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Transmission & Distribution, S.A.

IEC 61850 : COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS

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Index

- Introduction
- Content of the standard
- Architecture
- Sections 7 and 8 of the standard
- Key concepts
- Data model
- SCL language
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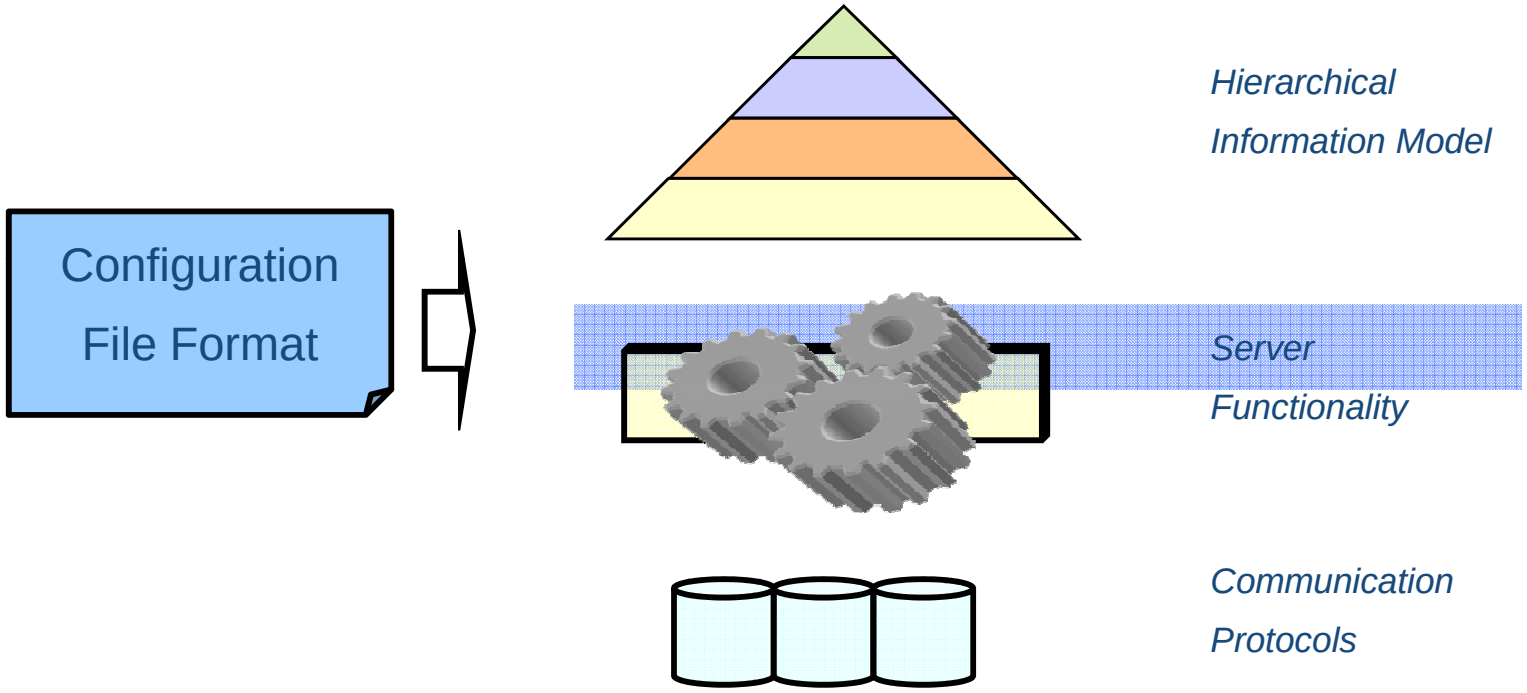
1 Introduction

1.1 Introduction

- IEC 61850: “Communication networks and systems in substations”.
- Common misunderstanding: “IEC 61850 is not only a communication protocol”.
- IEC 61850 specifies…



1.1 Introduction

- IEC 61850 standard looks for “Interoperability”: possibility of communication with different vendors using the same approach.

- An IEC 61850 device or software acting as a client shall be able to communicate with servers from different vendors.

1.2 History

UCA :

- Utility Communications Architecture
- Defined by the EPRI (Electric Power Research Institute) coordinating the work of a set of Northamerican enterprises.

IEC 61850 :

- Defined by IEC (International Electrotechnical Commission) : TC 57 -> WG10, WG11, WG12
- It was based on the UCA experience
- It has integrated the UCA group (compatibility with UCA 2.0)

1.3 UCA : Utility Communications Architecture

- In 1988, the UCA project was launched with the aim of fulfilling the requirements of the electrical industry
- This standard was very open, so it was not adopted by the industry in a generalized way.
- In 1997, version 2 was launched.
- Version 2.0 has a basic protocol family, as well as standardized object models for substations, self-described and independent from the provider.
- All the data acquisition and the applications control is carried out through MMS (Manufacturing Message Specification)
- The MMS/UCA standard is based on well-known open standards.
- UCA Version 2 protocol, also called UCA 2, increased the versatility, including the Internet potentialities to all type of services, electricity, gas and water.

1.4 Objectives

- Reduce the number of communication protocols existing inside the electrical substation.
- Make the integration between devices from different manufacturers easier (interoperability).
- Make the access to all the data of the substation easier :
  - All the data accessible to all the applications.
  - Make the interchange of data between utilities easier.
- Agreement between manufacturers and users about the free interchange of information between units.

1.4 Objectives

- Communications independence regarding the technology.
- Communication profiles based on international standards :
  - IEC / IEEE / ISO / OSI.
  - I.e. MMS, TCP/IP, Ethernet.
- Benefits of LAN technology :
  - Common physical level.
  - Wider communication bandwidth.
  - Incorporation to the enterprise corporative networks.

1.5 New services

- Free assignment of functions according to different system philosophies.
- Configuration language that makes the engineering and maintenance easier.
- Applications and IEDs shares the same :
  - Protocol.
  - Data format.
  - Data addresses and name conventions.
- Capacity of data communication through Internet:
  - TCP/IP, Ethernet.

1.6 Integration

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- **Interoperability :**
  - Common bus.
  - Same communication protocol.
  - Interpretation of the information of other units.
  - functions shared between different units.
  - Self-descriptive units (plug and play).

- **Change of an element :**
  - Minimum impact in the rest of the system.

1.6 Integration

- Model oriented to objects applied to the electrical industry.

- The models define:
  - Common data formats, identifiers and commands for substation.
  - Services (i.e file reading/writing).
  - Function standard behavior.

- Migration progress :
  - Coexistence with existing technology
  - Reusing of non-amortized units
  - Compatibility with the existing environment
  - Interface between the new system and the present ones.
  - Necessity of protocol converters (gateways).

1.7 Costs

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Manufacturers :

- Initial inversion in the development of the new architecture.
- The development of multiple protocols is avoided.

Integrating companies :

- Protocol converters are avoided.
- The specific formation is reduced in each protocol.
- Engineering costs are reduced.

Final users :

- The costs of the development and adaptation for each installation are reduced.
- The installation and maintenance costs are reduced.
- Reduction of the wiring
- Technological independence regarding the manufacturers.

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Contents of the standard IEC 61850

2

2.1 What is the IEC 61850 standard?

- It is NOT simply the definition of a new communication protocol (DNP, 870-5-101, Modbus...)
- It is a set of standards
  - IEC 61850-1, IEC 61850-2,…..IEC61850-10
- It ranges several aspects :
  - Electrical or quality requirements,
  - Platforms or communication protocols
  - Management of systems and projects
  - Definition of data and service models
  - and more....

2.2 Contents of the IEC 61850 standard

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- 61850-9 : Specific communication service mapping (SCSM)
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Philosophy of the new architecture and content of the other parts

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Collection of terms used in the standard

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Quality requirements (reliability, maintenance, security etc)

Environmental conditions

Auxiliary services

Other standards and specifications

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Engineering requirements (parameters, tools, documentation)

Life cycle of the system (product versions, discontinuation, support after the discontinuation)

Assurance of the quality (responsibilities, testing unit, type tests, system tests, approval in factory, approval in field)

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Basic requirements (generals)

Concept introduction :
Logical nodes
Logical communication links, benefits functions, etc.

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Language based on XML

Describes the configuration and the parameters of the IEDs, communication configurations, relationships between IEDs, etc.

Main objective : Interchange of data between engineering tools from different manufacturers.

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  - **7-1 : Principles and models**
  - **7-2 : Abstract communication service interface (ASCI)**
  - **7-3 : Common data classes**
  - **7-4 : Compatible logical node and data object addressing**
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Introduction to section 7

Communication principles and models

- **7-1 : Principles and models**
- 7-2 : Abstract communication service interface (ASCI)
- 7-3 : Common data classes
- 7-4 : Compatible logical node and data object addressing

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ACSI description

Specification of the abstract communication services

Specification of the Model of the structure of the unit database

- 7-1 : Principles and models
- **7-2 : Abstract communication service interface (ASCI)**
- 7-3 : Common data classes
- 7-4 : Compatible logical node and data object addressing

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Classes of common data and related attributes

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Logical nodes and data classes

- 7-1 : Principle[illegible] models
- 7-2 : Abstract[illegible]mmunication service interface (AS[illegible]
- 7-3 : Commo[illegible] data classes
- **7-4 : Compatible logical node and data object addressing**

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Profile that uses the MMS application protocol and Ethernet to implement the communication between the IED'S (substation bus)

Defines the messages implemented by the abstract services and the models defined in sections 7-2, 7-3 and 7-4

8-1 : Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3

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- **61850-9 : Specific communication service mapping (SCSM)**
  - **9-1 : Sampled values over serial unidirectional multidrop point to point link**
  - **9-2 :Sampled values over ISO/IEC 8802-3**
- 61850-10 : Conformance testing

Definition of communications for the process bus: between position and process levels.

Implies the use of electronic transformers with communication capacities.

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The test cases are defined, as well as the testing process, necessary documentation, methodology, etc.

2.3 Do I have to read the whole standard?

- About 1200 pages.....
- Not all the parts of the standard are necessary for all the users
- In section 7-1 (Principles and models, pag 10, table 1) :
  - Recommendations depending on the user's profile

2.3 Do I have to read the whole standard?

User		IEC 61850-1 (Introduction and overview)	IEC 61850-5 (Requirements)	IEC 61850-7-1 (Principles)	IEC 61850-7-4 (Logical nodes and data classes)	IEC 61850-7-3 (Common data classes)	IEC 61850-7-2 (Information exchange)	IEC 61850-6[a] (Configuration language)	IEC 61850-8-x IEC 61850-9-x[a] (Concrete communication stack)
Utility	Manager	x	–	Clause 5	–	–	–	–	–
	Engineer	x	x	x	x	x	In extracts	x	–
Vendor	Application engineer	x	x	x	x	x	In extracts	x	In extracts
	Communication engineer	x	x	x	–	–	x	–	x
	Product manager	x	x	x	x	In extracts	In extracts	In extracts	–
	Marketing	x	x	Clause 5	In extracts	In extracts	In extracts	In extracts	–
Consultant	Application engineer	x	x	x	x	x	–	x	–
	Communication engineer	x	–	x	–	–	x	x	x
All others		x	x	x	–	–	–	–	–

The "**x**" means that this part of the IEC 61850 series should be read.

The "**in extracts**" means that extracts of this part of the IEC 61850 series should be read to understand the conceptual approach used.

The "**–**" means that this part of the IEC 61850 series may be read.

[a] These documents are under consideration.

(de IEC 61850-7-1)

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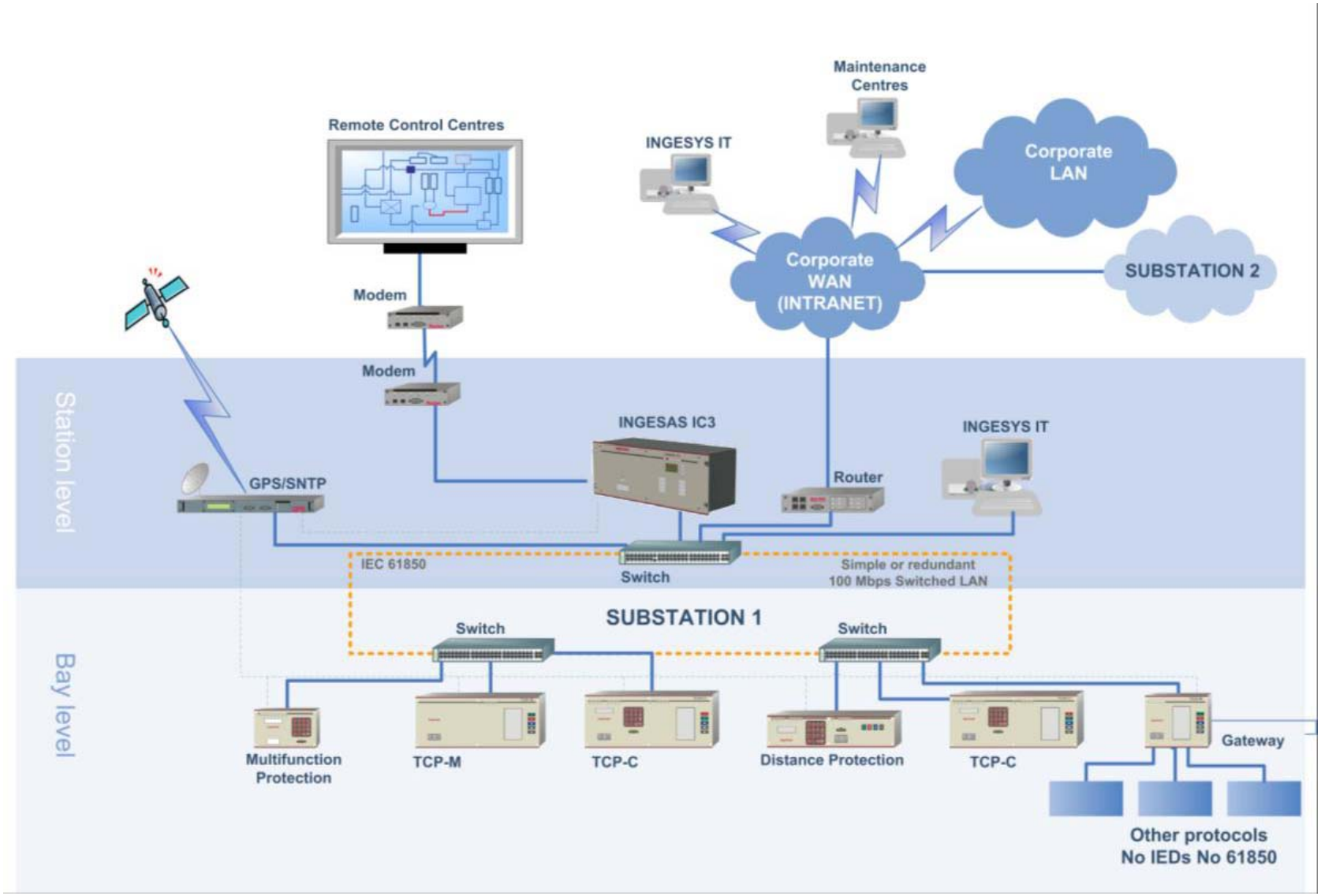
Architecture 3

3.1 Architecture



3.2 Ethernet

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- IEEE 802.3 : most used standard in LAN network

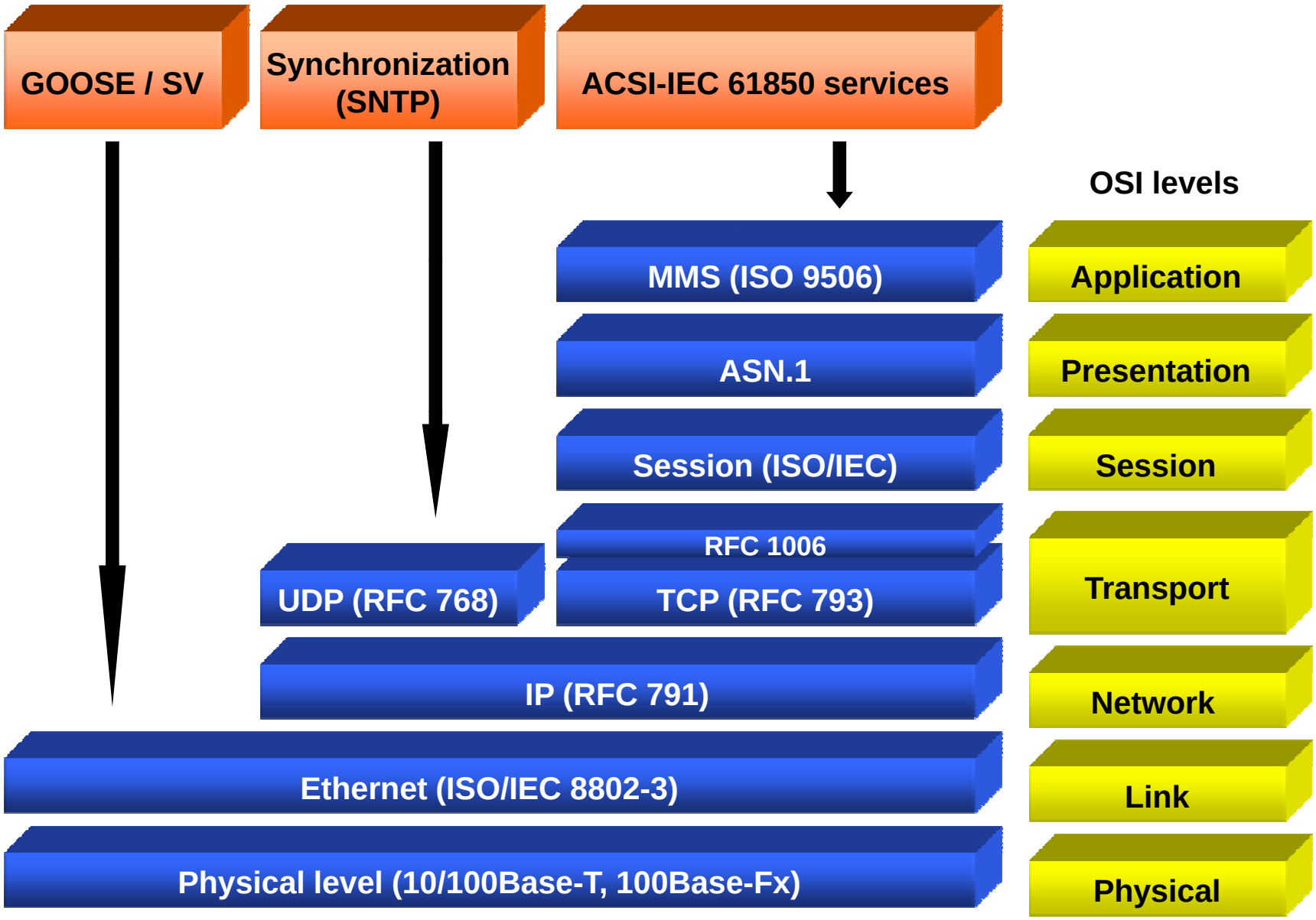
- CSMA/CD (Carrier Sense Multiple Access with Collision Detection)
  - Multiple access to a shared medium, a control mechanism is needed. (CSMA/CD)
  - Encapsulating of the information (mesh format)
  - Addressing (MAC)
  - Error detection, etc.
  - Operation mode (Half duplex or Full duplex depending on the characteristics of the physical medium, etc.)

3.3 TCP-IP

- **TCP (Transmission Control Protocol) : Transport level of the OSI model**
  - The **TPC includes two protocols**
    - **TCP (Transmission Control Protocol)**
      - **Oriented to the connection**
      - **Data sending control**
    - **UDP (User Datagram Protocol)**
      - **Not oriented to the connection**
      - **Does not guarantee the data reception**

- **IP (Internet Protocol) : Network level of the model OSI**
  - **Message fragmentation**
  - **IP addressing : “192.168.100.5”**

3.4 OSI model


GOOSE / SV
Synchronization (SNTP)
ACSI-IEC 61850 services
OSI levels
MMS (ISO 9506)
Application
ASN.1
Presentation
Session (ISO/IEC)
Session
A-Profile
RFC 1006
UDP (RFC 768)
TCP (RFC 793)
Transport
IP (RFC 791)
Network
Ethernet (ISO/IEC 8802-3)
Link
Physical level (10/100Base-T, 100Base-Fx)
Physical
T-Profile

3.5 Switch vs. Hub

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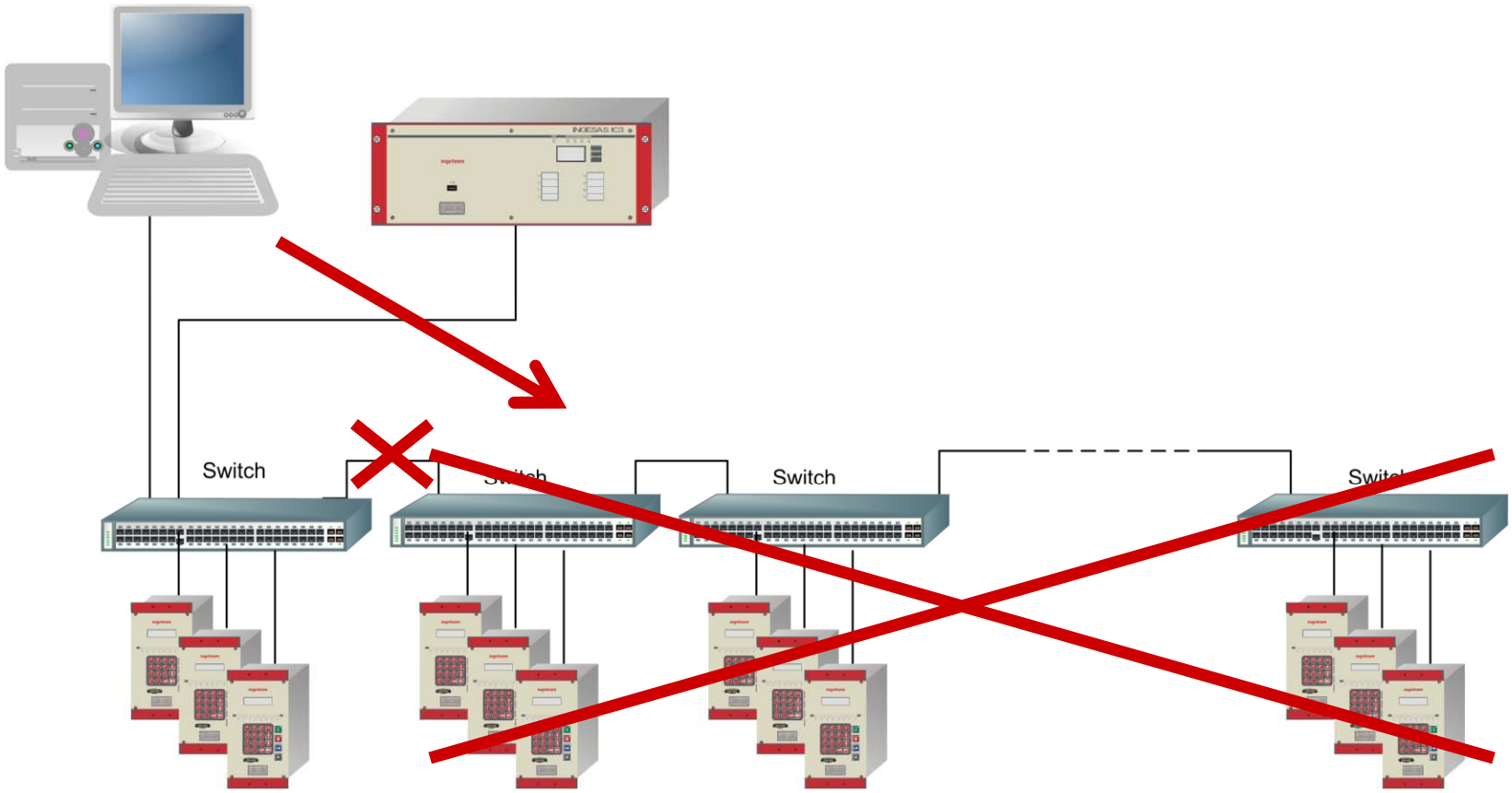
- **Hub :**
  - The hub is a multiport repeater, any message received in any of its ports, is repeated (amplified) to the rest of the ports.
  - The hub interconnects network segments, creating a single collision domain. They work in the physical layer of the OSI model.
- **Switch**
  - The switch can be considered as an intelligent Hub. It may interconnect multiple networks (collision domains) of the same or different type.
  - The switch works in the link layer of the OSI model.
  - Filters the messages depending on their addresses.
- **The IEC 61850 networks must use switches**

3.6 Examples of architectures

- The use of the ethernet network and switches allow a great variety of architectures.

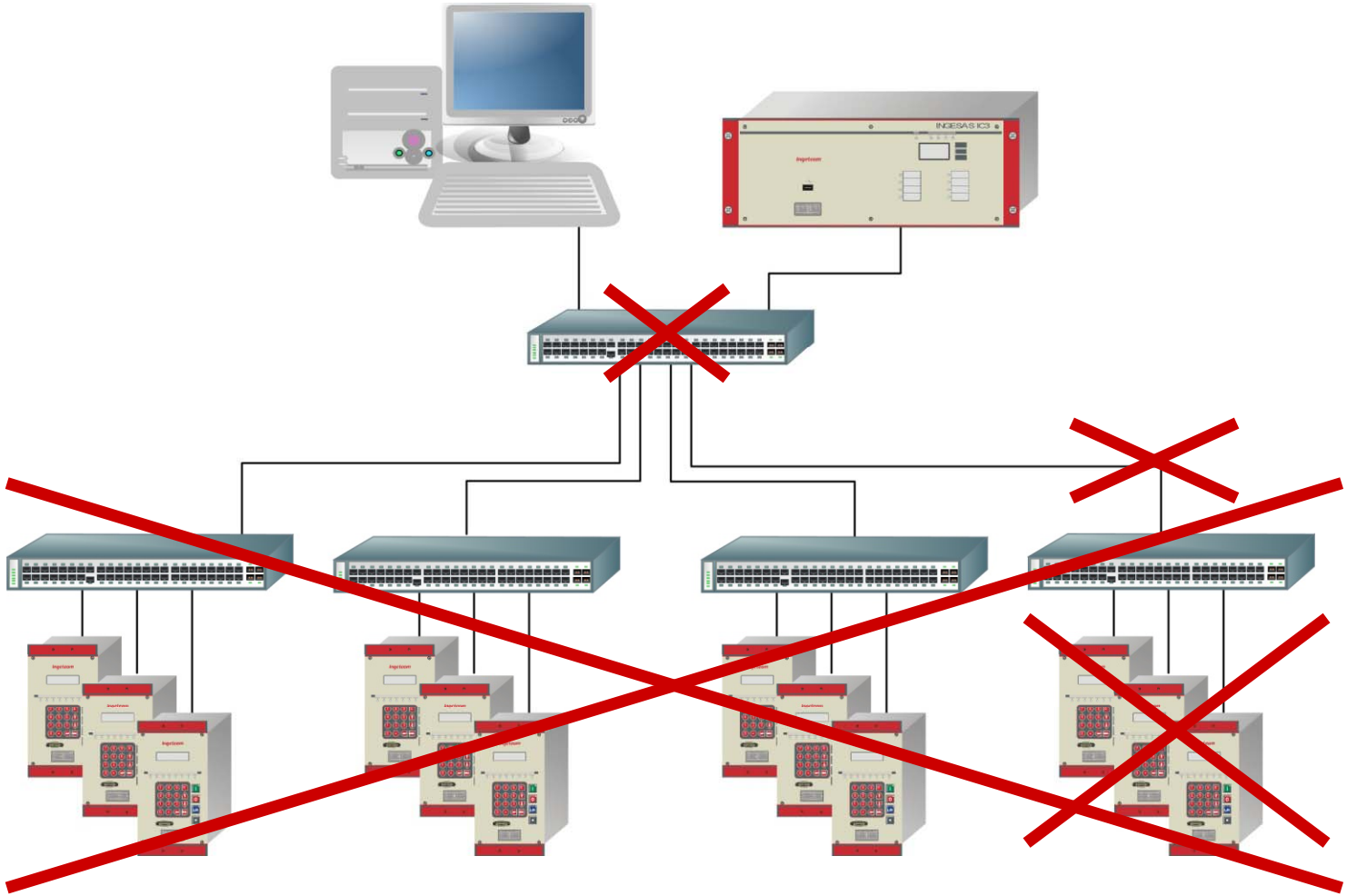
- Typical topologies of the network:
  - Bus
  - Star
  - Ring

3.6 Bus architecture



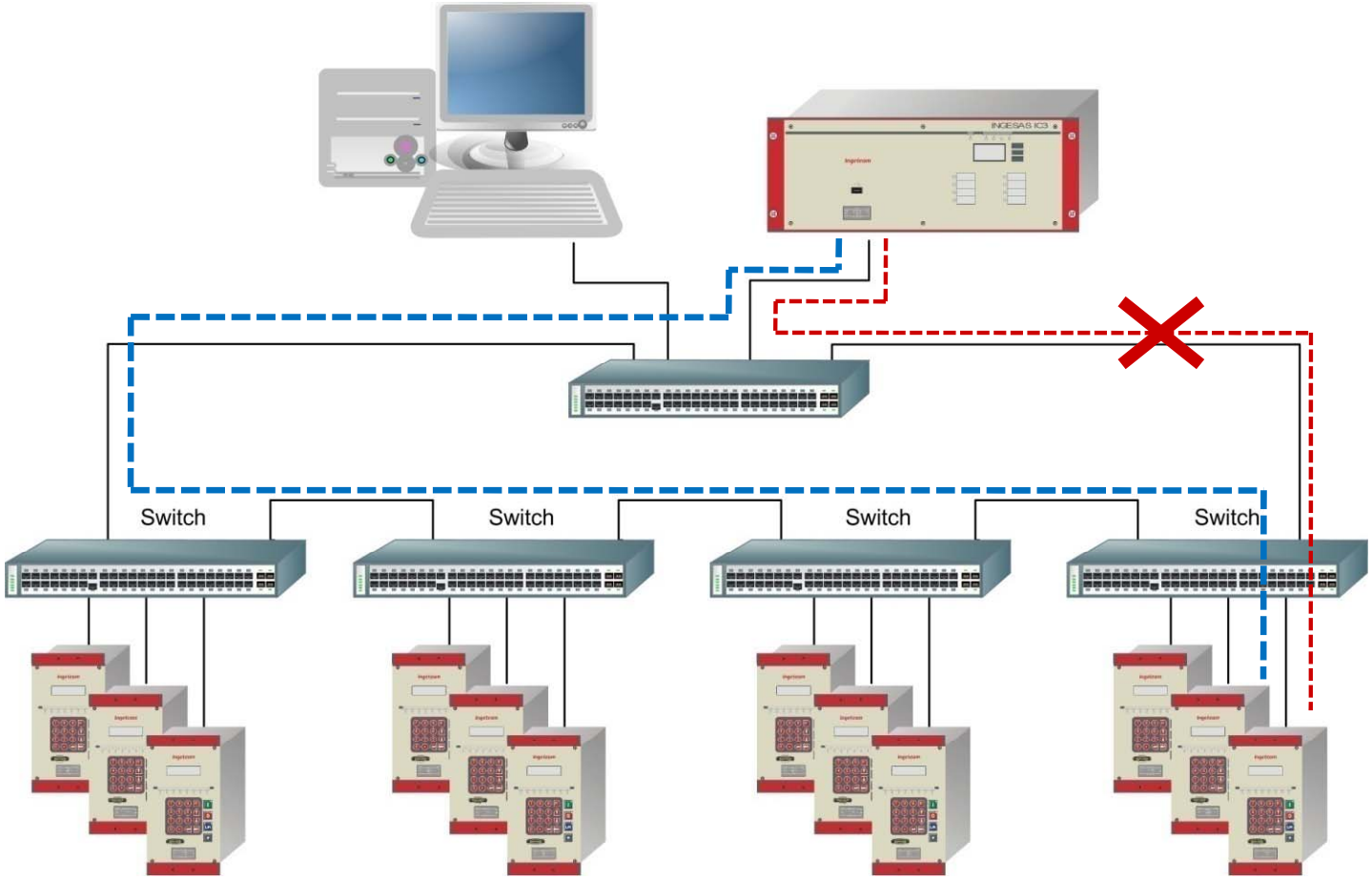
- Advantage : Shorter link distance between switches
- Disadvantage: Without redundancy, higher latency times

3.6 Star architecture



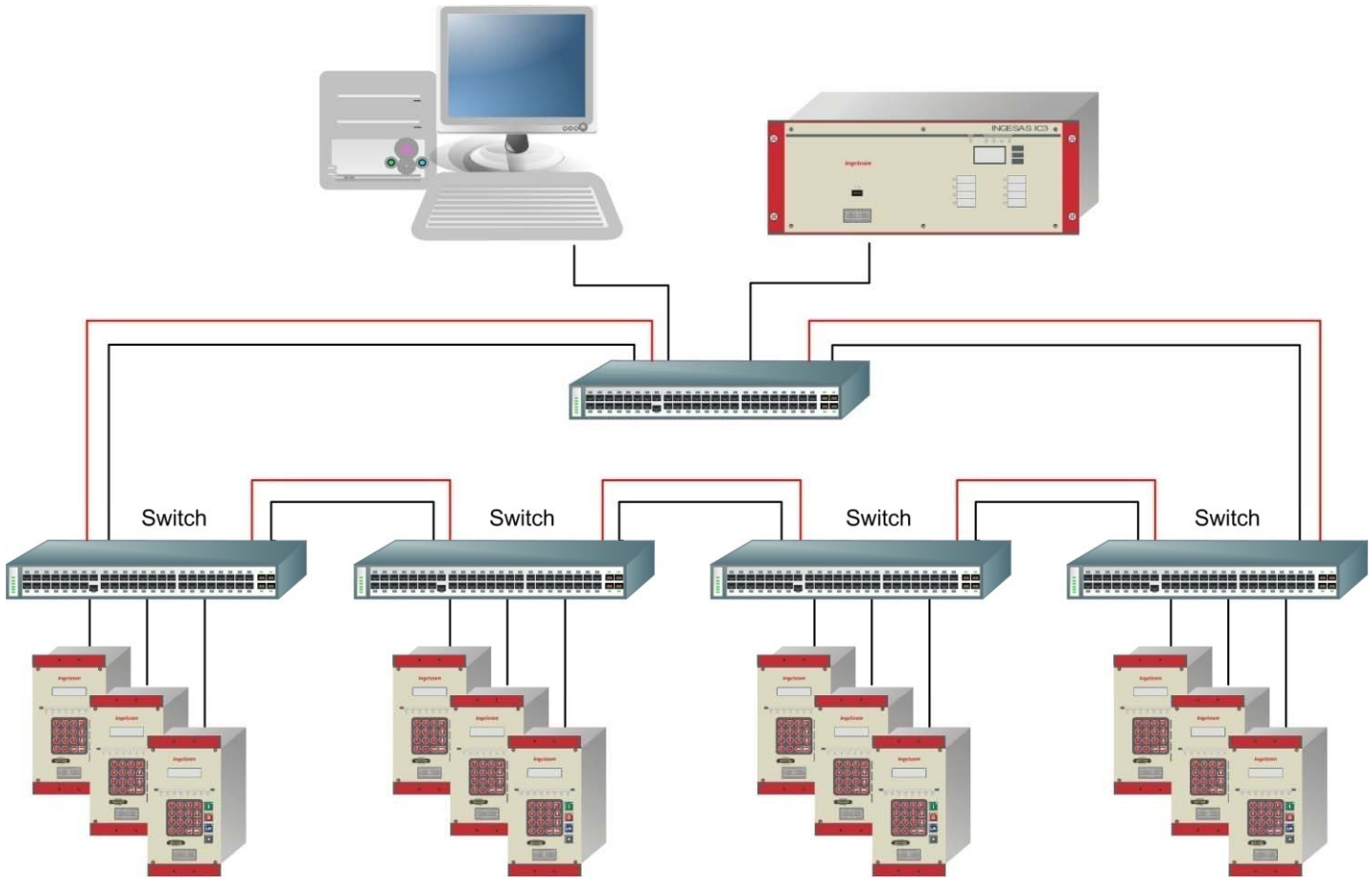
- Advantage : Lower latency (nº of switches between IEDs)
- Disadvantage : Without redundancy, critical head switch

3.6 Ring architecture



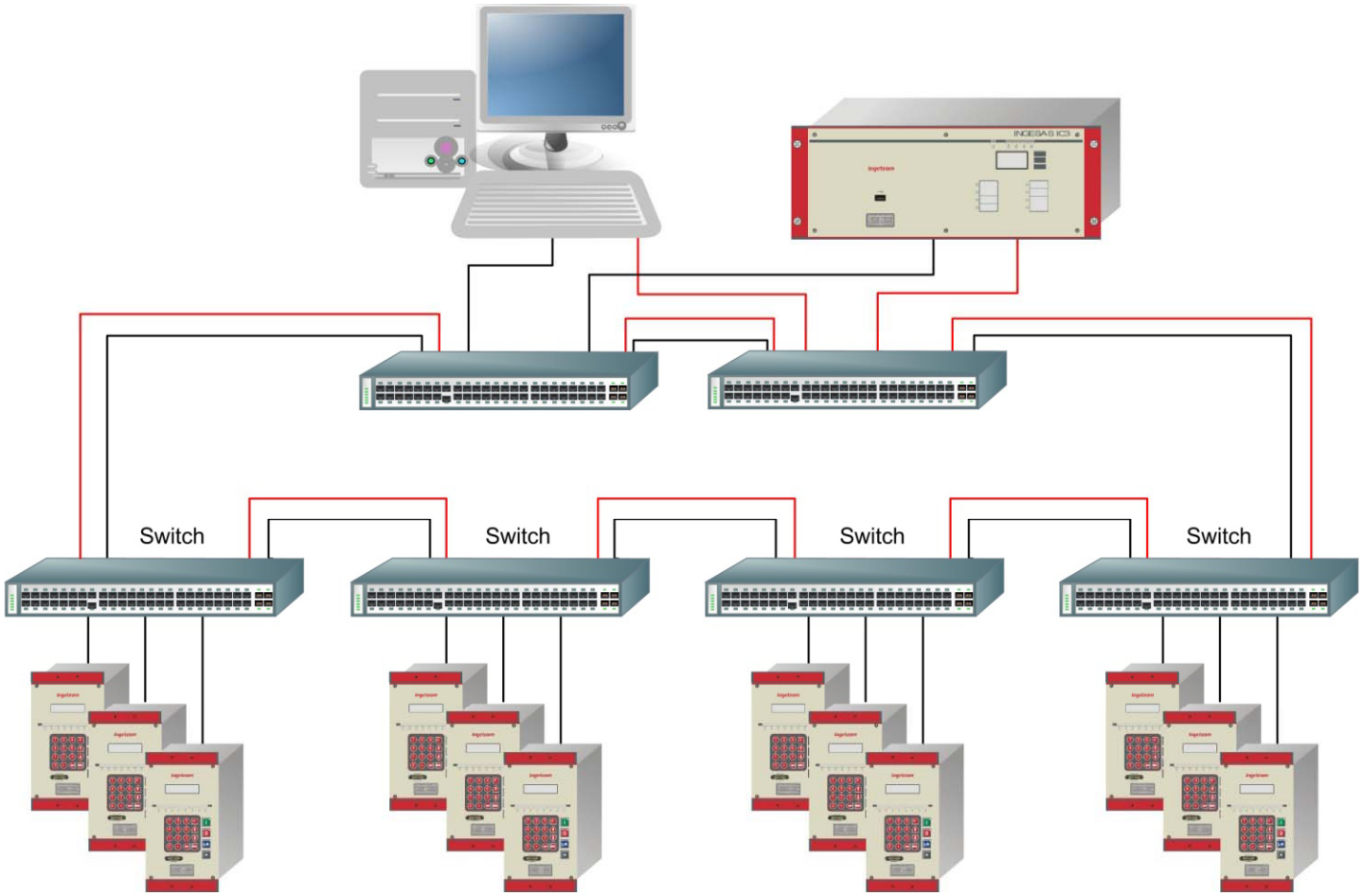
- Advantages : Supports a simple failure between switches, shorter link distances between switches
- Disadvantages : Higher latency

3.6 Redundant ring architecture (1)



- Advantages : Redundancy between switches
- Disadvantages : Higher link cost between switches (O.F.)

3.6 Redundant ring architecture (2)



- Advantages : Redundancy between switches + HMI and RTU redundancy + redundancy of the most critical switches
- Disadvantages : Higher cost

Sections 7 and 8 of the standard

4

4.1 Introduction

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- **Standardized aspects in IEC 61850 – 7 , 8 :**
  - **Functions and information visible in the system and how they are named and described (IEC 61850-7-4, -7-3, and -7-2)**
  - **How the functions are accessed and how the information is interchanged (IEC 61850-7-2)**
  - **How the units are connected to the communication networks (IEC 61850-8-x y -9-x).**

4.2 IEC 61850-7-2

- **Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)**

4.2 IEC 61850-7-2 (Services)

- Client- server model
  - Commands
  - Data access
  - Publisher/Subscriber (reports)
  - File request
- Peer-to-peer model (communication between equals)
  - GOOSE services
  - Sampled values services

4.2 IEC 61850-7-2 (Services)

- **Server**
  - **Represents the visible behavior of the unit. The rest of the services are included in it.**
  - Services : ServerDirectory
- **Association**
  - **Indicates how the units are connected.**
  - Services : Associate, Abort, Release
- **Logical device**
  - **Represents a group of functions (logical nodes)**
  - Services : LogicalDeviceDirectory
- **Logical node**
  - **Represents a specific function within the system**
  - Services : LogicalNodeDirectory

4.2 IEC 61850-7-2 (Services)

- **Data**
  - **Information of a logical node**
  - Services : GetDataValues, SetDataValues, GetDataDefinition, GetDataDirectory
- **Data set**
  - **Data groups**
  - Services : GetDataSetValue, SetDataSetValue, CreateDataSet, DeleteDataSet , GetDataSetDirectory
- **Substitution**
  - **Substitution of the real values by some other manually introduced**
  - Services : Substitute, UnSubstitute
- **Setting group control**
  - **Interchange and edition of setting groups**
  - Services : ActivateSG, SetSGValues, GetSGValues, GetSGControl

4.2 IEC 61850-7-2 (Services)

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- **Reporting and logging**
  - **Report :**
    - **Immediate reports or with a small delay (buffer)**
    - **Buffered report control:**
      - Services : Report, AckReport, GetReportControlValue, SetReportControlValue
    - **Unbuffered report control:**
      - Services : Report, GetReportControlValue, SetReportControlValue
  - **Logging:**
    - **Events chronologically stored.**
    - Services : GetLogControlValue, SetLogControlValue, QueryLogByTime, GetLogStatusValue, QueryLogByEntry

4.2 IEC 61850-7-2 (Services)

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- **GSE (Generic Substation Event)**
  - **I/O data quick distribution (peer-to-peer communication)**
  - **There are two classes :**
    - **GOOSE : Generic Object Oriented Substation Event**
    - **GSSE : Generic Substation State Event (bit pairs)**
  - **The information is interchanged through an publisher/subscriber mechanism**
  - Services : GetReference, GetGSEElementNumber, GetGSEControlValue, SetGSEControlValue

4.2 IEC 61850-7-2 (Services)

- **Control**
  - **Control operations (commands)**
  - **Types :**
    - **Direct control with normal security :**
      - Operate, TimeActivatedOperate
    - **SBO Control (Select Before Operate) with normal security :**
      - Select, Cancel, Operate, TimeActivatedOperate
    - **Direct control with extended security :**
      - Operate, TimeActivatedOperate , CommandTermination
    - **SBO Control (Select Before Operate) with extended security :**
      - SelectWithValue, Cancel, Operate, TimeActivatedOperate , CommandTermination
    - **Control with Synchrocheck**

4.2 IEC 61850-7-2 (Services)

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- **Time**
  - **Gives the time base of the system**
- **FILE transfer**
  - **Defines the interchange of great blocks of data**
  - **Services :**
    - GetFile, SetFile, DeleteFile, FileDirectory
- **Transmission of sampled values**
  - **Quick and cyclical sample transference**
  - **Multicast SMVC services:**
    - GetMSMVCValues, SetMSMVCValues
  - **Unicast SMVC services:**
    - GetUSMVCValue, SetUSMVCValue, GetNextUSMVC

4.2 IEC 61850-7-2 (Service example)

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- **GetLogicalDeviceDirectory :**
  - **The client requests this service to get a list with the references of all the Logical Nodes of the LD**

Parameter Name
Request
LDReference
Response+
LNReference [3..n]
Response–
ServiceError

4.3 IEC 61850-7-3 (Classes of Common Data)

Ingeteam

- **This part of IEC 61850 specifies common attribute types and common data classes related to substation applications.**
- **In particular it specifies:**
  - common data classes for **status information,**
  - common data classes for **measured information,**
  - common data classes for **controllable status information,**
  - common data classes for **controllable analogue set point information,**
  - common data classes **for status settings,**
  - common data classes for **analogue settings and**
  - **attribute types used in these common data classes.**

4.3 IEC 61850-7-3 (Classes of Common Data)

- **Status information**
  - **Single point status (SPS)**
  - **Double point status (DPS)**
  - **Integer status (INS)**
  - **…..**
- **Measurement information**
  - **Measured value (MV)**
  - **Sampled value (SAV)**
  - **Phase to ground related measured values of a three phase system (WYE)**
  - **……**

4.3 IEC 61850-7-3 (Classes of Common Data)

Ingeteam

- **Controllable status information**
  - Controllable single point (SPC)
  - Controllable double point (DPC)
  - Controllable integer status (ISC)
  - Binary controlled step position information (BSC)
  - Integer controlled step position information (ISC)

- **Controllable analogue information**
  - Analogue set point (ASP)
  - Setting curve (CURVE)

4.3 IEC 61850-7-3 (CDC example)

INS class					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
				stat	
stVal	INT32	ST	dchg		
q	Quality	ST	qchg		
t	TimeStamp	ST			
				substit	
subEna	BOOLEAN	SV			
subVal	INT32	SV			
subQ	Quality	SV			
subID	VISIBLE STRING64	SV			
				configuration, descrip	
d	VISIBLE STRING255	DC		Te	
dU	UNICODE STRING255	DC			
cdcNs	VISIBLE STRING255	EX			
cdcName	VISIBLE STRING255	EX			
dataNs	VISIBLE STRING255	EX			
Services					
As defined in Table 13					

- **Integer Status (INS)**
  - **stVal : Data integer value**
  - **q : Data quality**
  - **t : data timestamp**
  - **d : Description (text) of the data**

(de IEC 61850-7-3)

4.4 IEC 61850-7-4 (Logical Nodes)

Ingeteam

Logical node groups	Group Indicator
System Logical Nodes	L
Protection functions	P
Protection related functions	R
Control	C
Generic References	G
Interfacing and Archiving	I
Automatic Control	A
Metering and Measurement	M
Switchgear	X
Instrument Transformer	T
Power Transformer	Y
Further power system equipment	Z
Extensions	E

4.4 IEC 61850-7-4 (Examples of the LNs)

- System Logical Nodes. LN Group: L
  - Logical node zero - LLN0
  - Physical device information - LPHD
- Logical Nodes for Protection Functions. LN Group: P
  - Distance protection - PDIS (IEEE: 21)
  - Instantaneous overcurrent - PIOC (IEEE: 50)
  - Time overcurrent - PTOC (IEEE: 51)
- Logical Nodes for Metering and Measurement LN Group: M
  - Measurement Unit - MMXU
  - Metering - MMTR
- Logical Nodes for Switchgear Related LN Group: X
  - Circuit breaker - XCBR
  - Circuit Switch - XSWI

4.4 IEC 61850-7-4 (Example of LN)

Ingeteam

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health (external sensor)		O
EEName	DPL	External equipment name plate		O
Loc	SPS	Local operation		O
OpCntRs	INC	Resetable operation counter		O
Measured values				
AnIn	MV	Analogue input		O
Controls				
SPCSO	SPC	Single point controllable status output		O
DPCSO	DPC	Double point controllable status output		O
ISCSO	INC	Integer status controllable status output		O
Status Information				
IntIn	INS	Integer status input		O
Alm	SPS	General single alarm		O
Ind	SPS	General indication (binary input)		O

(de IEC 61850-7-4)

4.4 IEC 61850-7-4 (Example of LN)

SPS class					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
status					
stVal	BOOLEAN	ST	dchg	TRUE | FALSE	M
q	Quality	ST	qchg		M
t	TimeStamp	ST			M
substitution					
subEna	BOOLEAN	SV			PICS_SUBST
subVal	BOOLEAN	SV		TRUE | FALSE	PICS_SUBST
subQ	Quality	SV			PICS_SUBST
subID	VISIBLE STRING64	SV			ST
configura					
d	VISIBLE STRING255	DC			
dU	UNICODE STRING255	DC			
cdcNs	VISIBLE STRING255	EX			_M
cdcName	VISIBLE STRING255	EX			_M
dataNs	VISIBLE STRING255	EX			M
Services					
As defined in Table 13					

- **Single Point Status (SPS)**
  - **MiLD/GGIO1.Ind.stVal**
  - **MiLD/GGIO1.Ind.q**
  - **MiLD/GGIO1.Ind.t**

(de IEC 61850-7-3)

4.5 IEC 61850-8-1 (Mapping to MMS)

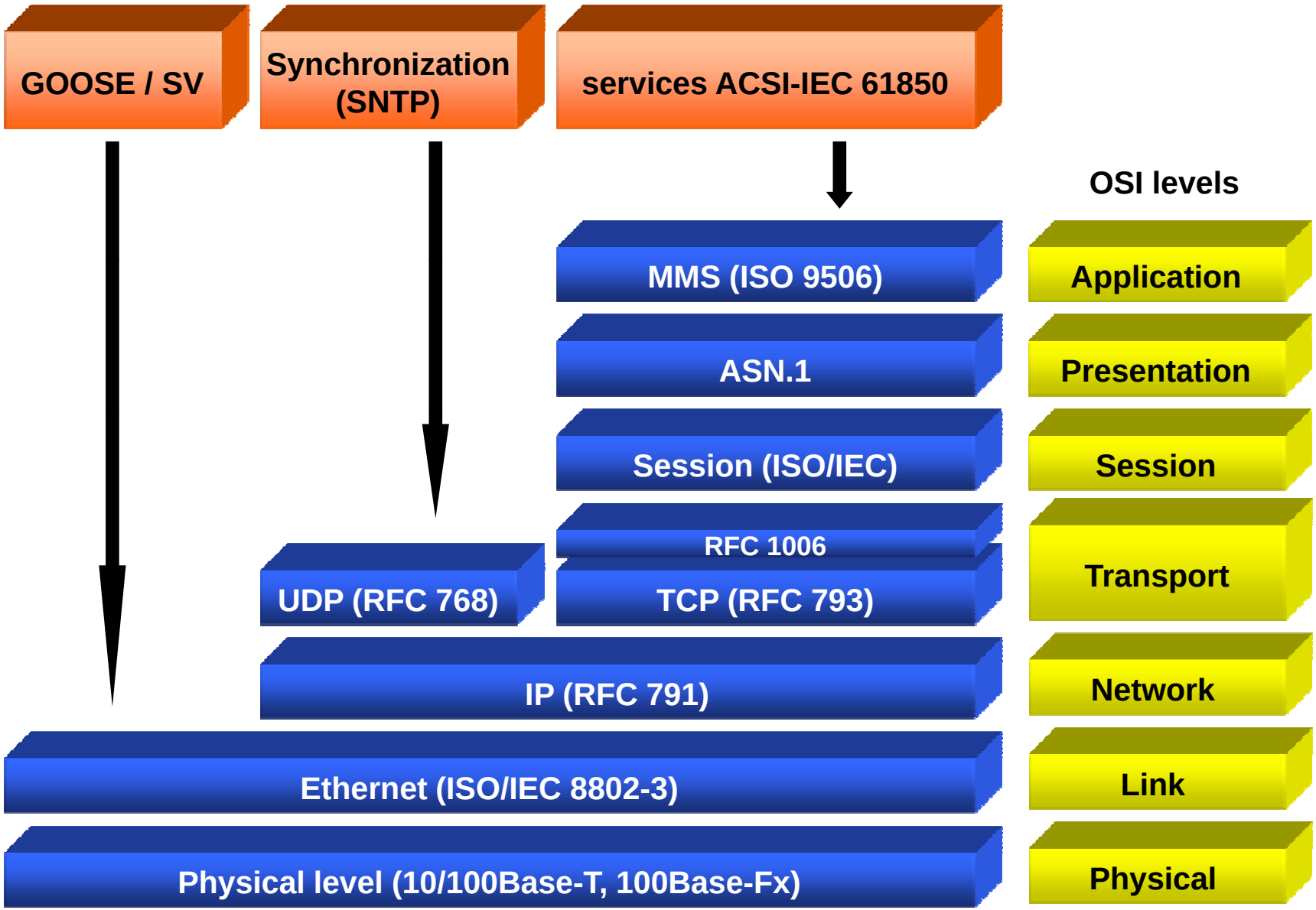
- The **SCSM** (Specific Communication Service Mapping) describes how to map the concepts, objects and services described in the ACSI, using MMS object concepts and services.

- **MMS** provides the capacity of carrying out the REAL concretion of the abstract models of the ACSI (Abstract Communication Service Interface)

4.5 IEC 61850-8-1 (Communication profile)

Application level :	MMS
Presentation level :	ASN.1
Session level :	ISO/IEC 8326, 8327 (Connection Oriented Session)
Transport level :	TCP
Network level :	IP
Link level :	CSMA/CD (Ethernet)
Physical level :	Optical fiber

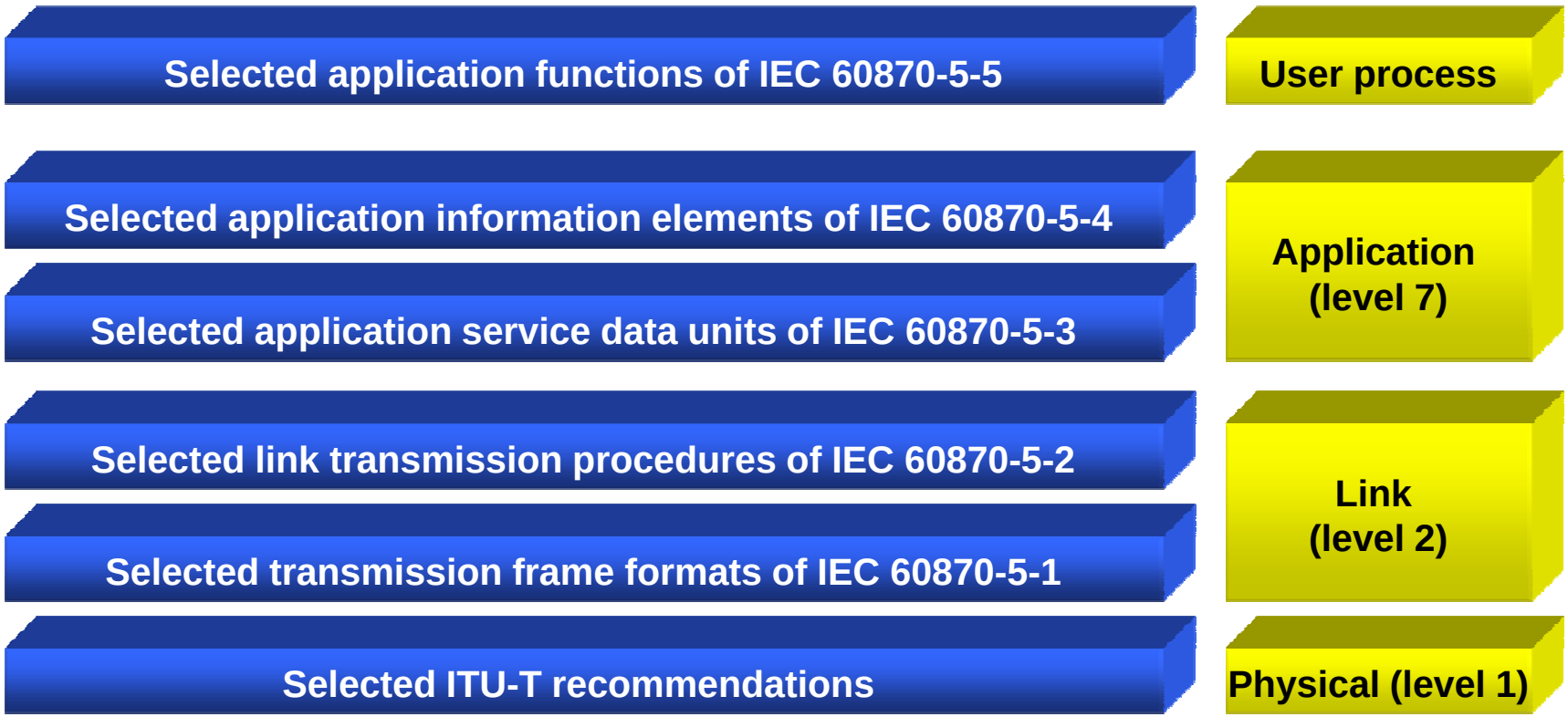
4.5 IEC 61850-8-1 (TCP/IP profile)



4.5 EPA (Enhanced Performance Architecture)

Ingeteam

- IEC 60870-5-101, DNP 3.0, Procome
- 3 layer reference model



Sections 7 and 8 of the standard

Ingeteam

Key concepts

5

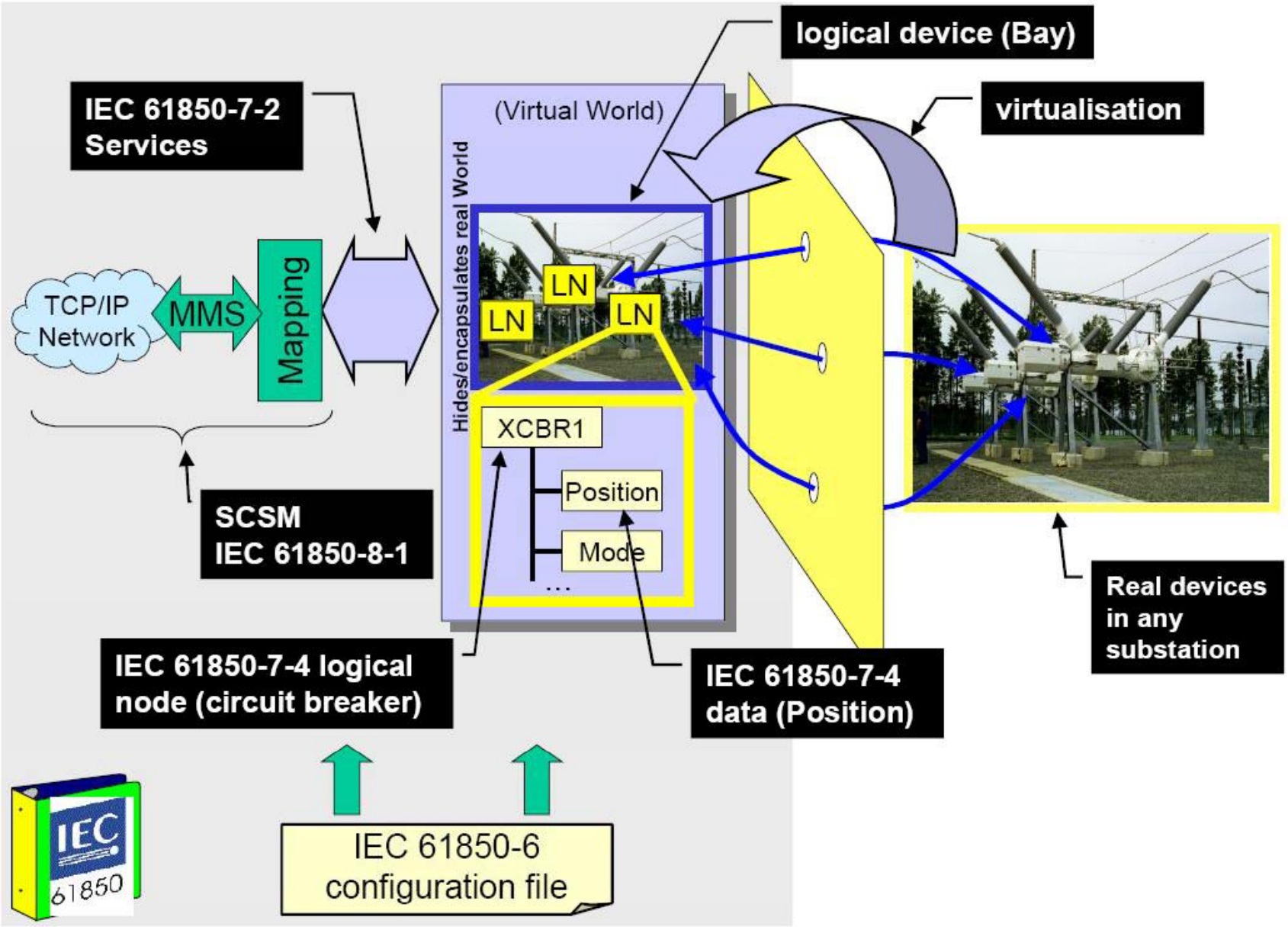
5.1 Key concepts

- The standard provides the capacity of representing the IEDs, its functions and the necessary communication capacities.
- This representation is carried out through the ACSI (Abstract Communication Service Interface), which implies ABSTRACT and OBJECT ORIENTED COMMUNICATION MODELS.
- Abstract :
  - It is aimed at the definition of WHAT is offered by the services.
  - It does not care HOW these services are effectuated, so that SCSMs will be specified.
- Object Oriented :
  - All the meaning entity is modeled as an object with its own characteristics (own parameter).
  - The possible interaction between objects are specified.

5.1 Key concepts

- **Client – Server :**
  - **Master-Slave concept substituted by Client-Server (multiple clients can get access to the same server).**
  - **Master-Slave :**
    - **Master send questions (Request)**
    - **Slave responds (Respond)**
  - **Client / Server :**
    - **Server gives services and data**
    - **Several clients may be connected to the server at the same time.**
- **Peer-to-peer : Communication between IEDs of the bay level.**
- **Publisher-Subscriber : Communication architecture not oriented to the connection. A “one to many” (i.e. reports).**

5.1 Key concepts (Modelling)

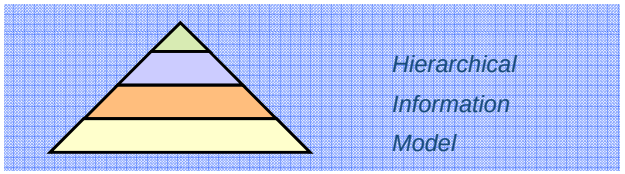


(de IEC 61850-7-1)

5.1 Key concepts

- **ACSI (Abstract Communication Service Interface)**
  - **Virtual interface to an IED that offers abstracted communication services, access to variables, data transference, device control, file transmission etc. Regardless the communication profile used.**
- **SCSM (Specific Communication Service Mapping)**
  - **Assignation of the ACSI over a certain communication profile.**
- **Function**
  - **Decomposition of the tasks carried out within the substation**

5.1 Key concepts



- **IEC 61850 defines an information hierarchy whose levels are called: server, logical device, logical node, data and data attribute.**
- **IEC 61850 creates information models for the different components and functionalities inside the substation.**

5.1 Key concepts

- **Server :**
  - The server represents the visible behavior of a device through the set of data the clients can get access to.
- **Logical Device (LD) :**
  - The logical device represents a group of related functions. Each function is defined through Logical Nodes (LN)
- **Logical Node (LN) :**
  - The logical nodes represent specific functions. It is the smallest part of a function that interchanges data
- **Data :**
  - Information of the Logical Nodes.
- **Data attributes :**
  - Information in the data

5.2 ACSI : Object hierarchy

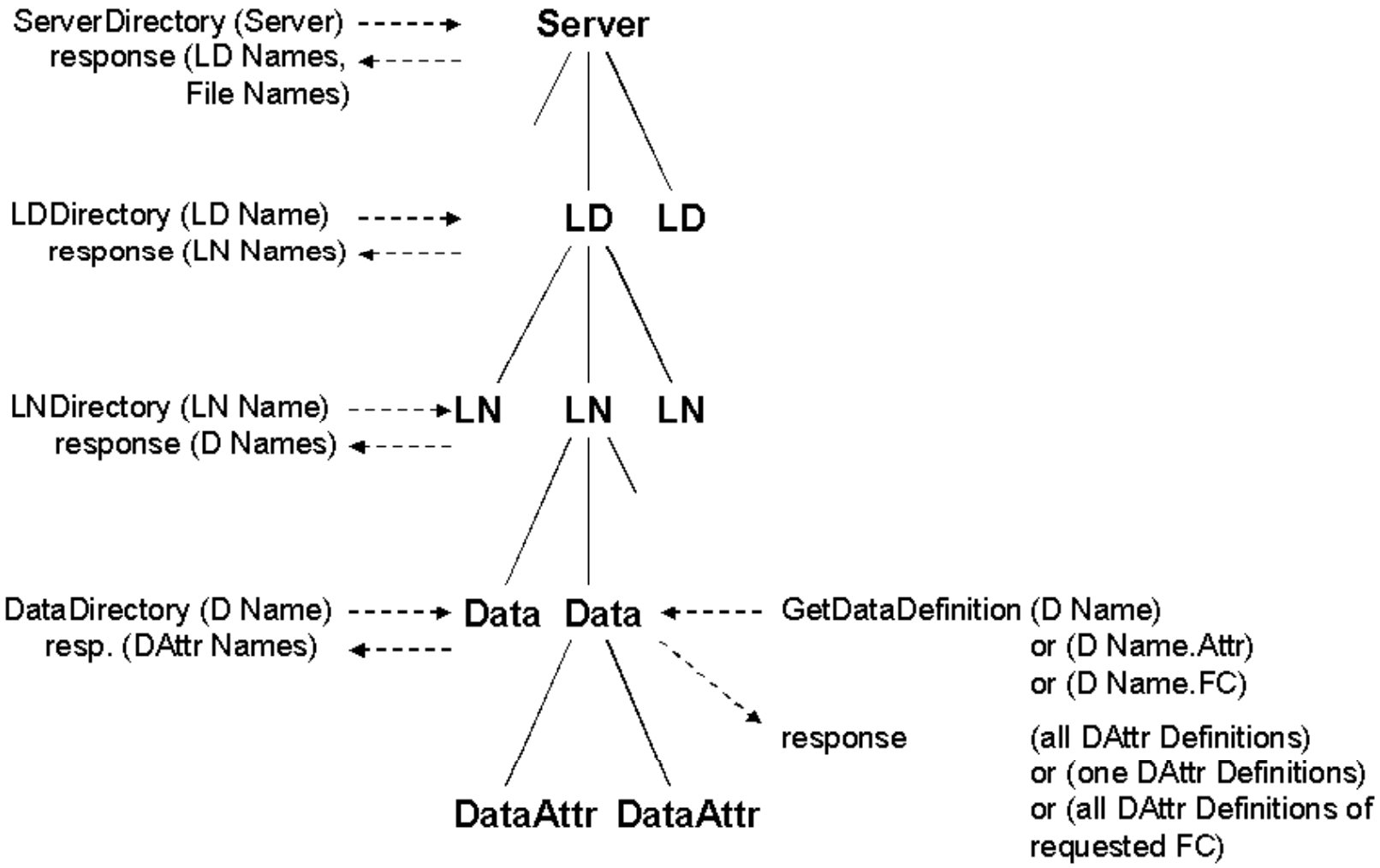
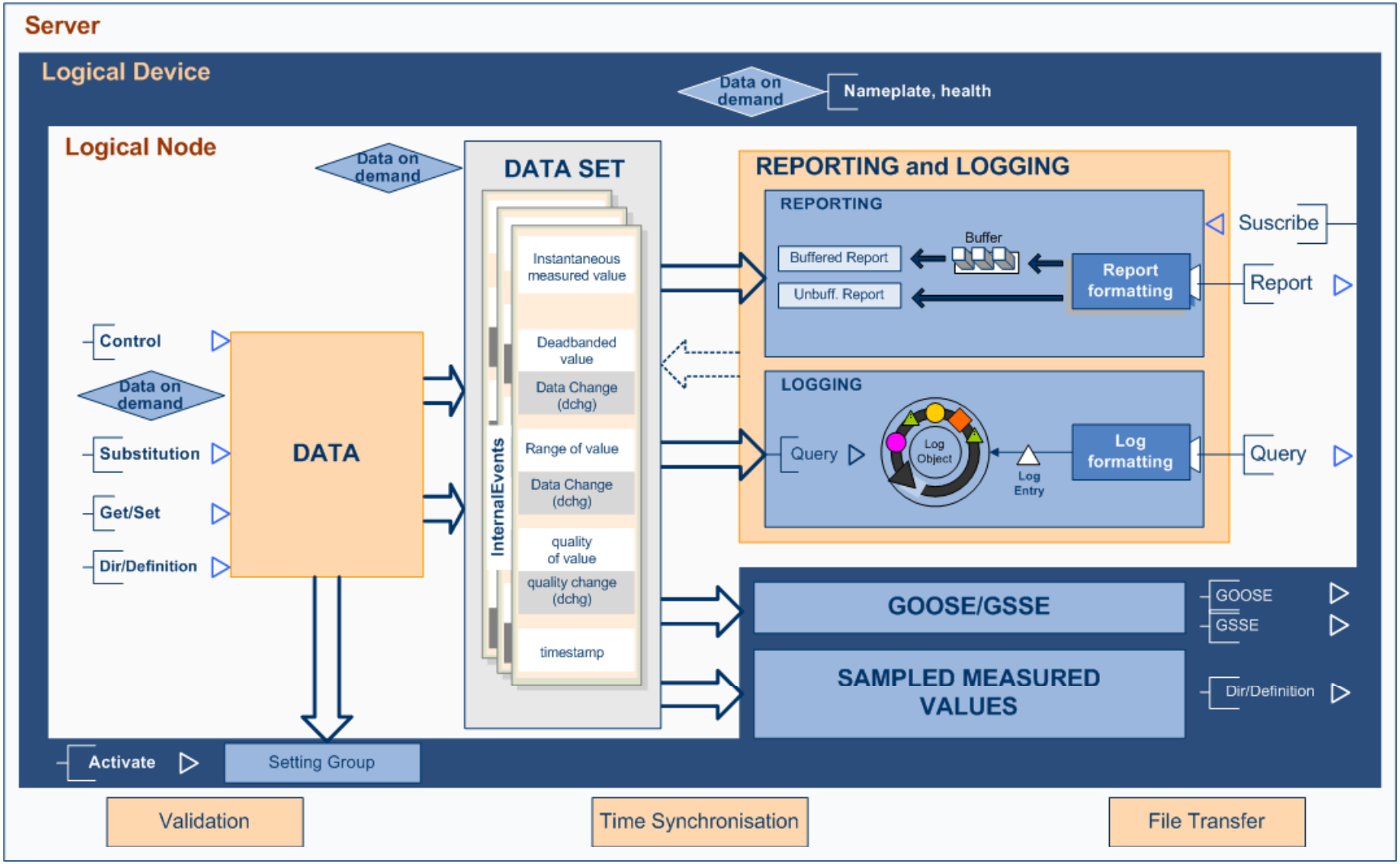
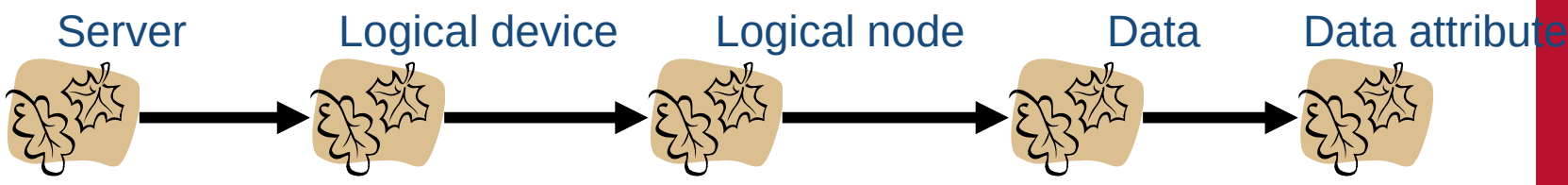


Figure 1 – Object Hierarchy from IEC 61850-7-2 clause 6.2.1

5.2 ACSI : Server



5.2 ACSI : References (7-2)



LDName / LNName . DataName . DataAttributeName

- **IEC 61850 uses text references to address information.**
- **The text reference syntax and semantics are defined in the standard.**
- **With a text reference, the type and meaning of the information referenced is known.**

TCPCONTROL / XCBR1 . Pos . stVal

XCBR = Circuit Breaker 1

Pos = position

DPC = Controllable double point

Status value = opened | closed | invalid state | intermediate state

5.2 ACSI : References (7-2)

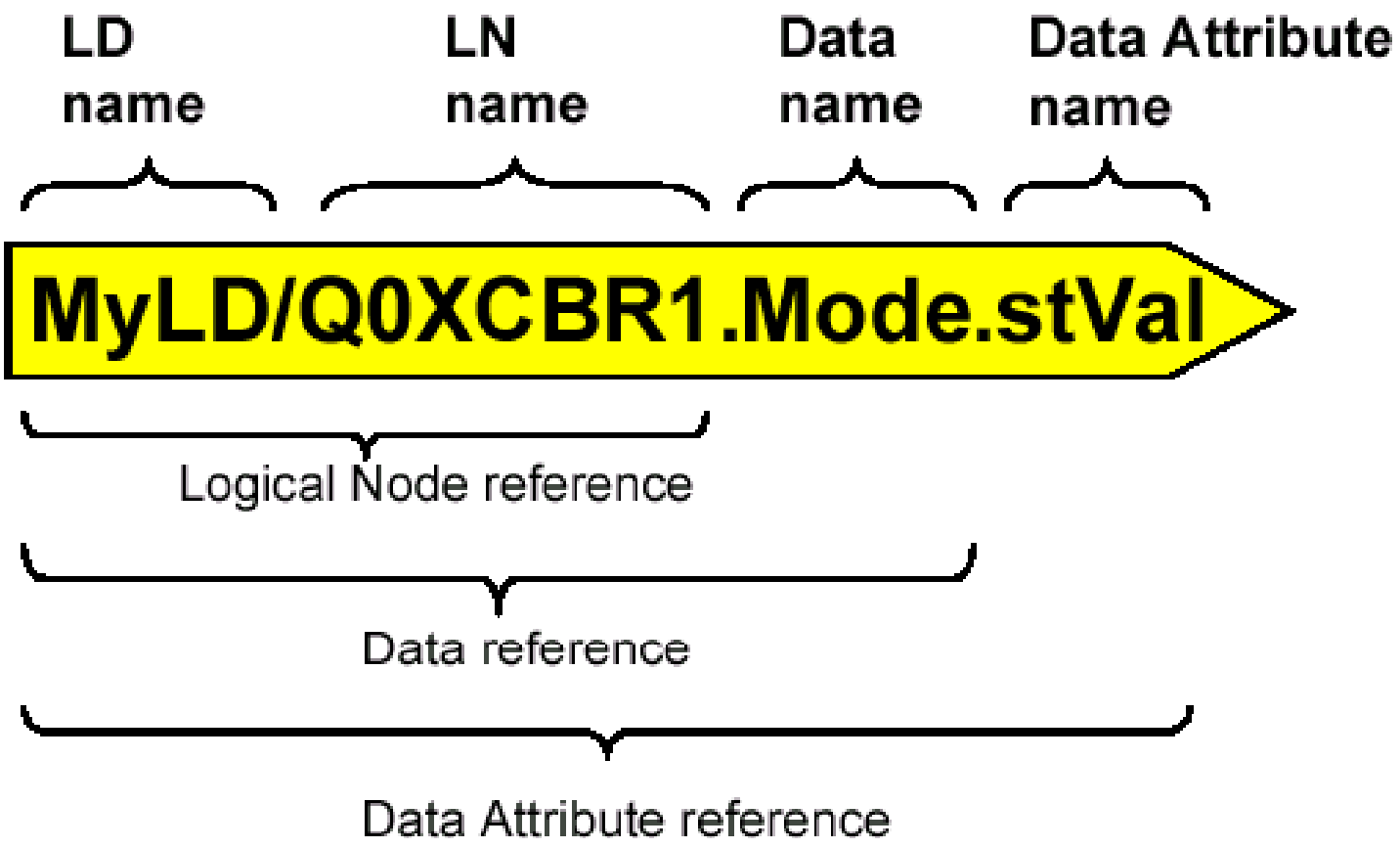


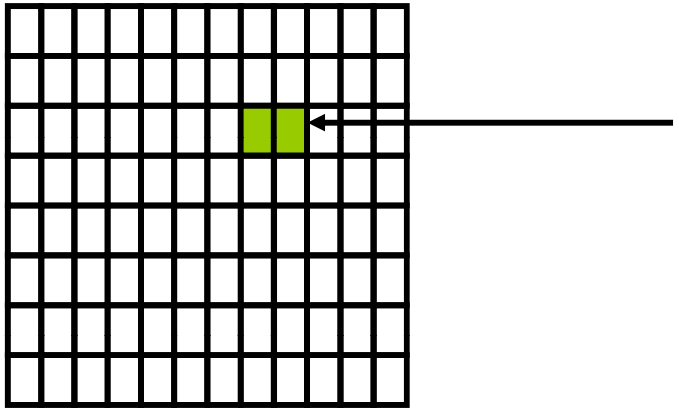
Figure 32 – References

(de IEC 61850-7-2)

5.2 ACSI : References vs. Indexes

- Other protocols identify the data through indexes
- I.e. DNP :
  - Object :
    - “1” = Binary Input Static
    - “2” = Binary Input Event
    - …..
  - Variation :
    - “1” = With status
    - “2” = Without status
    - …..
  - Index : Index within the elements of the same type.
- Identification of a data: Obj 2, Var 2, Index 8.

5.2 ACSI : References vs. Indexes



Information Object
Address = 1342
double-point

TCPCONTROL / XCBR1 . Pos . stVal

XCBR = Circuit Breaker 1

Pos = position

DPC = Controllable double point

Status value = opened | closed | invalid state | intermediate state

5.2 ACSI : Reference vs. Indexes

- The names (references IEC 61850) include the meaning of the data, making the comprehension easier for the user:
  - Obj 2, Var 2, Index 8.
  - QA0XCBR1.Pos.stVal (state of a breaker)
- The references are sent through communications so a wider bandwidth is required.

5.3 Information categories in LNs

Ingeteam

Logical Node

COMMON LOGICAL NODE INFORMATION

information independent from the dedicated function represented by the LN, e.g., mode, health, name plate, etc.

STATUS INFORMATION

information representing either the status of the process or of the function allocated to the LN, e.g., switch type, switch operating capability, etc.

SETTINGS

information needed for the function of a logical node, e.g., first, second, and third reclose time, close pulse time, and reclaim time of an autoreclosing function.

MEASURED VALUES

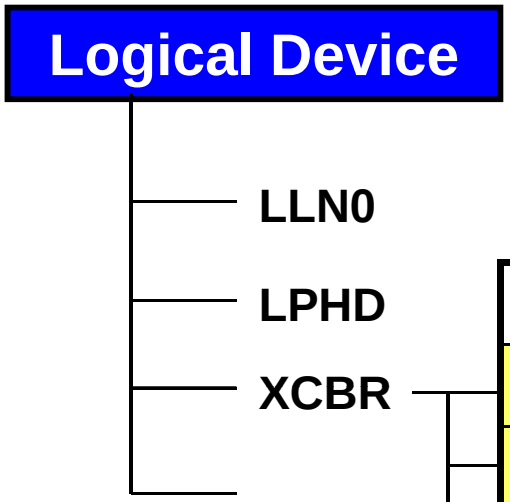
are analogue data measured from the process or calculated in the functions like currents, voltages, power, etc., e.g., total active power, total reactive power, frequency, net real energy since last reset, etc.

CONTROLS

are data which are changed by commands like switchgear state (ON/OFF), tap changer position or resetable counters, e.g., position, block opening, etc.

5.3 Information categories in LNs

Ingeteam



Data	Type	Description
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation
OpCnt	INS	Operation counter
Pos	DPC	Switch position
BlkOpn	SPC	Block opening
BlkCls	SPC	Block closing
SumSwARs	BCR	Sum of switched amperes
CBOpCap	INS	Circuit breaker operating capability

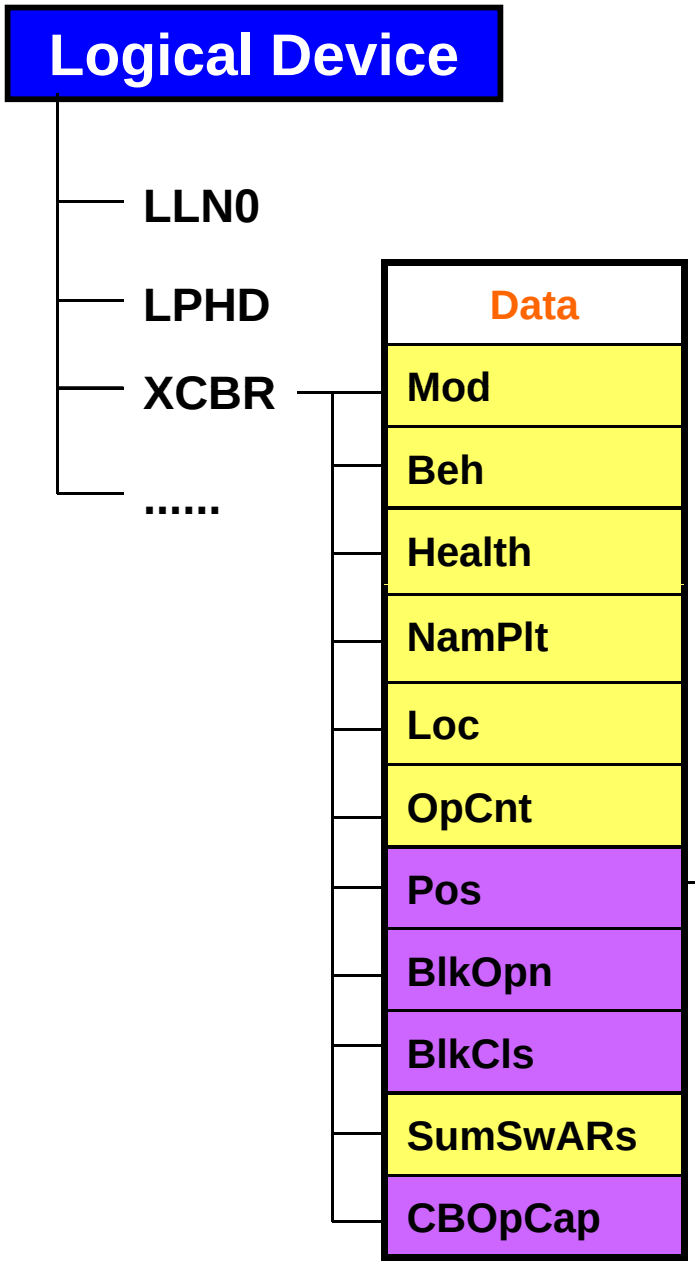
COMMON LOGICAL NODE INFORMATION

CONTROLS

MEASURED VALUES

STATUS INFORMATION

5.3 Information categories in LNs



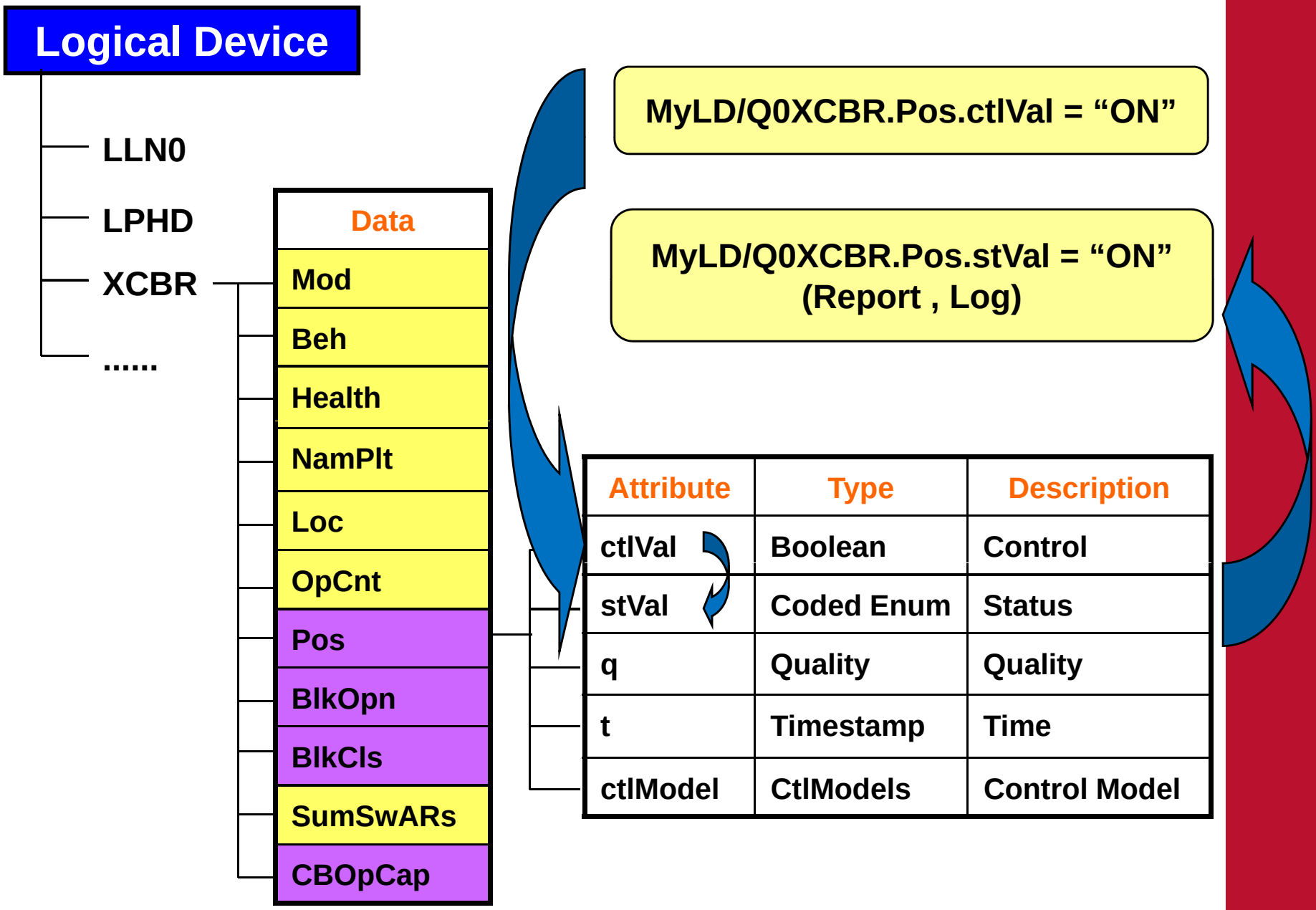
References :

MyLD/Q0XCBR.Pos.ctlVal

MyLD/Q0XCBR.Pos.stVal

Attribute	Type	Description
ctlVal	Boolean	Control
stVal	Coded Enum	Status
q	Quality	Quality
t	Timestamp	Time
ctlModel	CtlModels	Control Model

5.3 Information categories in LNs



5.3 DPC Common Data Class

DPC class					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
control and status					
ctlVal	BOOLEAN	CO			AC_CO_M
operTm	TimeStamp	CO			AC_CO_O
origin	Originator	CO, ST			AC_CO_O
ctlNum	INT8U	CO, ST			AC_CO_O
stVal	CODED ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q	Quality	ST	qchg		M
t	TimeStamp	ST			M
stSeld	BOOLEAN	ST	dchg		AC_CO_O
substi					
subEna	BOOLEAN	SV			PICS_SUBST
subVal	CODED ENUM	SV		intermediate-state | off | on | bad-state	PICS_SUBST
subQ	Quality	SV			PICS_SUBST
subID	VISIBLE STRING64	SV			PICS_SUBST
configuration, description and extension					
pulseConfig	PulseConfig	CF			AC_CO_O
ctlModel	CtlModels	CF			M
sboTimeout	INT32U	CF			AC_CO_O
sboClass	SboClasses	CF			AC_CO_O
d	VISIBLE STRING255	DC		Text	O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M
Services					
As defined in Table 31					

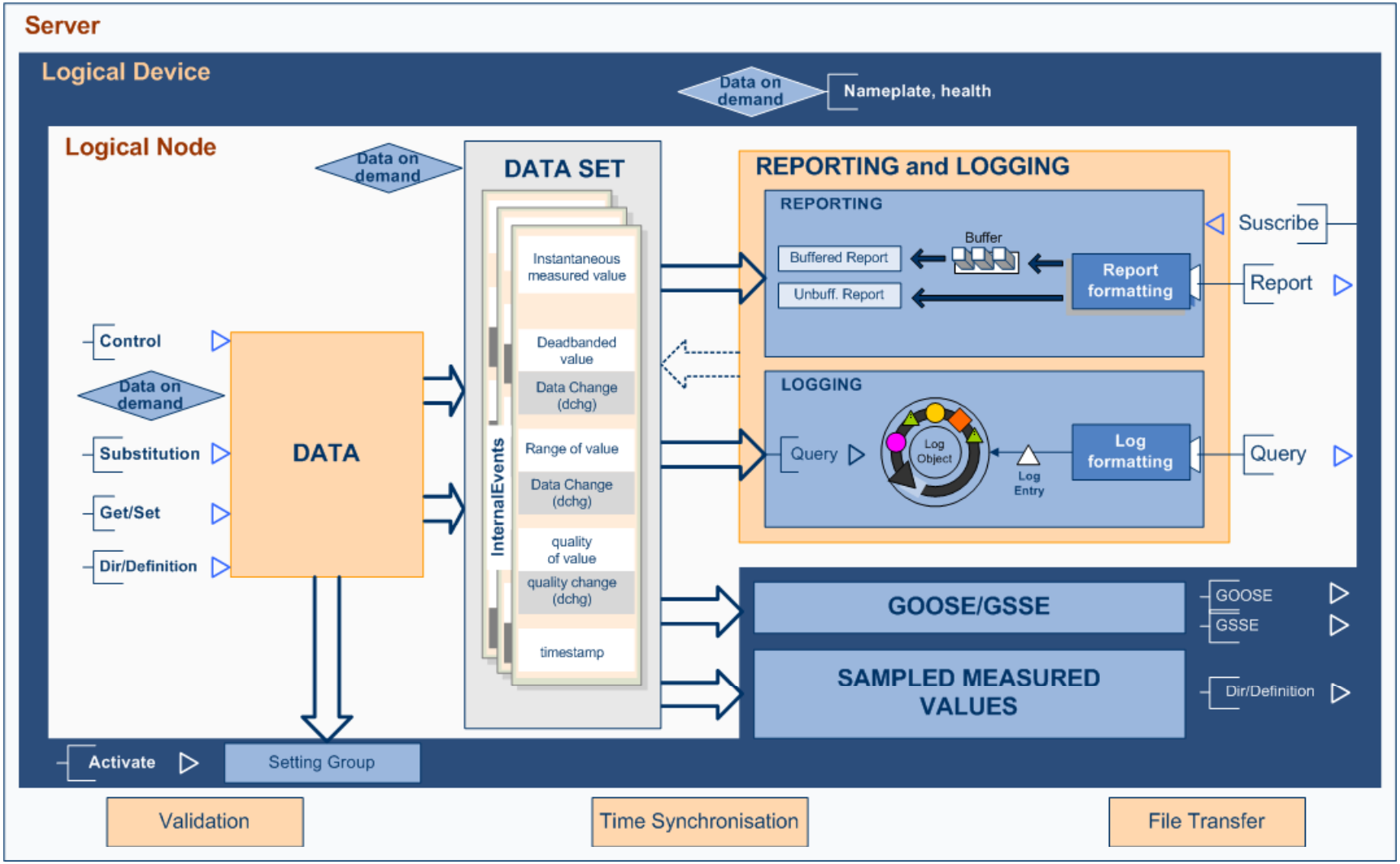
M/O data if there is control model

Mandatory data

Optional data

(de IEC 61850-7-3)

5.4 IEC 61850-7-2 (Server)



5.5 IEC 61850-7-2 (REPORTS)

Ingeteam

- **REPORT :**
  - **Mechanisms for transferring data values caused by well-defined conditions from a logical node to one client**
  - **Time stamped reports serve as an indication to clients under real-time constraints (optionally keeping sequence-of-events to the client)**
  - **Reports are sent only when required (controlled by several attributes) :**
    - **caused by trigger options data-change, quality-change, and data-update**
  - **Low-frequency integrity scan and client-initiated general interrogation are available**

5.5 IEC 61850-7-2 (REPORTS)

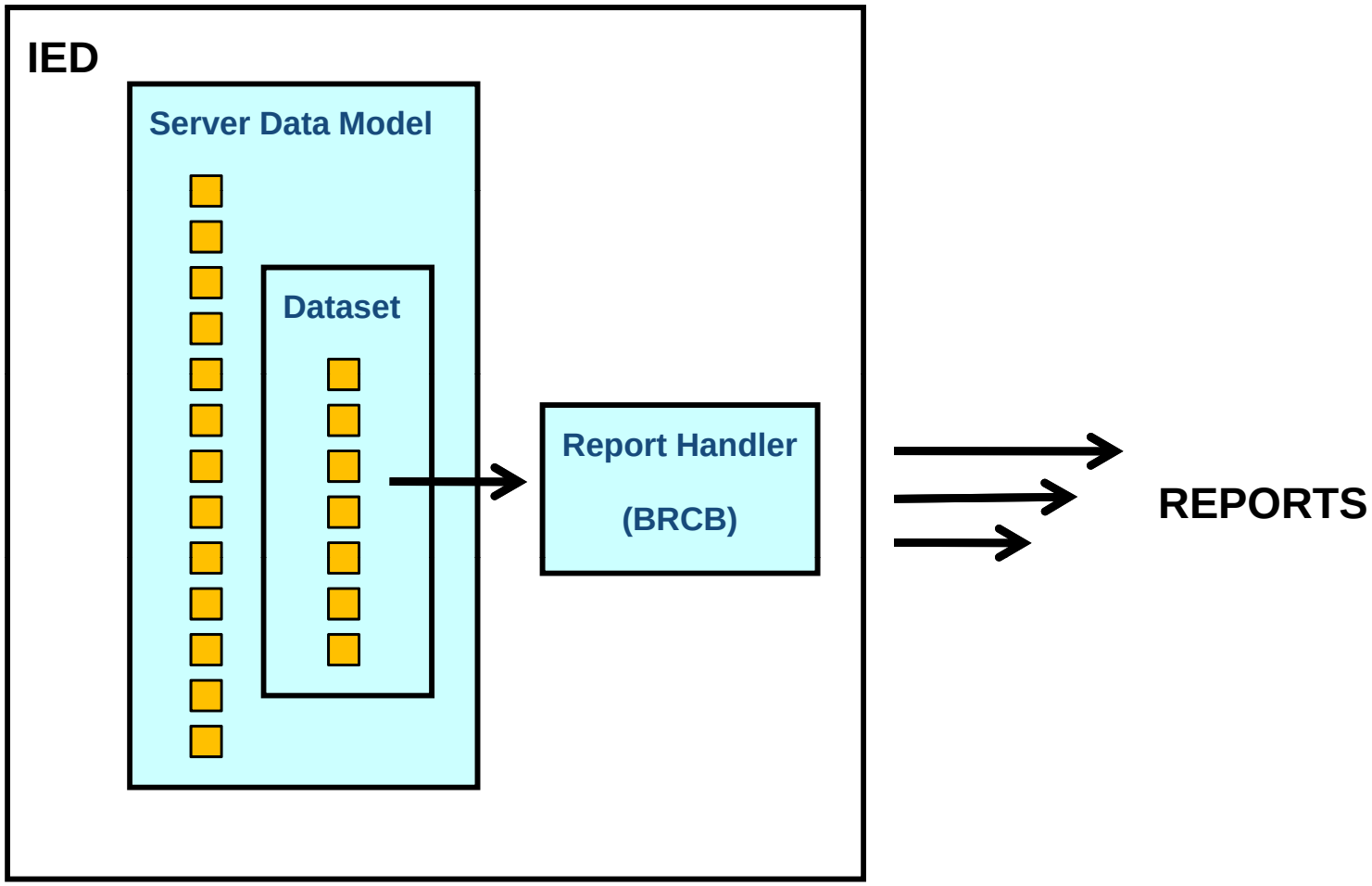
Ingeteam

There are two classes of report control defined, each with a slightly different behavior :

- BUFFERED-REPORT-CONTROL-BLOCK (BRCB) :
  - internal events issue immediate sending of reports or buffer the events (to some practical limit) for transmission, such that values of DATA are not lost due to transport flow control constraints or loss of connection.
  - BRCB provides the sequence-of-events (SOE) functionality.
- UNBUFFERED-REPORT-CONTROL-BLOCK (URCB) :
  - internal events issue immediate sending of reports on a “best efforts” basis. If no association exists, or if the transport data flow is not fast enough to support it, events may be lost.

5.5 IEC 61850-7-2 (REPORTS)

- Events from a predefined dataset are sent



5.5 IEC 61850-7-2 (REPORTS)

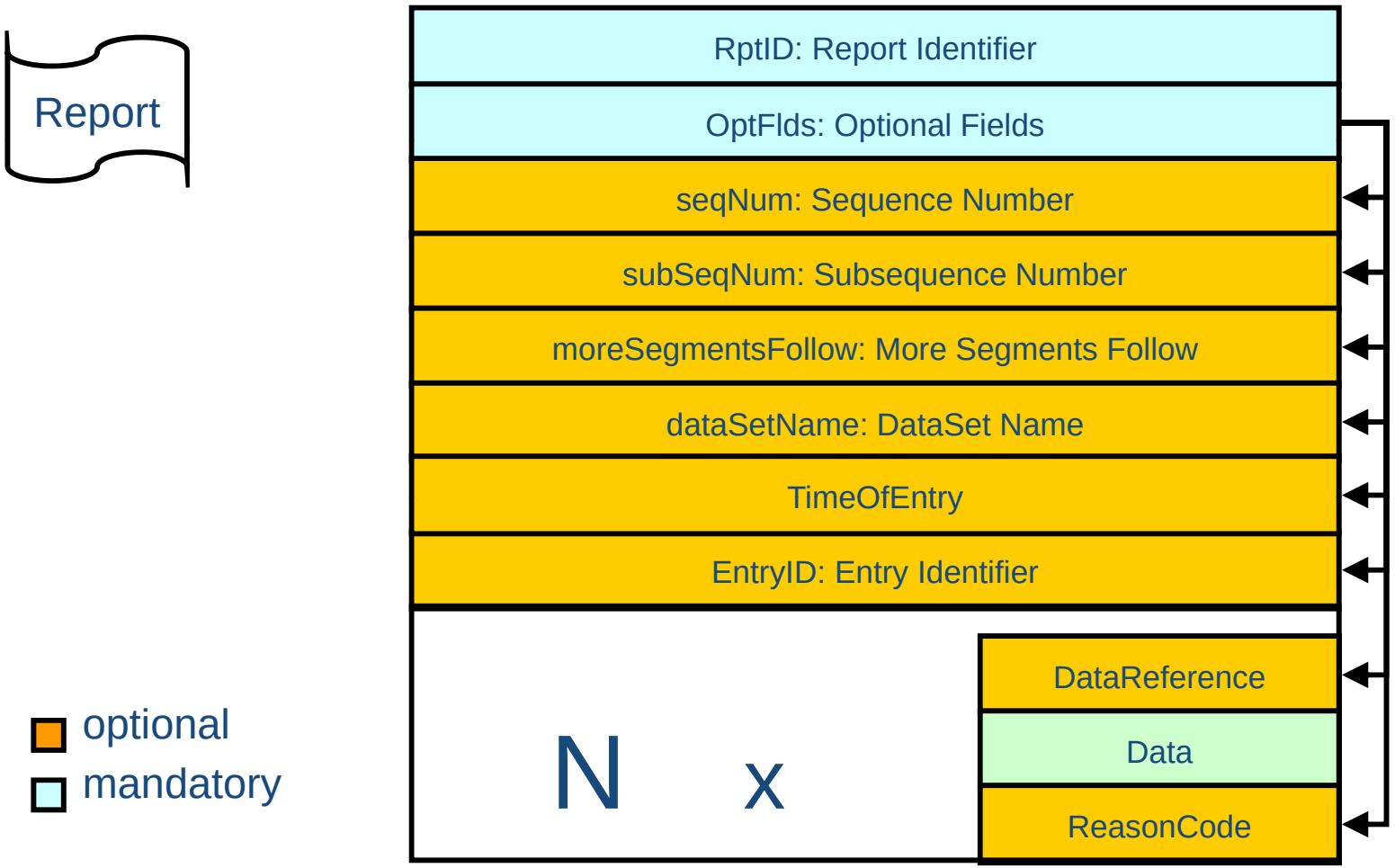
Ingeteam

- **Trigger options (TrgOpt) :** trigger conditions which shall be monitored by the **BRCB**
  - **data-change (dchg)**
  - **quality-change (qchg)**
  - **data-update (dupd)**
  - **Integrity :**
    - **the attribute IntgPd shall indicate the period in milliseconds used for generating an integrity report. An integrity report shall report the values of all members of the related DATA-SET.**
  - **general-interrogation :**
    - **The attribute GI shall indicate the request to start the general-interrogation process. After setting to TRUE, the BRCB shall start the general-interrogation process.**

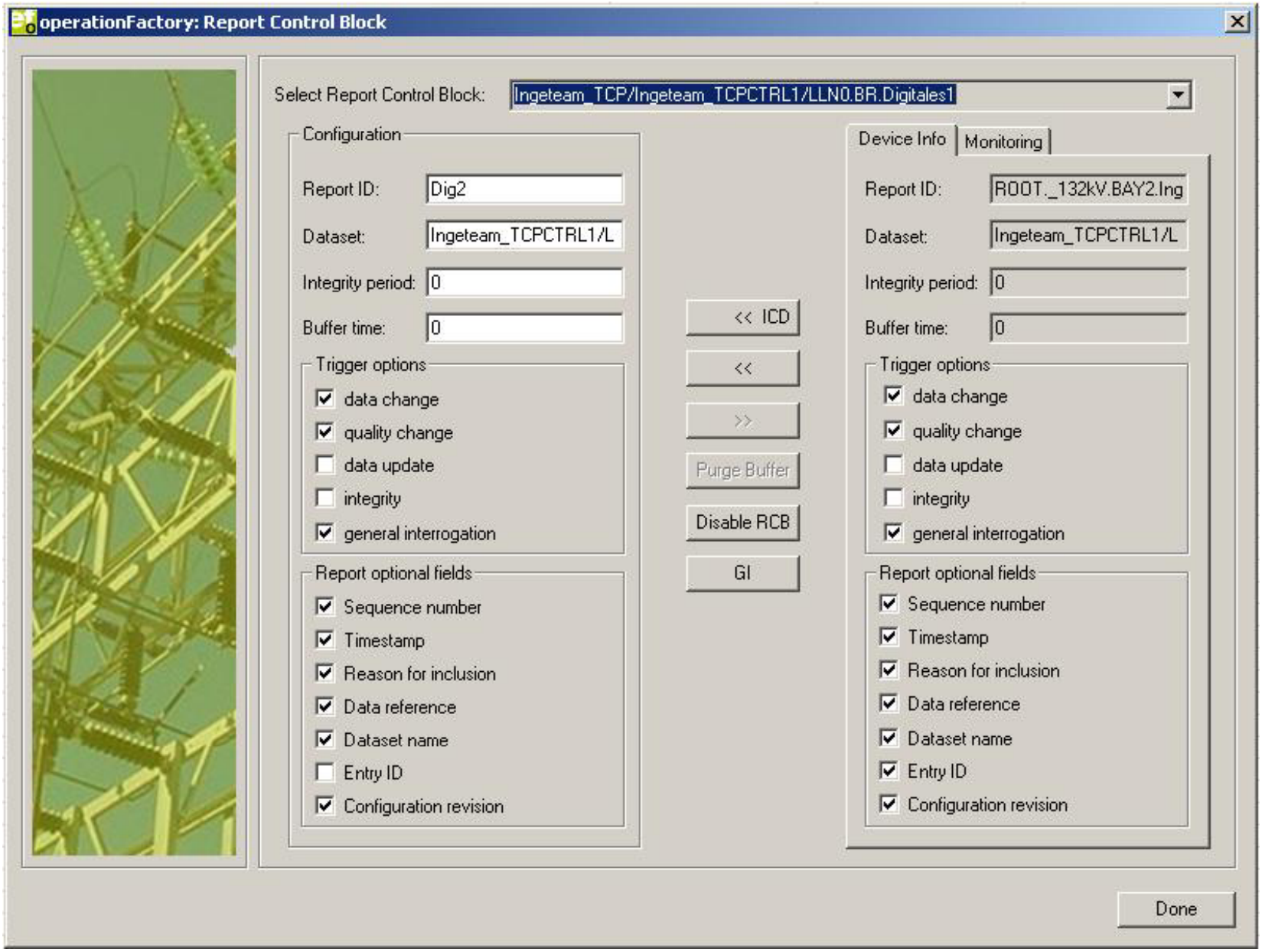
5.5 IEC 61850-7-2 (REPORTS)

Ingeteam

- **The Report is a variable structure with optional fields**



5.5 IEC 61850-7-2 (REPORTS)



5.6 IEC 61850-7-2 (GSE)

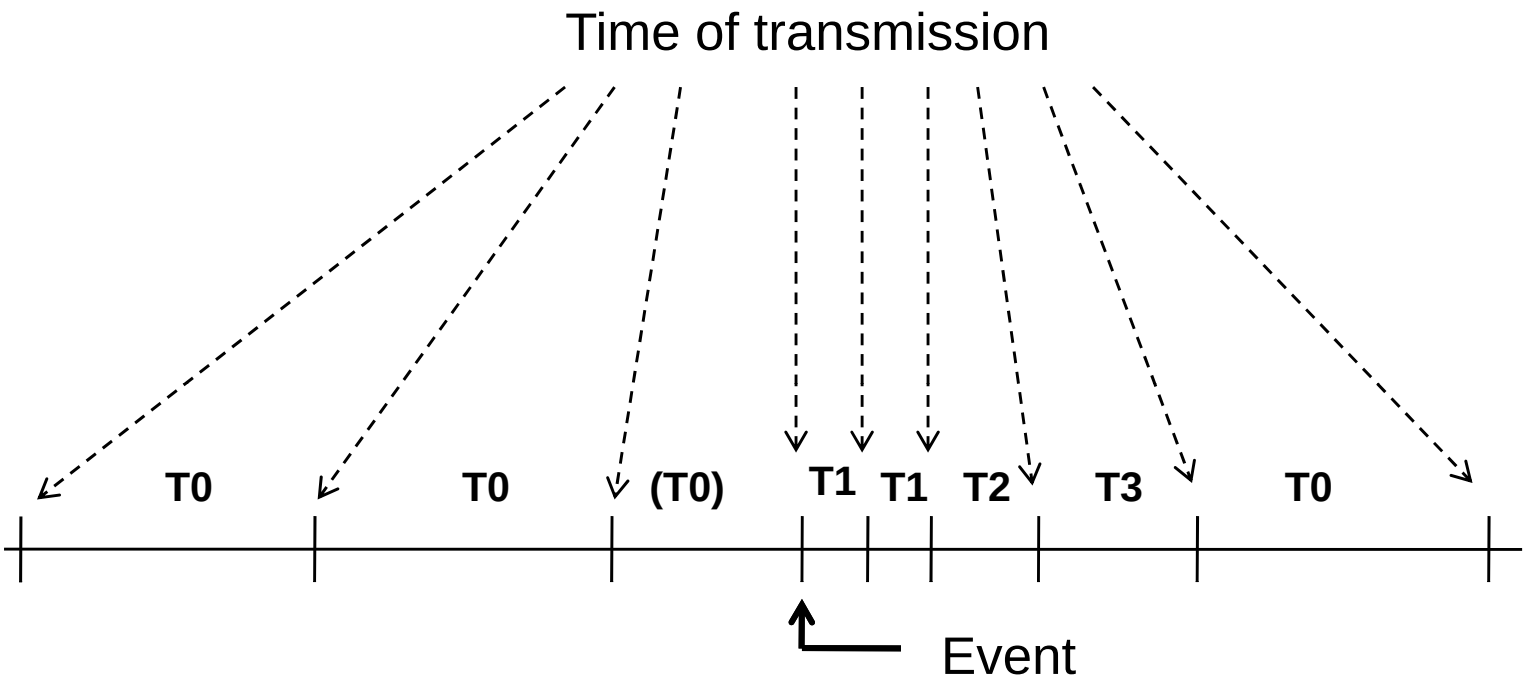
Ingeteam

- GSE :Generic substation event
  - Possibility for a fast and reliable system-wide distribution of input and output data values
  - Based on the multicast application association
  - GOOSE : generic object oriented substation event
    - supports the exchange of a wide range of possible common data organized by a DATA-SET.
  - GSSE : generic substation state event
    - provides the capability to convey state change information (bit pairs).

5.6 IEC 61850-7-2 (GOOSE)

- Upon power-up the IED send current data (status) or values as the initial GOOSE message.
- Shall continue to send the message with a long cycle time, even if no status/value change has occurred.
- This ensures that devices that have been activated recently will know the current status values of their peer devices.
- Lost of connection can be detected immediately
- When a data included in the Goose changes, a message is sent.

5.6 IEC 61850-7-2 (GOOSE)



T0 retransmission in stable conditions (no event for a long time).
(T0) retransmission in stable conditions may be shortened by an event.
T1 shortest retransmission time after the event.
T2, T3 retransmission times until achieving the stable conditions time.

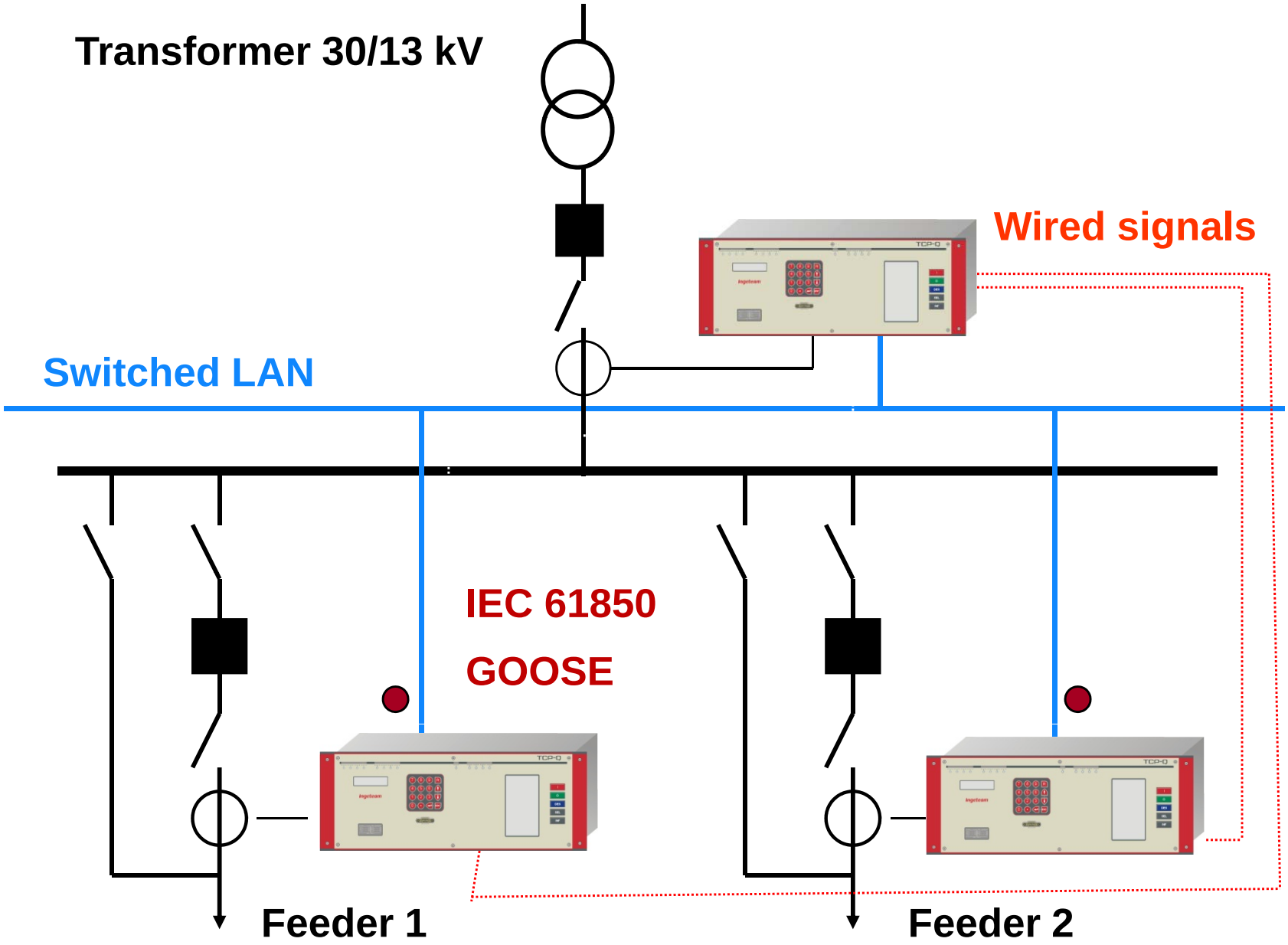
5.6 IEC 61850-7-2 (GOOSE)

Ingeteam

- GoCB : Goose Control Block
  - Parameters to configure a Goose message
    - GoCBName – GOOSE control name
    - GoCBRef – GOOSE control reference
    - AppID – application identification
    - DatSet – data set reference
    - ConfRev – configuration revision
    - NdsCom – needs commissioning
  - MAC address :
    - Recommended multicast addresing range

Service	Starting address	Ending address
GOOSE	01-0C-CD-01-00-00	01-0C-CD-01-01-FF
GSSE	01-0C-CD-02-00-00	01-0C-CD-02-01-FF
Multicast Sampled Values	01-0C-CD-04-00-00	01-0C-CD-04-01-FF

5.6 Goose example

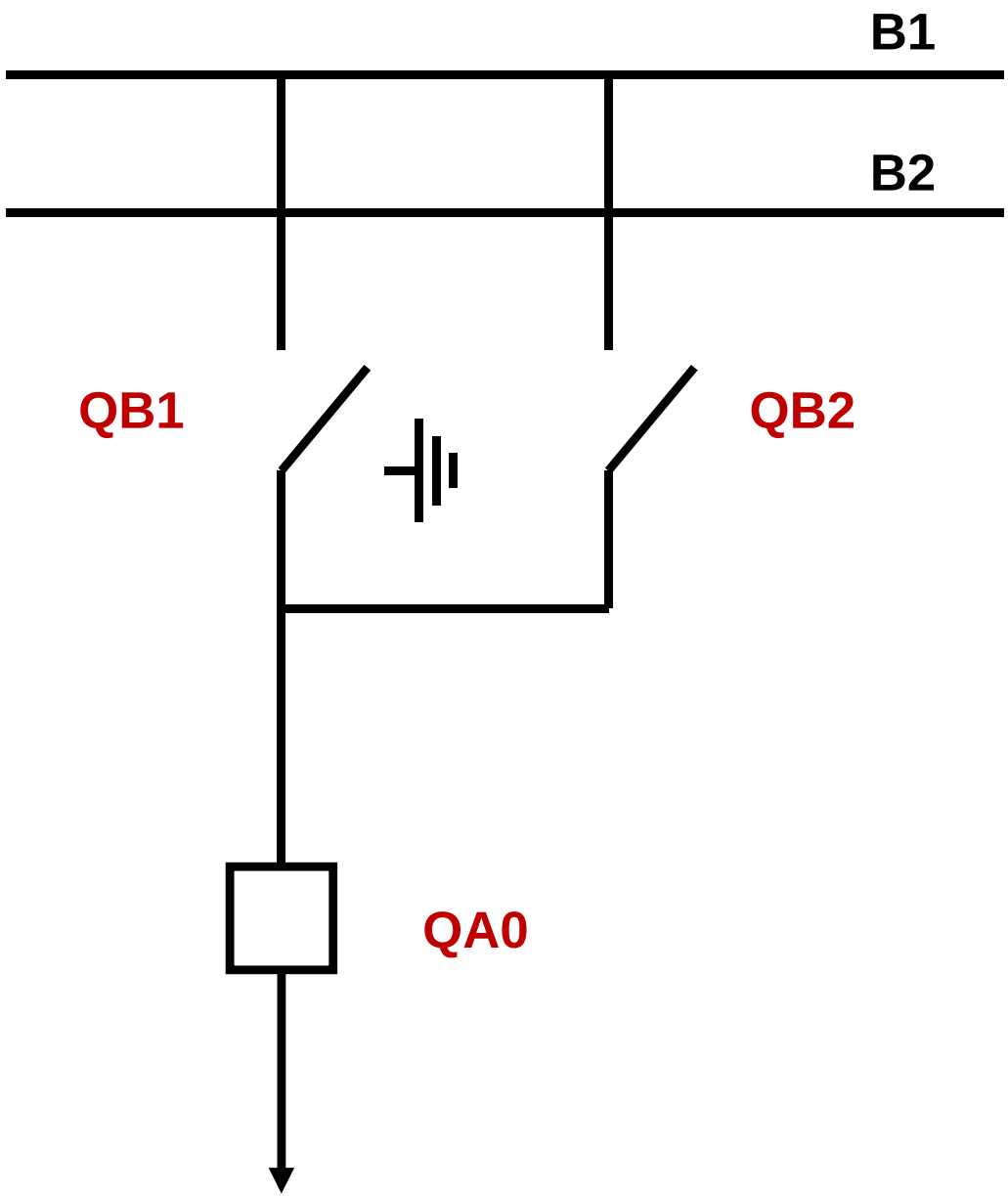


Ingeteam

Data model

6

6.1 Data model example



6.1 Data model example

XCBR : Circuit Breaker LN

- modeling switches with short circuit breaking capability

XSWI : Circuit Breaker LN

- Modeling switches without short circuit breaking capability, for example disconnectors, air break switches, earthing switches, etc.

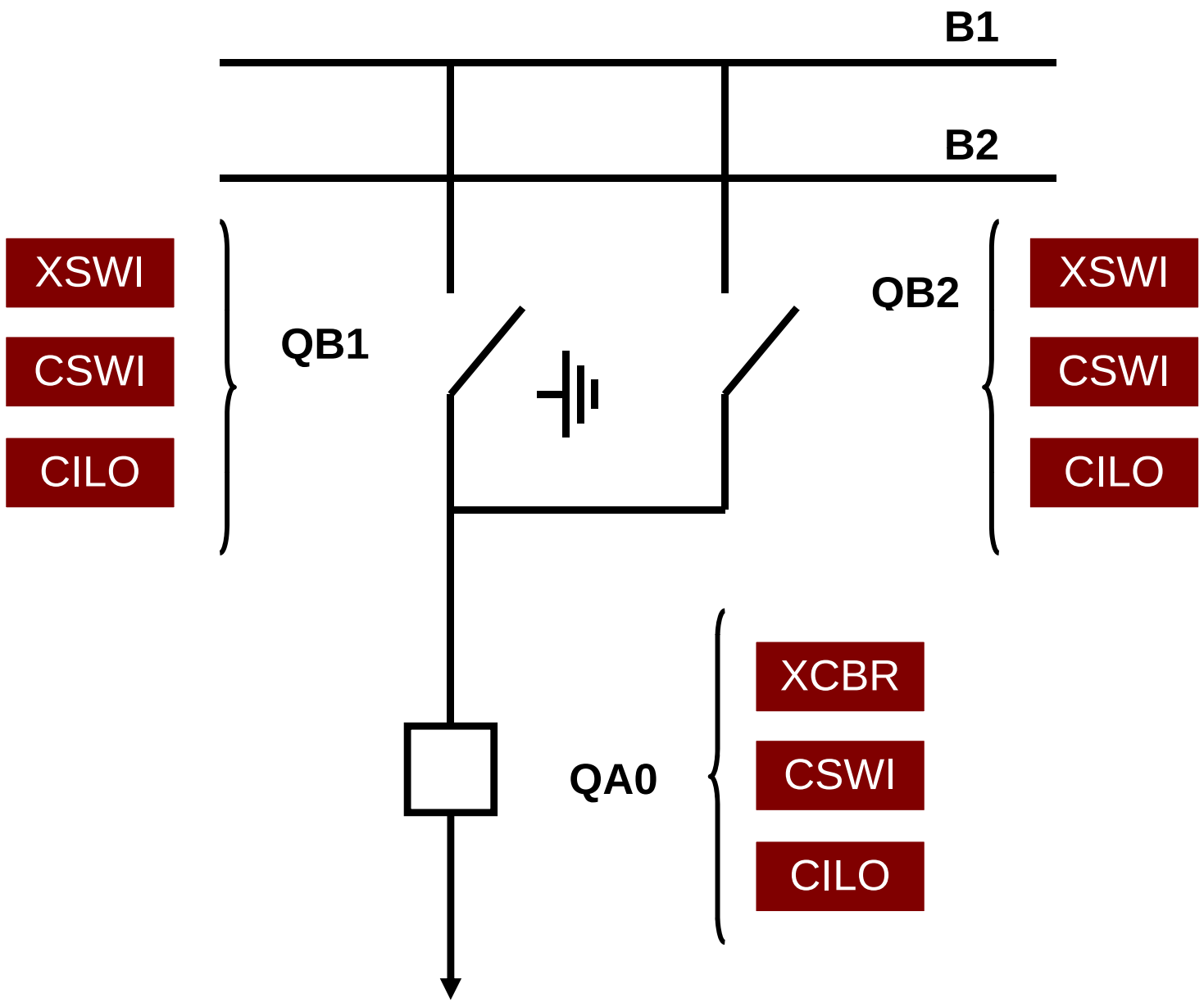
CSWI : Circuit Breaker LN

- control all switching conditions above process level

CILO : Circuit Breaker LN

- used to “enable” a switching operation if the interlocking conditions are fulfilled

6.1 Data model example



6.1 Data model example

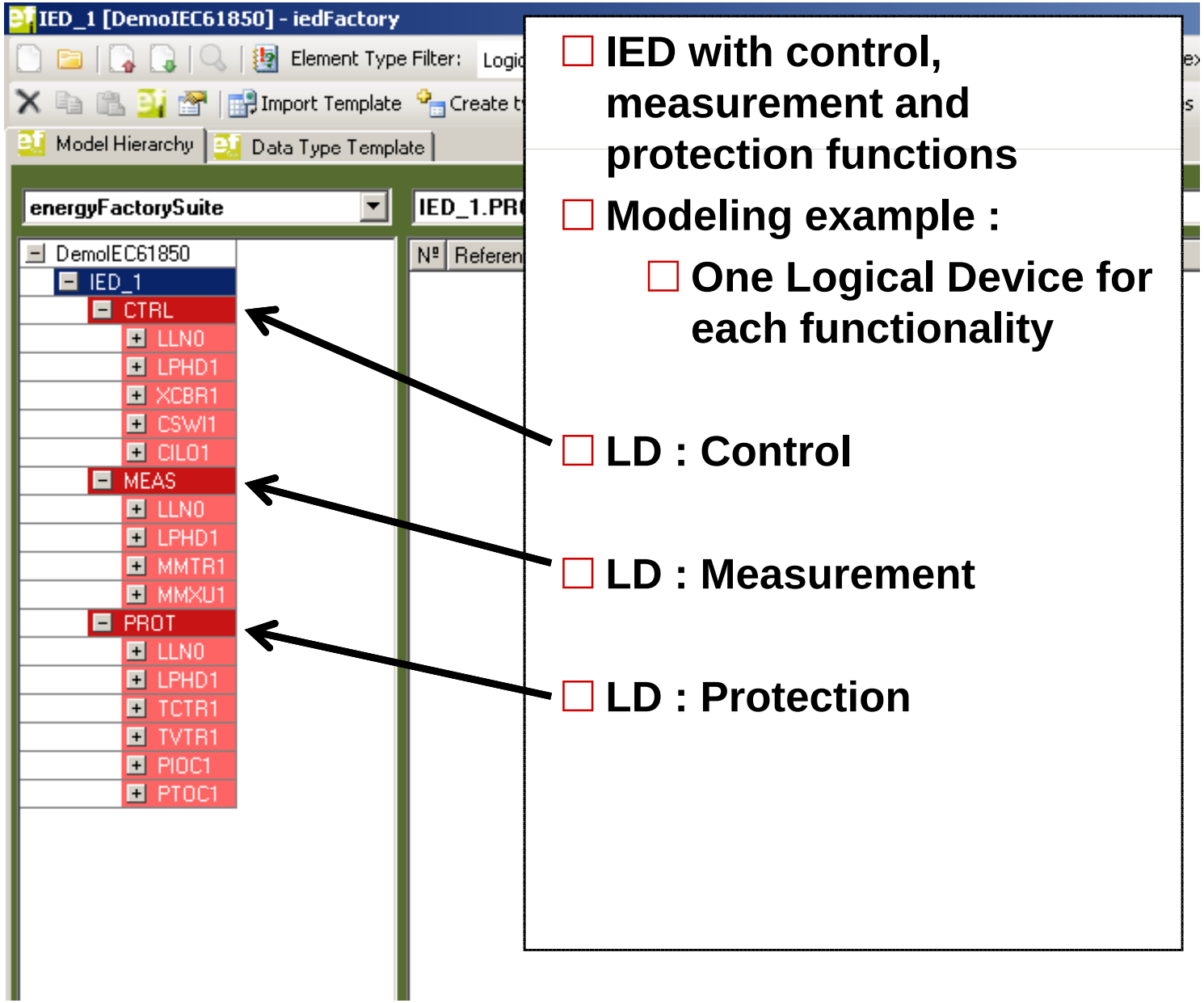
BREAKER MODELING :

XCBR1 → **Breaker status**

CSWI1 → **Open/Close commands**

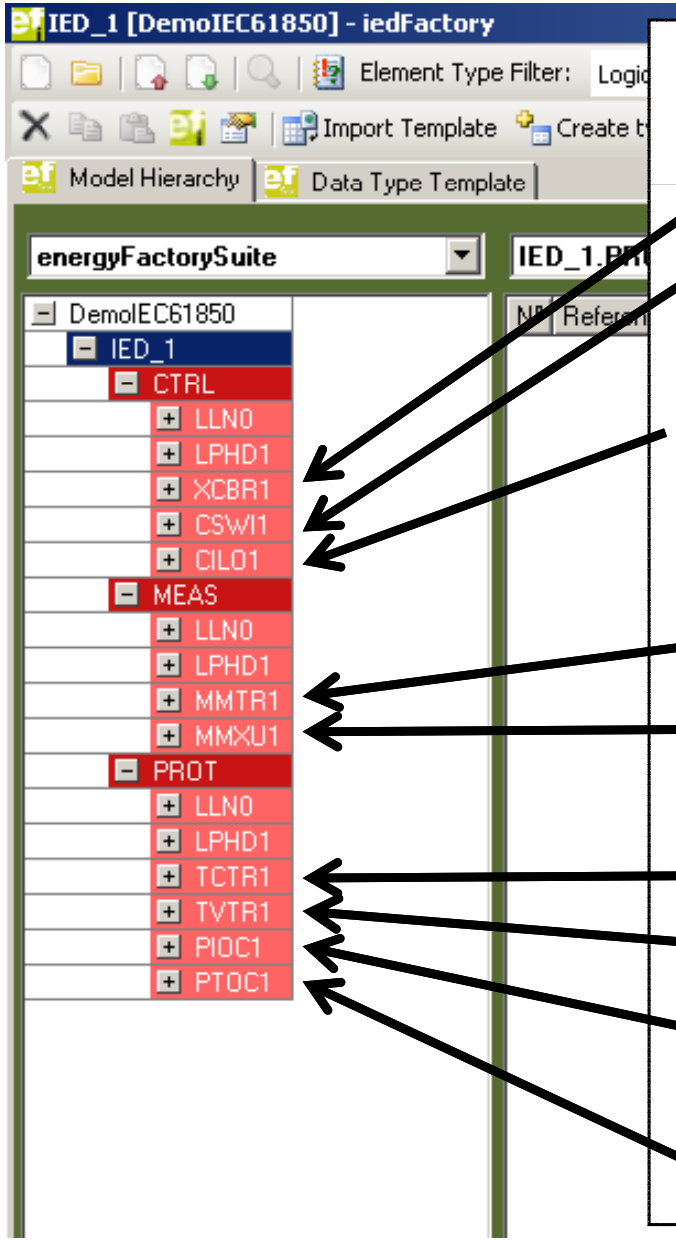
CILO1 → **Open/Close interlocking**

6.1 Data model example



- IED with control, measurement and protection functions
- Modeling example :
  - One Logical Device for each functionality
- LD : Control
- LD : Measurement
- LD : Protection

6.1 Data model example



Logical Nodes :

- XCBR1 : Circuit Breaker
- CSWI1 : Circuit Breaker commands
- CILO1 : Circuit Breaker interlockings
- MMTR1 : Metering
- MMXU1 : Measurements
- TCTR1 : Current Transformer
- TVTR1 : Voltage Transformer
- PIOC1 : Instantaneous overcurrent
- PTOC1 : Time overcurrent

Ingeteam

SCL language

7

7.1 SCL language

- Every IED, IEC 61850 server, must go with a configuration file (ICD file) that describes its data model and its capacity.

- This language is defined in section 6 of the standard.

7.1 SCL language

- SCL : Substation Configuration Language
- Based on XML (eXtensible Markup Language)
- Defines a format for the configuration files
- Not defined as the IED configuration format (although it may be).

7.1 SCL language

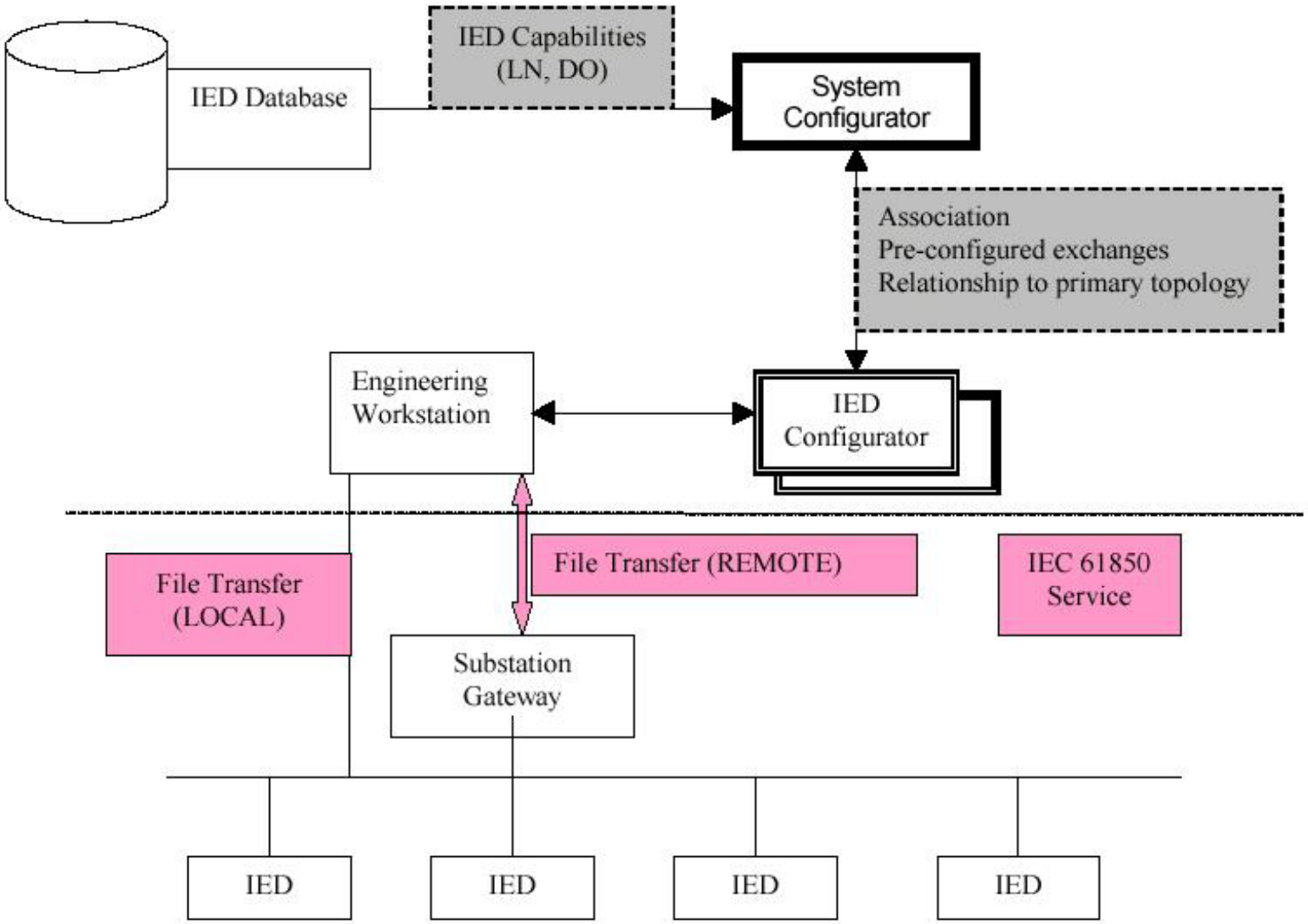
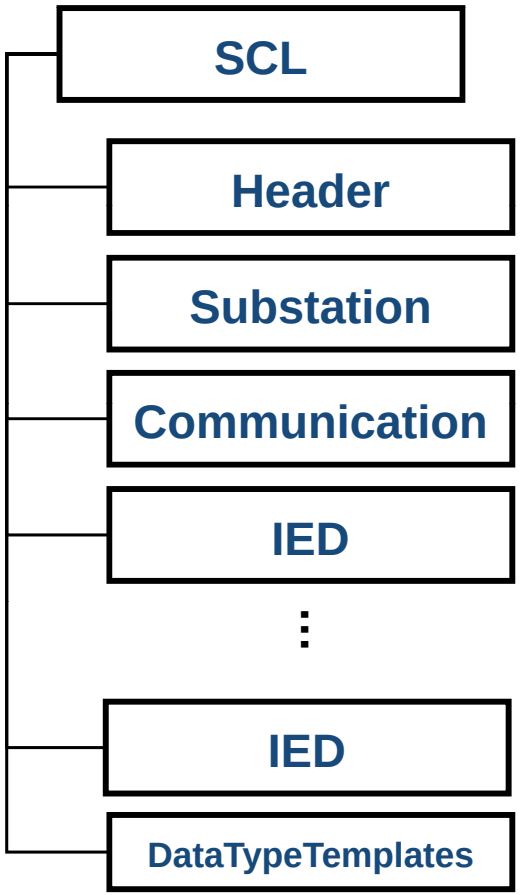


Figure 2 - Reference model for information flow during configuration process

(de IEC 61850-7-6)

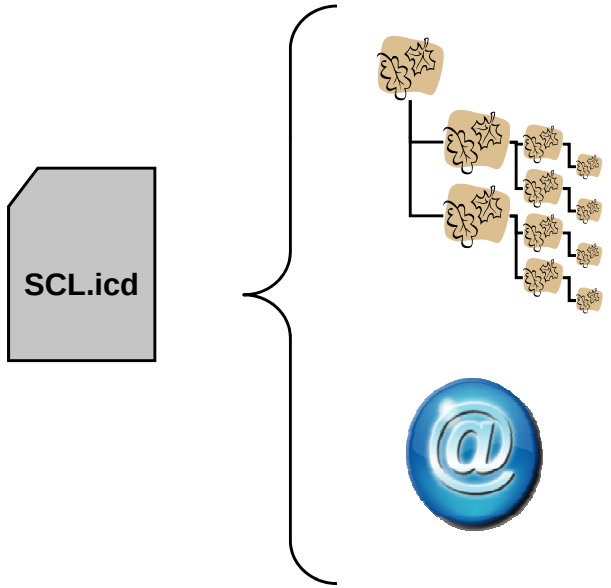
7.1 SCL language

- XML file that describes:
  - Substation topology: voltage levels, bays,…
  - Communication topology: sub-networks, access-points,…
  - IED information model.
  - Information model templates.
- Schema (XSD file) to check the content (structure) of the SCL file.
- SCL file types:
  - ICD: IED Capabilities Description
  - CID: Configured IED Description
  - SCD: Substation Configuration Description
  - SSD: Substation Specification Description



7.1 SCL language : IED configuration

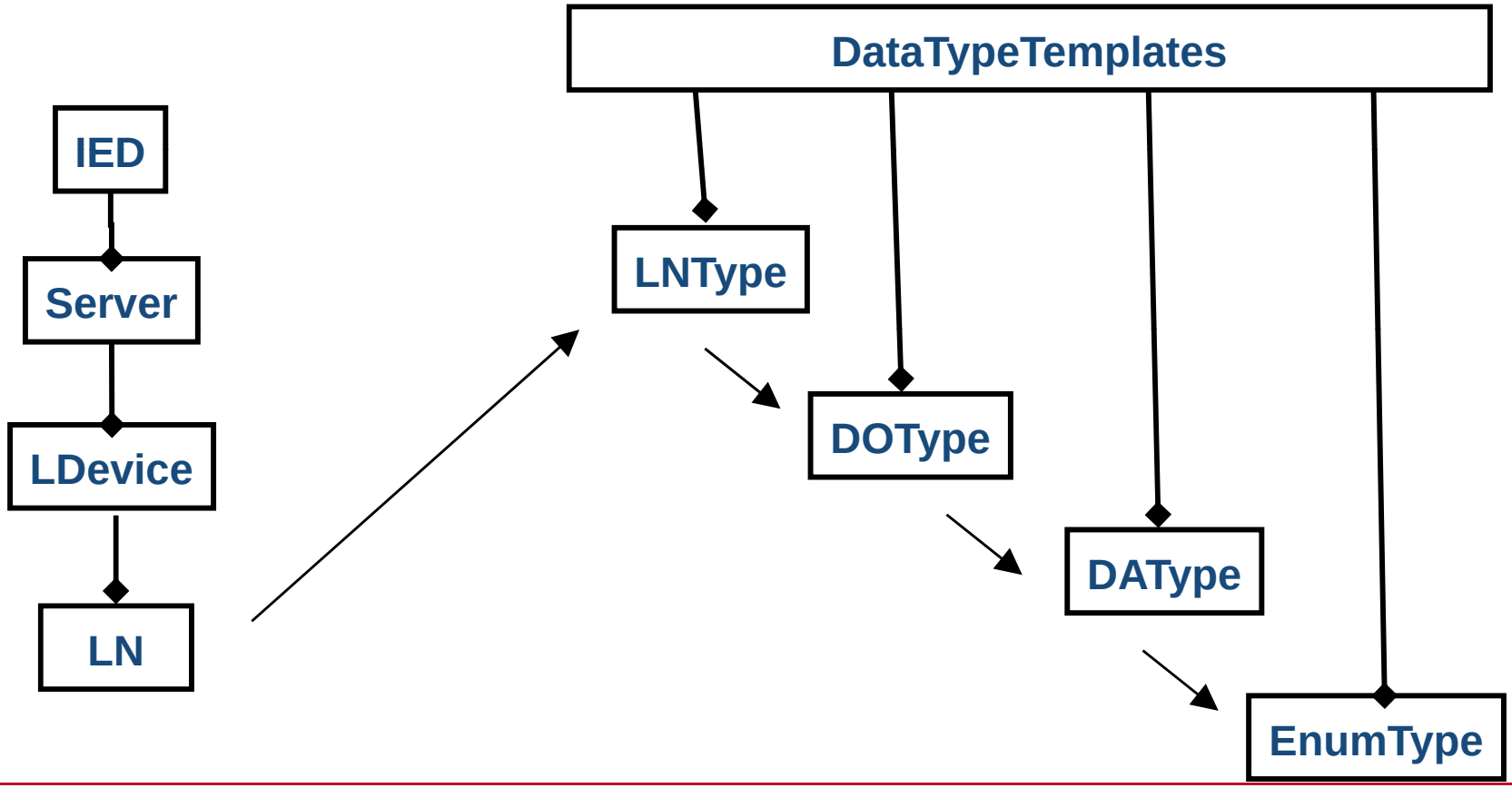
- It is described in the ICD or CID file.
- These files always include:
  - The information model hierarchy. The content the device will show using the different communication services.
  - A communication section which the address used to contact the device.



7.2 SCL Information model configuration

- The definition of the information model is based on the creation of templates: data objects and logical node structure is created and included in the DataTypeTemplates section.

- These types shall be instantiated later in the IED section to be included in the device modeled.



7.3 Content of a SCL file

- The main sections of a SCL file are the following ones:
  - Header [1]
  - Substation [0..n]
  - Communication [0..1]
  - IED [0..n]
  - DataTypeTemplates [0..1]

7.4 Header section

Ingeteam

- **Fields :**
  - **Header [1]**
    - **History [0..n]**
      - revision
      - version
      - when
      - who
      - what
      - why
    - **Text [0..1]**

```
<Header id="SI122" nameStructure="IEDName" toolID="0" revision="1.1" version="1.1"
   >
      <History>
         <Hitem revision="1" version="1.5" when="22/11/06" who="RPM"
         what="Inicialización de valores" why="Actualización "></Hitem>
      </History>
</Header>
```

7.5 Substation section

- **Elements of the section:**
  - **PowerTransformer [0..n]**
    - **LNode [0..n]**
    - **TransformerWinding [0..n]**
      - **LNode**
      - **Terminal**
      - **SubEquipment**
      - **TapChanger**
  - **VoltageLevel [1..n]**
    - **Bay [1..n]**
      - **ConnectivityNode [0..n]**
      - **ConductingEquipment [0..n]**
        - **Terminal**
        - **Subequipment**
      - **LNode**
    - **Voltage**
    - **Lnode**

7.5 Substation section

Ingeteam

- Elements of the section (cont.) :
  - GeneralEquipment [0..n]
  - Function [0..n]
    - SubFunction [0..n]
      - GeneralEquipment [0..n]
  - LNode

7.5 Substation section

Ingeteam

- **Example : Section of a substation with a bay unit containing a circuit breaker (QA1) and a switch (QB1), electrically connected to node L1. A CSWI-type logical node controls each element.**

```
<Substation Ref="">
    <VoltageLevel Ref="E1">
                <Bay Ref="Q1">
                    <Device Ref="QA1" Type="CBR">
                        <LNode Ref="1" LNClass="CSWI"/>
                        <Connection TNodeRef="L1"/>
            </Device>
                    <Device Ref="QB1" Type="DIS">
                        <LNode Ref="2" LNClass="CSWI"/>
                        <Connection TNodeRef="L1"/>
                     </Device>
            </Bay>
    </VoltageLevel>
</Substation>
```

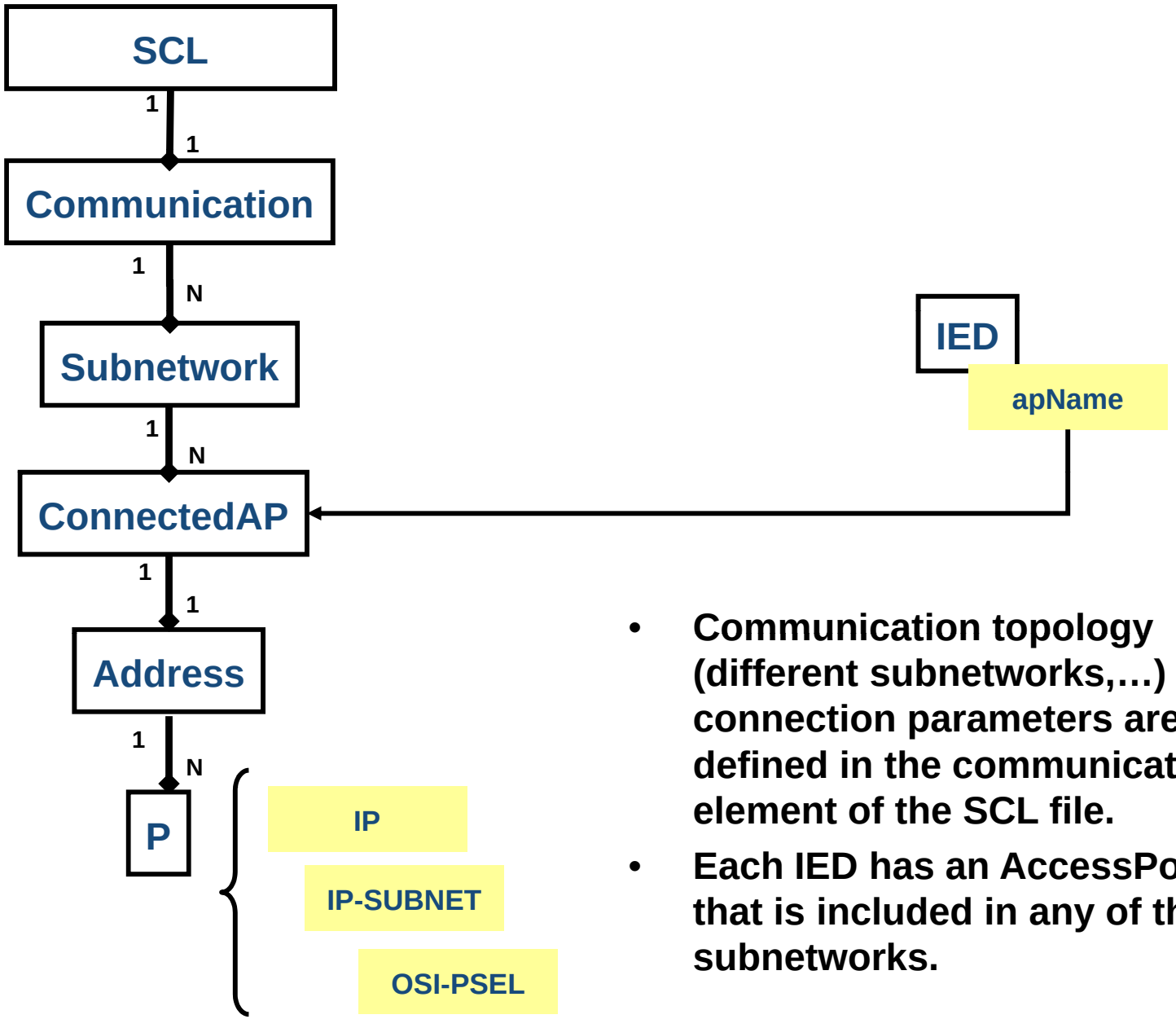
7.6 Communication section

Ingeteam

Fields :

- SubNetwork [1..n]
  - BitRate [0..1]
  - ConnectedAP [1..n]
    - Address [0..1]
    - PhysConn [0..n]
      - Type (p.ej. FOC)
      - Plug (p.ej. ST)
    - GSE [0..n]
      - Address [0..1]
      - MinTime [0..1]
      - MaxTime [0..1]
    - SMV [0..n]
      - Address [0..1]

7.6 SCL Communication configuration



- Communication topology (different subnetworks,…) and connection parameters are defined in the communication element of the SCL file.
- Each IED has an AccessPoint that is included in any of the subnetworks.

7.6 Communication section: Example

```
<Communication>
    <SubNetwork name="SubRedIngeteam" type="8-MMS">
        <ConnectedAP apName="IngeteamTD" iedName="SANGKQ01I01">
            <Address>
                <P type="IP">192.168.201.123</P>
                <P type="SNTP-IP">10.193.0.132</P>
                <P type="IP-SUBNET">255.255.0.0</P>
                <P type="IP-GATEWAY">192.168.201.1</P>
                <P type="OSI-AP-Title">1,3,9999,23</P>
                <P type="OSI-AE-Qualifier">23</P>
                <P type="OSI-PSEL">00000001</P>
                <P type="OSI-SSEL">0001</P>
                <P type="OSI-TSEL">0001</P>
            </Address>
            <GSE cbName="GooseCB" ldInst="CTRL">
                <Address>
                    <P type="MAC-Address">01-0C-CD-01-01-01</P>
                    <P type="APPID">0001</P>
                    <P type="VLAN-ID">1</P>
                    <P type="VLAN-PRIORITY">4</P>
                </Address>
            </GSE>
        </ConnectedAP>
    </SubNetwork>
</Communication>
```

7.7 IED section

Ingeteam

- Fields :
  - Services
  - AccessPoint
    - Server [1]
    - Authentication[1]
    - Ldevice [1..n]
    - LN0 [1]
    - LN [1..n]
    - AccessControl [0..n]
    - Association [0..n]

7.7 IED section

```
<IED configVersion="" desc="13 LINEA 1“ manufacturer="Ingeteam“ name="SANGKQ01I01"
    type=“TCP_IH">
  <Services>
   …….
  </Services>
  <AccessPoint name="IngeteamTD">
      <Server>
          <Authentication/>
              <LDevice inst="CTRL">
                  <LN0 inst="" lnClass="LLN0" lnType="TCP_IHLLN0_T1“/>
                  <LN inst="1" lnClass="LPHD" lnType="TCP_IHLPHD_T1">
                  <LN desc="Generic I/O" inst="1" lnClass="GGIO" lnType="TCP_IHGGIO_T1“/>
                  <LN desc="Generic I/O" inst=“2" lnClass="GGIO" lnType="TCP_IHGGIO_T1“/>
              </LDevice>
              <LDevice inst=“PROT">
                  <LN0 inst="" lnClass="LLN0" lnType="TCP_IHLLN0_T1“/>
                  <LN inst="1" lnClass="LPHD" lnType="TCP_IHLPHD_T1">
                  <LN desc="IOC" inst="1" lnClass="PIOC" lnType="td_PIOC1" prefix="">
                  <LN desc="IOC" inst=“2" lnClass="PIOC" lnType="td_PIOC1" prefix="">
              </LDevice>
      </Server>
  </AccessPoint>
</IED>
```

7.7 IED section : Services

```
<Services>
        <DynAssociation/>
        <SettingGroups>
        <SGEdit/>
        </SettingGroups>
        <GetDirectory/>
        <GetDataObjectDefinition/>
        <DataObjectDirectory/>
        <GetDataSetValue/>
        <SetDataSetValue/>
        <DataSetDirectory/>
        <ConfDataSet max="5" maxAttributes="100"/>
        <ReadWrite/>
        <ConfReportControl max="5"/>
        <GetCBValues/>
        <ConfLogControl max="1"/>
        <ReportSettings bufTime="Dyn" cbName="Conf" datSet="Conf“
            intgPd="Dyn" optFields="Dyn" rptID="Dyn" trgOps="Dyn"/>
        <GOOSE max="16"/>
        <FileHandling/>
        <ConfLNs fixLnInst="false" fixPrefix="false"/>
</Services>
```

7.7 IED section: Initial values

```
<LN desc="IOC" inst="1" lnClass="PIOC" lnType="td_PIOC1" prefix="">
   <DOI desc="Instantaneous Overcurrent Enabled" name="PIOCEna">
      <DAI name="setVal" sAddr="A,2,21,2,0,0,1">
         <Val sGroup="1">     1</Val>
         <Val sGroup="2">     1</Val>
         <Val sGroup="3">     0</Val>
         <Val sGroup="4">     0</Val>
         <Val sGroup="5">     1</Val>
         <Val sGroup="6">     1</Val>
      </DAI>
      <DAI name="d">
         <Val> Instantaneous Overcurrent Enabled </Val>
      </DAI>
   </DOI>
</LN>
```

7.8 DataTypeTemplates section

Ingeteam

- Fields :
  - LNodeType
    - DO
  - DOType
    - DA
    - SDO
  - DAType
    - BDA
  - EnumType
    - EnumVal

7.8 DataTypeTemplates section

Ingeteam

LNodeType

```
<LNodeType id="TCP_IHLLN0_T1" iedType="TCP_IH_A" lnClass="LLN0">
    <DO name="Mod" type="TCP_IHINC_Mod_T1"/>
    <DO name="Beh" type="TCP_IHINS_Beh_T1"/>
    <DO name="Health" type="TCP_IHINS_Health_T1"/>
    <DO name="NamPlt" type="TCP_IHLPL_T1"/>
    <DO name="LocKey" type="TCP_IHSPS_T1"/>
    <DO name="RemCtlBlk" type="TCP_IHSPC_T1"/>
    <DO name="LocCtlBeh" type="TCP_IHSPS_T1"/>
    <DO name="OpTmh" type="TCP_IHINS_T1"/>
    <DO name="Diag" type="TCP_IHSPC_T1"/>
    <DO name="LEDRs" type="TCP_IHSPC_T1"/>
</LNodeType>
```

7.8 DataTypeTemplates section

Ingeteam

DOType

```
<DOType cdc="SPS" desc="Single point status"
   id="TCP_IHSPS_T1" iedType="TCP_IH_A">
   <DA bType="BOOLEAN" dchg="true" fc="ST" name="stVal"/>
   <DA bType="Quality" fc="ST" name="q" qchg="true"/>
   <DA bType="Timestamp" fc="ST" name="t"/>
   <DA bType="VisString255" fc="DC" name="d"/>
</DOType>
```

7.8 DataTypeTemplates section

Ingeteam

DAType

```
<DAType id="tdRangeConfig" iedType="TCP_IH_A">
    <BDA name="hhLim" bType="Struct" type="tdAnalogueValue"/>
    <BDA name="hLim" bType="Struct" type="tdAnalogueValue"/>
    <BDA name="lLim" bType="Struct" type="tdAnalogueValue"/>
    <BDA name="llLim" bType="Struct" type="tdAnalogueValue"/>
    <BDA name="min" bType="Struct" type="tdAnalogueValue"/>
    <BDA name="max" bType="Struct" type="tdAnalogueValue"/>
</DAType>

<DAType id="tdAnalogueValue">
    <BDA name="i" bType="INT32"/>
    <BDA name="f" bType="FLOAT32"/>
</DAType>
```

7.8 DataTypeTemplates section

Ingeteam

EnumType

```
<EnumType id="ctlModel">
    <EnumVal ord="0">    status-only </EnumVal>
    <EnumVal ord="1">    direct-with-normal-security </EnumVal>
    <EnumVal ord="2">    sbo-with-normal-security </EnumVal>
    <EnumVal ord="3">    direct-with-enhanced-security </EnumVal>
    <EnumVal ord="4">    sbo-with-enhanced-security </EnumVal>
</EnumType>

<EnumType id="Health">
    <EnumVal ord="1">    Ok </EnumVal>
    <EnumVal ord="2">    Warning </EnumVal>
    <EnumVal ord="3">    Alarm </EnumVal>
</EnumType>
```

Certification 8

8.1 Certification

- One of he main activities of the UCA International Users Group is to support the tests
- Activities of the UCAIug :
  - Keep the list of approved products
  - Keep the list of certification companies authorized by the UCAIug
  - Develop, maintain and clarify the “Testing Quality Assurance Program”, the approval procedures and the test protocols
  - Support to the users and manufacturer in the application of tests
  - Act as a final authority in the interpretation of the test procedure (the IEC is the final authority in the specifications)

8.1 Certification

- **Certification companies authorized by the UCAIug :**
  - **I.e. KEMA**
    - **Arnhem, Holanda**
    - **AEP/Dolan laboratories, North America**

- **Certified :**

  The product has not shown to be non-conforming to:

  IEC 61850-6, 7-1, 7-2, 7-3, 7-4 and 8-1

  Communication networks and systems in substations

- **It is carried according to the IEC 61850-10, with the PICS, MICS, TICS, PIXIT versions indicated by the manufacturer.**

8.1 Certification

- **PICS – Protocol Implementation Conformance Statement**
  - Indicates the implemented parts of the standard (i.e ACSI services)
- **MICS – Model Implementation Conformance Statement**
  - Specifies the implemented model (i.e LNs, Data, attributes, etc.)
- **PIXIT – Protocol Implementation eXtra Information for Testing**
  - Specific information about the device regarding its communication capacities and that are outside the IEC61850 range (i.e. addresses, supported values, etc.)
- **TICS – Technical Issues Implementation Conformance Statement**
  - Modifications after the standard publication
  - It is specified which of these modifications have been implemented

8.1 Certification

- IEC 61850-10 section of the standard specifies the test cases in an abstract way.
  - Indicates WHAT has to be tested but not HOW
- HOW : UCA Users Group Test Procedures
- Conformance Blocks :
  - Groups of tests
  - Detailed in the conformity certificate

8.1 Certification

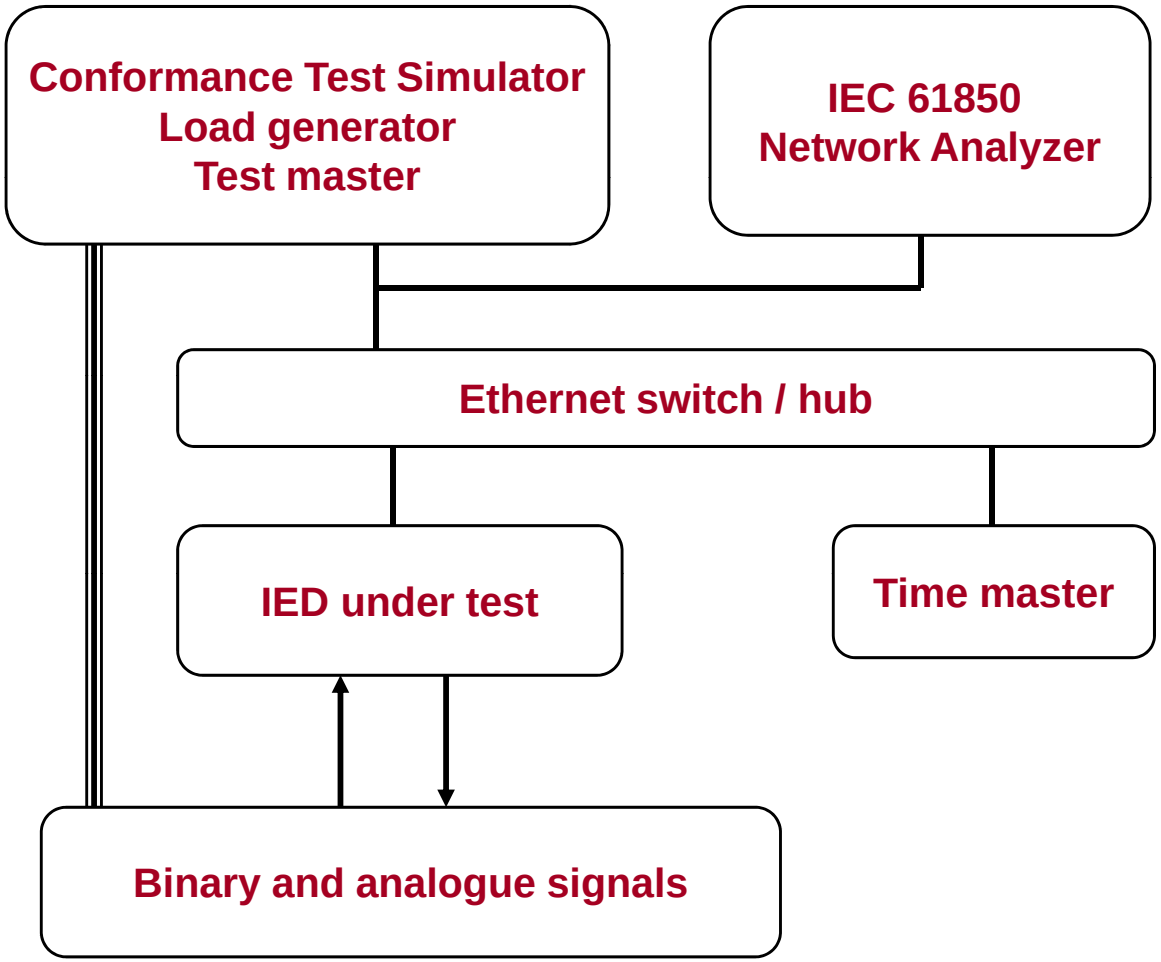
Ingeteam

☐ Example of the test case, IEC 61850-10 :

Test reference RptP1	Test purpose GetLogicalNodeDirectory(BRCB) and GetBRCBValues	☐ Passed ☐ Failed ☐ Inconclusive
Ref. Part & Parag. of IEC 61850 IEC 61850-7-2 Subclause 9.2.2 and 14.2.3.3 IEC 61850-8-1 Subclause 12.3.1 and 17.2.2		
Expected result 1) DUT sends GetLogicalNodeDirectory(BRCB) Response+ 2) DUT sends GetBRCBValues Response+		
Test description 1) For each logical node Client requests GetLogicalNodeDirectory(BRCB) 2) For each BRCB Client requests GetBRCBValues()		
Comment		

8.1 Certification

Example of test architecture (KEMA) :



8.1 Certification

IEC 61850 Certificate Level A[1]

International Usersgroup

No. 30710139-Consulting 07-2496

Issued to:
INGETEAM T&D, S.A.
Pol. Ind. Artunduaga
Usausuaga, 7 - 1º
48970 Basauri, Vizcaya
Spain

For the product:
TCP-IH
Integrated Protection & Control System
Hardware version 06.02.06
Software revision S

Issued by: KEMA

The product has not shown to be non-conforming to:

IEC 61850-6, 7-1, 7-2, 7-3, 7-4 and 8-1

Communication networks and systems in substations

The conformance test has been performed according to IEC 61850-10 with product's protocol, model and technical issue implementation conformance statements: "IEC 61850 PICS – Protocol Implementation Conformance Statement TCP-IH, version TCP61850_PICS/F", "IEC 61850 MICS – Model Implementation Conformance Statement TCP-IH, version TCP61850_MICS/F", "IEC 61850 TICS – Technical Issues Implementation Conformance Statement, version TCP61850_TICS/D" and product's extra information for testing: "IEC 61850 PIXIT – Protocol Implementation eXtra Information for Testing, version TCP61850_PIXIT/G".

The following IEC 61850 conformance blocks have been tested with a positive result (number of relevant and executed test cases / total number of test cases as defined in the UCA International Users Group Device Test procedures v1.1):

1 Basic Exchange (19/23)	12a Direct Control (5/11)
2 Data Sets (2/5)	12b SBO Control (7/15)
4 Setting Group Selection (2/3)	12c Enhanced Direct Control (5/11)
5 Unbuffered Reporting (11/13)	12d Enhanced SBO Control (10/17)
6 Buffered Reporting (14/15)	13 Time Synchronization (4/4)
9a GOOSE Publish (8/11)	14 File Transfer (5/6)
9b GOOSE Subscribe (9/9)	

This Certificate includes a summary of the test results as carried out at Robotiker in Spain with UniCAsim 61850 version 3.16.00 with test suite 3.16.03 and UniCA 61850 analyzer version 4.16.00. The test is based on the UCA International Users Group Device Test Procedures version 1.1. This document has been issued for information purposes only, and the original paper copy of the KEMA report: No. 30710139-Consulting 07-2495 will prevail.

The test have been carried out on one single specimen of the products as referred above and submitted to KEMA by INGETEAM T&D. The manufacturer's production process has not been assessed. This Certificate does not imply that KEMA has certified or approved any product other than the specimen tested.

Arnhem, December 19, 2007

S.J.L.M. Janssen
Managing Director KEMA Consulting

R.Schimmel
Certification Manager

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Utrechtseweg 310, 6812 AR Arnhem P.O.Box 9035, 6800 ET Arnhem The Netherlands
T +31 26 356 61 42 F +31 26 351 54 56 sales@kema.com www.kema.com

8.1 Certification

Conformance Block	Mandatory	Conditional
1: Basic Exchange	Ass1, Ass2, Ass3, AssN2, AssN3, AssN4, AssN5 Srv1, Srv2, Srv3, Srv4, Srv5, SrvN1abcd, SrvN4	Srv6, Srv7, Srv8, SrvN1e, SrvN3
2: Data Sets	Dset1, DsetN1ae	
4: Setting Group Selection	Sg1, SgN1	
5: Unbuffered Reporting	Rp1, Rp2, Rp3, Rp4, Rp7 RpN1, RpN2, RpN3, RpN4	Rp5, RpN6
6: Buffered Reporting	Br1, Br2, Br3, Br4, Br7, Br8, Br9 BrN1, BrN2, BrN3, BrN4, BrN5	Br5, BrN6
9a: GOOSE publish	Gop2, Gop3, Gop4, Gop7, Gop9	Gop1, Gop6, GopN1
9b: GOOSE subscribe	Gos1, Gos2, Gos3, GosN1, GosN2, GosN3, GosN4, GosN5, GosN6	
12a: Direct control	CltN3, CtlN8 DOns1, DOns3	Ctl2
12b: SBO control	Ctl3, CltN1, CltN2, CltN4 SBOns1, SBOns2	Ctl2
12c: Enhanced Direct Control	CltN3, CtlN8 DOes2, DOes5	Ctl2
12d: Enhanced SBO Control	Ctl3, CltN1, CltN2, CltN3, CltN4, CtlN9, SBOes1, SBOes2, SBOes3	Ctl2
13: Time sync	Tm1, Tm2, TmN1	TmN2
14: File transfer	Ft1, Ft2ab, FtN1ab	Ft2c, FtN1c

Ingeteam

UCAIug 9

9.1 UCA International Users Group

- the **UCA International Users Group is** a not-for-profit corporation focused on assisting users and vendors in the deployment of standards for real-time applications for several industries with related requirements.

- The Users Group does not write standards, however works closely with those bodies that have primary responsibility for the completion of standards (notably IEC TC 57: Power Systems Management and Associated Information Exchange).

9.1 UCA International Users Group

http://www.ucaiug.org

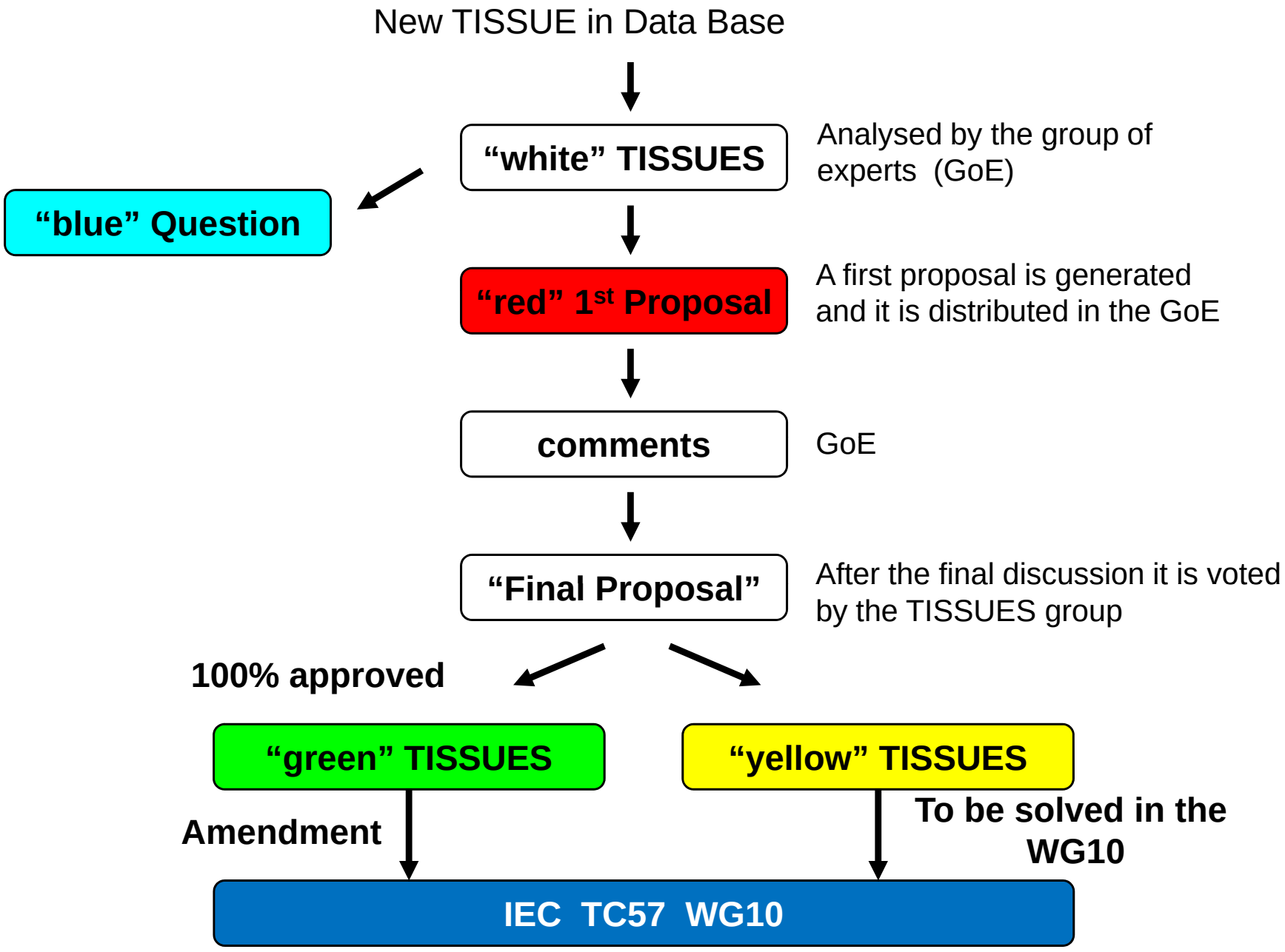
9.1 UCA International Users Group

- The mission of the UCAIug is to enable utility integration through the deployment of open standards by providing a forum in which the various stakeholders in the utility industry can work cooperatively together as members of a common organization to:
  - Influence, select, and/or endorse open and public standards appropriate to the utility market based upon the needs of the membership.
  - Specify, develop and/or accredit product/system-testing programs that facilitate the field interoperability of products and systems based upon these standards.
  - Implement educational and promotional activities that increase awareness and deployment of these standards in the utility industry.

9.2 UCAIug IEC 61850 : Technical Issues

- IEC 61850 standard maintenance
- What is a “TISSUE”
  - errors, usually results in modifications
  - ambiguities, usually results in clarifications
  - ideas, usually results in additions
- For errors and ambiguities, solutions need to be found within short term
  - The TISSUE process defines the rules for that
  - TISSUES are handled through a database
- tissues.iec61850.com
  - Everybody can enter TISSUES
  - Solved TISSUES are also published at the UCA webpage

9.2 UCAIug IEC 61850 : Technical Issues



9.2 UCAIug IEC 61850 : Technical Issues

Ingeteam

- Possible states of a Tissue :
  - **“white”** : Tissue created
  - **“blue”** : Tissue is only a question
  - **“red”** : Tissue in the process of discussion
  - **“green”** : Tissue accepted and resolved
  - **“yellow”** : Tissue still open. Waiting for the WG10 decision

Thank you for your attention