or may have been computed inside an IED.

There are also several services that may be used to remotely manage the IED to some (restricted) degree, for example, to define a data set, to set a reference to a specific value, or to enable sending specific reports by a report control block. The information models (logical nodes and data classes) and the service models (for example, for reporting and logging) provide means to retrieve comprehensive information about the information model and the services that operate on the information models (self-description).

The following description of the output and input models are conceptual only. Details on the information and services involved in the models are defined in IEC 61850-7-4, IEC 61850-7-3, and IEC 61850-7-2.

6.4.2 Output model

6.4.2.1 Control model concept

The concept of the control model is depicted in Figure 14. The example is a circuit breaker logical node (XCBR) with the controllable data object XCBR.Pos (shown in Figure 15). A control service request is issued to the controllable data object. The service request contains service parameters like the control value, the originator of the request, the time when the originator sent the request and others. The data attribute XCBR.Pos.ctlModel (shown in Figure 15) indicates the type of control service to use. Before the right control service request performs the change of the position of a real device, some conditions have to be met, for example, the output can be generated only if the local/remote switch is in the "remote" position and the interlocking node (CILO) has released this operation. The chain of conditions to be met may possibly include:

- the local/remote behavior of the circuit breaker (data object XCBR.Loc) and/or local/remote behaviour of the logical device (LD) (data object LLN0.Loc),
- the control authority condition at the station level (data object LLN0.LocSta),
- the control output signal is not being blocked, either by the process or:
 - by the mode of the circuit breaker (data object XCBR.Mod) or,
 - following an external control request (data object XCBR.BlkOpn and/or XCBR.BlkCls),

NOTE For controllable data in LNs not having specific data like BlkOpn and BlkCls, the blocked control output signal indication could be CmdBlk.

- check conditions of the device, and
- other attributes of the controllable data, for example, interlocking, pulse configuration, control model, sbo class, and sbo timeout as defined in the common data class DPC (controllable double point in IEC 61850-7-3).

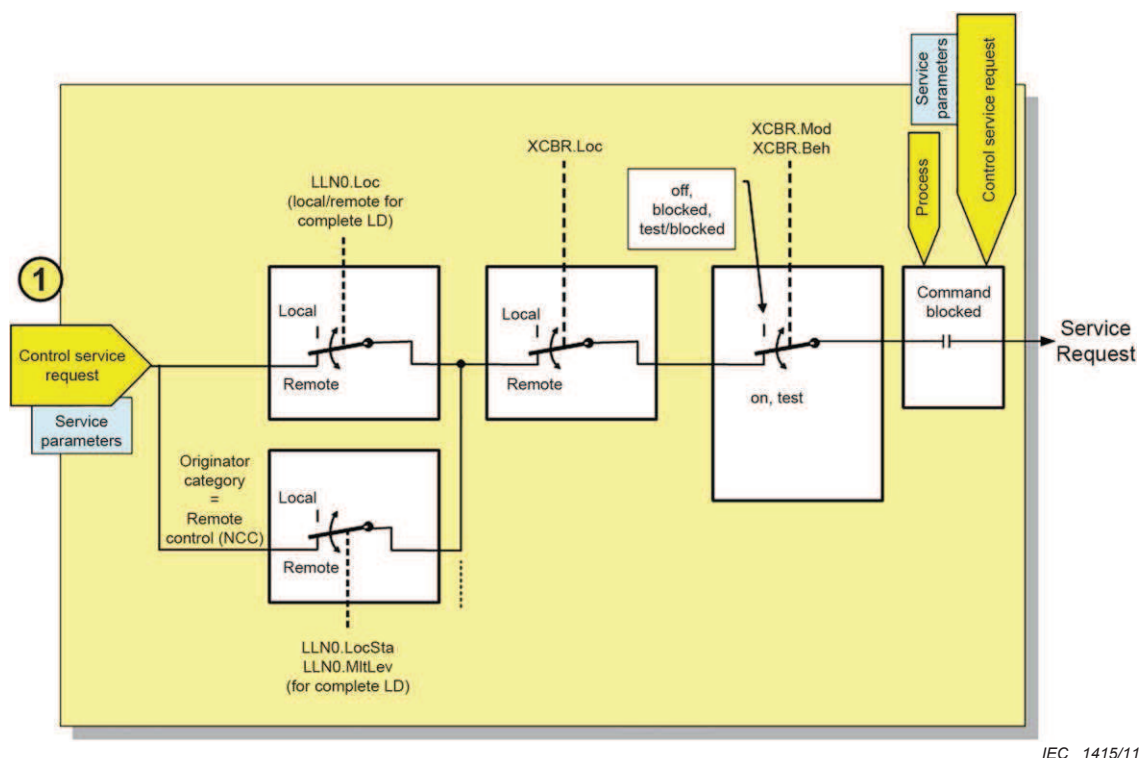


Figure 14 – Output model (step 1) (conceptual)

After all conditions have been met and all checks are positive, the output signal can be conditioned and control the real equipment (the circuit breaker – not shown).

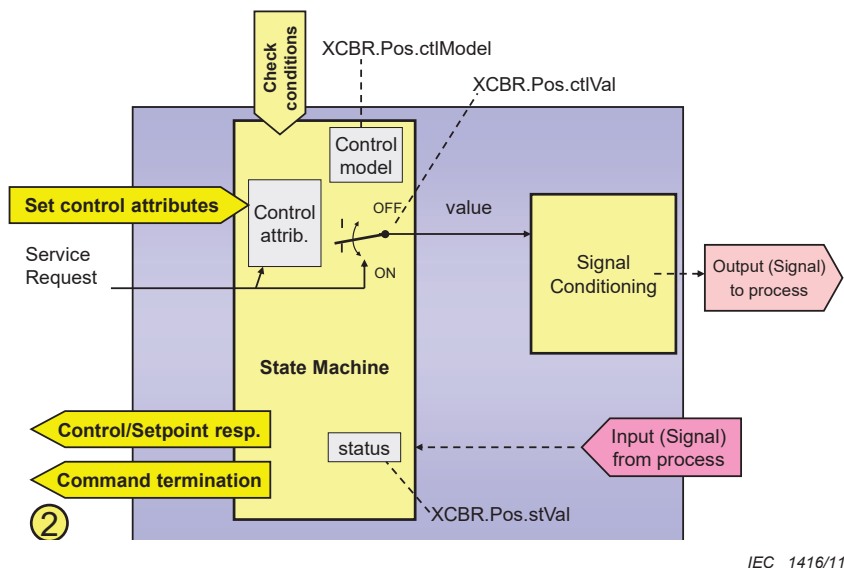


Figure 15 – Output model (step 2) (conceptual)

The state change of the real circuit breaker causes a change in the status information modelled with the data attribute XCBBR.Pos.stVal. The status change issues a control service response. A command termination completes the control transaction.

6.4.2.2 GSE and SMV model concept

The generic substation event (GSE – GOOSE) and the sampled measured values (SMV), as shown in Figure 16, provides the peer-to-peer information exchange between the input data values of one IED to the output data of many other IEDs (multicast). The GOOSE and SMV messages received by an IED may be used to compute data for internal purposes also. An example for internal purposes are received switch positions to calculate the interlocking conditions locally or line current sample values to calculate the fundamental or RMS values.

NOTE 1 The GOOSE/SMV data values are defined in the input model described in 6.4.3.

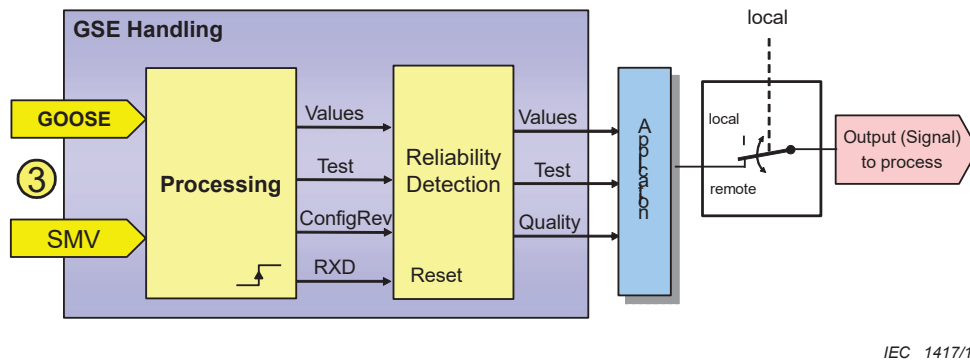


Figure 16 – GSE output model (conceptual)

The conditions to be met and the checks to run before the values are used as output signals such as interlocking are partly described within the IEC 61850 series and partly defined by the local application outside the scope of the IEC 61850 series.

The act of receiving GOOSE and SMV messages by an IED is called subscription. How to define subscriptions by means of configuration tools is given in the normative Annex H.

NOTE 2 Many GOOSE messages may be transmitted in certain cases, for example, fault detected by a protection relay. A SCSM usually filters these messages at the data link layer to prevent flooding the IEDs.

6.4.2.3 Attributes of data and control blocks

Many data attributes of the hierarchical information model can be set with a Set-service, for example, SetDataValues and SetDataSetValues. Setting the values of data attributes is usually constrained only by the application.

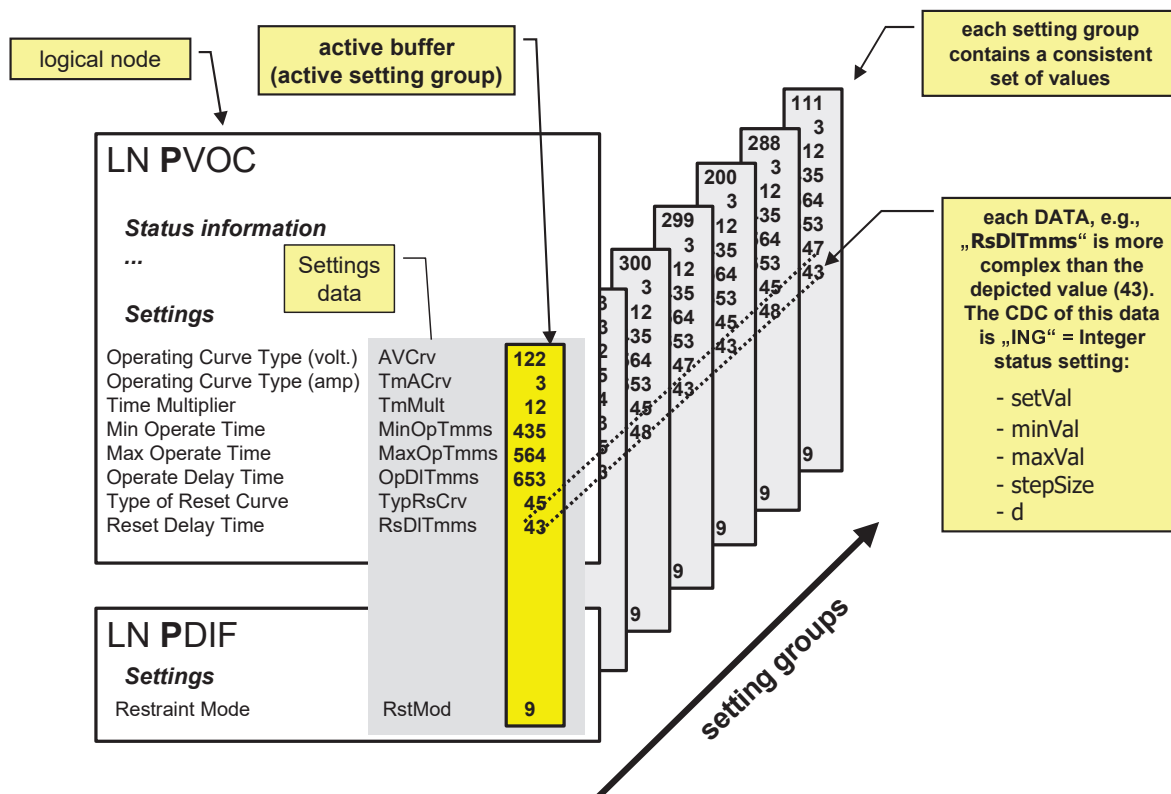
The various control blocks, for example, the setting group control block (SGCB), the buffered report control block (BRCB) and log control block (LCB), have control block attributes that can usually be set to a specific value. The services to set these attributes are defined with the control blocks in IEC 61850-7-2. Setting the values of the control block attributes is constrained by the state machine of the corresponding control block.

The control blocks behave according to the values of their attribute set. The values may also be configured using the SCL file or by other local means.

All control block attributes can be read by another IED.

6.4.2.4 Setting data and setting group control block

A special treatment of output data values is required for setting data contained in several logical nodes as defined in IEC 61850-7-4, for example, the settings for the voltage controlled overcurrent protection logical node PVOC (see Figure 17). The setting data (for example AVCrv, TmACrv, TmMult, etc.) have as many values as setting groups are defined. Each setting group has a consistent set of values.



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Figure 17 – Setting data (conceptual)

The values depicted are complex in the sense that each data has a type derived from a common data class. The RsDITmms is derived from the common data class ING. The ING has several data attributes as listed in Table 3.

Table 3 – Excerpt of integer status setting

ING class					
Attribute name	Attribute type	FC	TrgOp	Value/value range	PresCond
DataAttribute for configuration, description and extension					
setting					
setVal	INT32	SP	dchg	The value of the status setting.	M
setVal	INT32	SG, SE		The value of the status setting.	M
configuration, description and extension					
minVal	INT32	CF	dchg	Minimum setting for 'setVal'.	O
maxVal	INT32	CF	dchg	Maximum setting for 'setVal'.	O
stepSize	INT32U	CF	dchg	(range=[1... (maxVal-minVal)]) Step between the individual values of 'setVal'.	O
units	Unit	CF	dchg	Unit for 'setVal', 'minVal', 'maxVal', 'stepSize'.	O
d	VISIBLE STRING255	DC		Textual description of the data. In case it is used within the CDC LPL, the description refers to the logical node.	O
...	...	...			...

The values of a specific setting group contained in the setting data can be set only if that group is in the “EDIT” state (indicated by the FC=SE; edit setting data). After all values of that group are set, the values of that group can be confirmed as containing a consistent set of values. This newly confirmed set of values can then be selected for use by the application (setting group in active state: FC=SG; active setting data).

The setVal of FC=SP means “simple” setting data (set point); applied when the setting group control model is not supported. This value can be set as a regular data attribute.

6.4.3 Input model

6.4.3.1 Input analogue signal acquisition

The concept of the input analogue signal acquisition is depicted in Figure 18. Normally, the signal is conditioned by a signal conditioner. In the IEC 61850 model, an analogue input does not exist as data before it is converted from analogue to digital. The sample rate (data attribute smpRate of a configurable data) determines how often the value shall be sampled. Alternatively, the raw digital values may be directly obtained from sample values transmitted over communication links (see also Figure 27). The method used for processing the signal (True RMS, Peak amplitude, ...) may be set through the data ClcMth. In absence of the data ClcMth, the calculation method shall be considered as UNSPECIFIED, meaning UNKNOWN.

The conditions to be met before the value can be communicated (modelled as the data attribute instMag of the data, for example, a voltage of a specific phase – see Figure 18) may comprise the values of the following attributes:

- substitute/unsubstitute “switch” of the data (modelled as the data attribute subMag of the data, for example, a voltage of a specific phase),
- operator blocked or unblocked “switch”.

The result of these first steps is the “intermediate value” (still an analogue value) accompanied by the corresponding quality information.

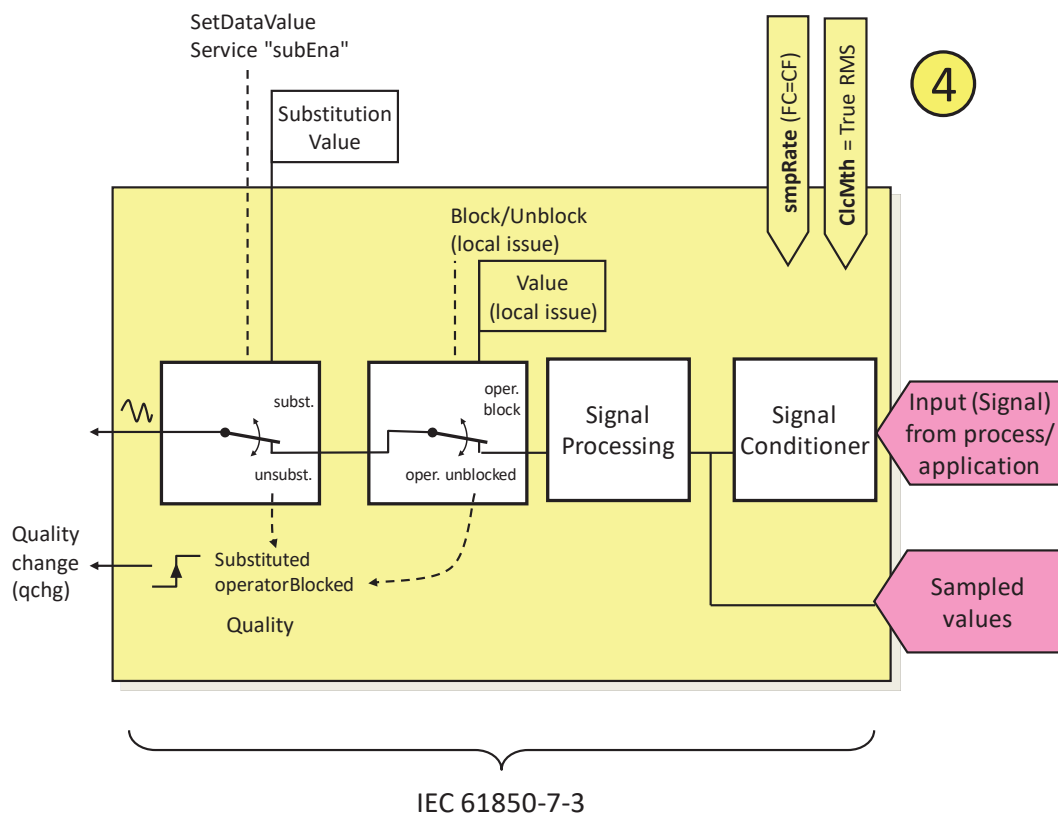


Figure 18 – Input model for analogue values (step 1) (conceptual)

6.4.3.2 Data attribute value processing, monitoring and event detection

The “intermediate value” is used for various purposes. As shown in Figure 20, the first use is to provide this value as the instantaneous data attribute value (magnitude) of the data. The data attribute has the name *instMag*; with the functional constraint FC=MX (indicating a measurand value). There is no trigger option associated with the instantaneous value.

The second application is the calculation of the deadbanded value, the *mag* value. The deadbanded value shall be based on a deadband calculation from *instMag* as illustrated in Figure 19. The value of *mag* shall be updated to the current value of *instMag* when the value has changed according to the value of the configuration parameters *db* and *dbRef* of this data.

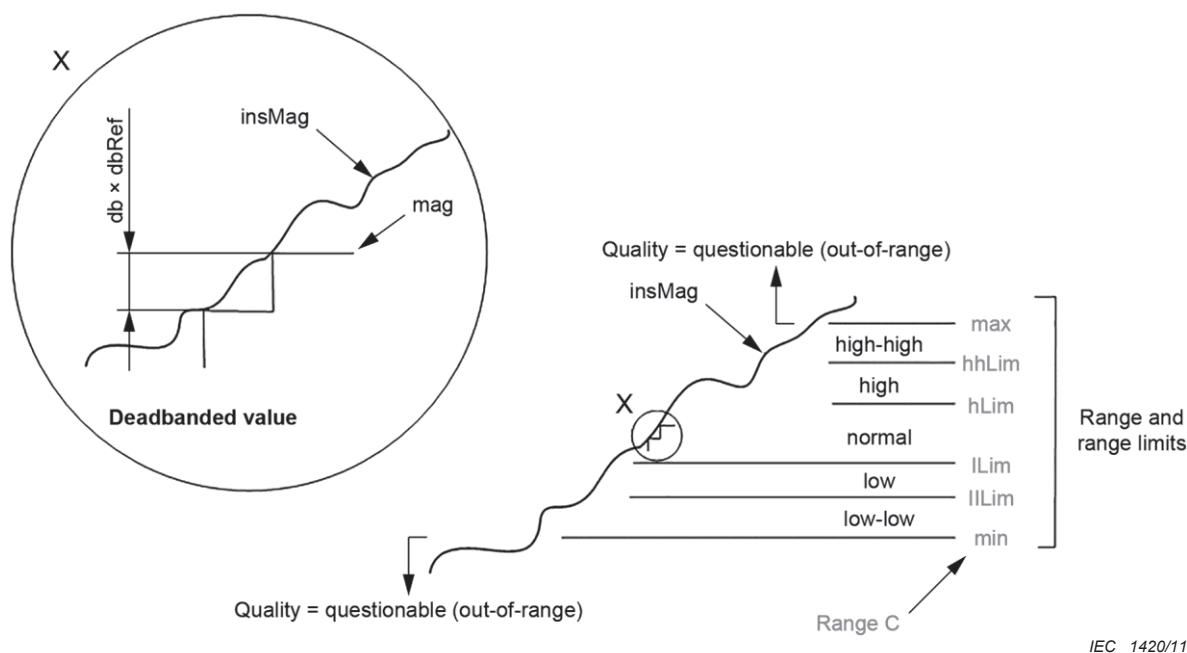


Figure 19 – Range and deadbanded value (conceptual)

The value of the deadband configuration *db* shall represent the percentage of the deadband reference *dbRef* in units of 0,001 % (fixed deadband). A value of *dbRef* of 0 means that the value *db* shall represent the percentage of the last transmitted values in units of 0,001 %. This allows for a deadband calculation that is related to the last refreshed value (variable deadband).

NOTE The *db* value has nothing to do with the accuracy of the data defined both by the accuracy of the analogue transducer and by the accuracy of the A/D conversion.

An internal event is created any time the *mag* value changes. The deadbanded value *mag* and the event (data change – according to the trigger option *TrgOp=dchg*) are made available for further actions, for example, reporting or logging.