Norma IEC 61850
– Pregled glavnih značajki i budući razvoj
(I. dio)

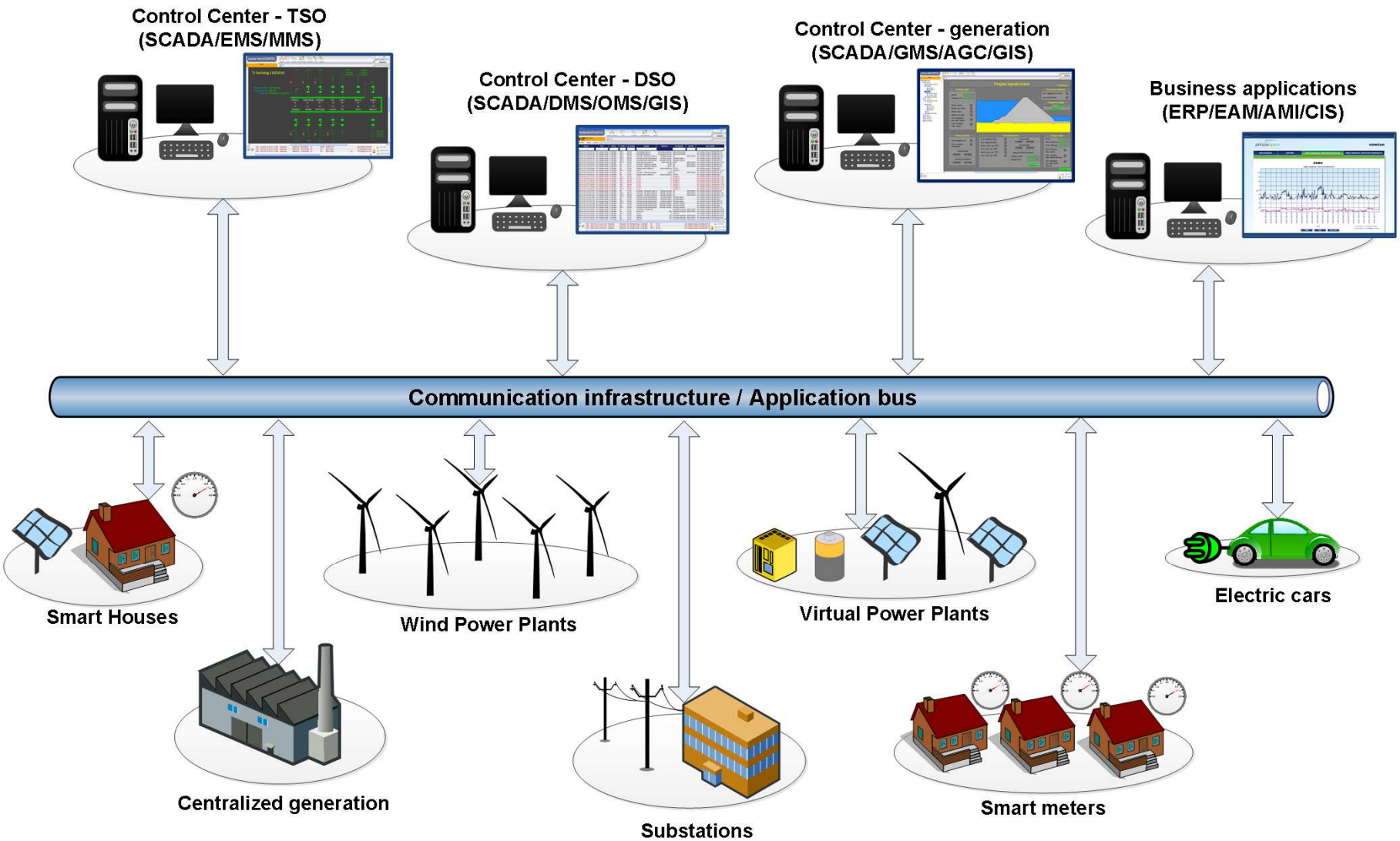
Predavač:
Stjepan Sučić, mag.ing.el. Končar–KET

CIRED
HRVATSKI OGRANAK

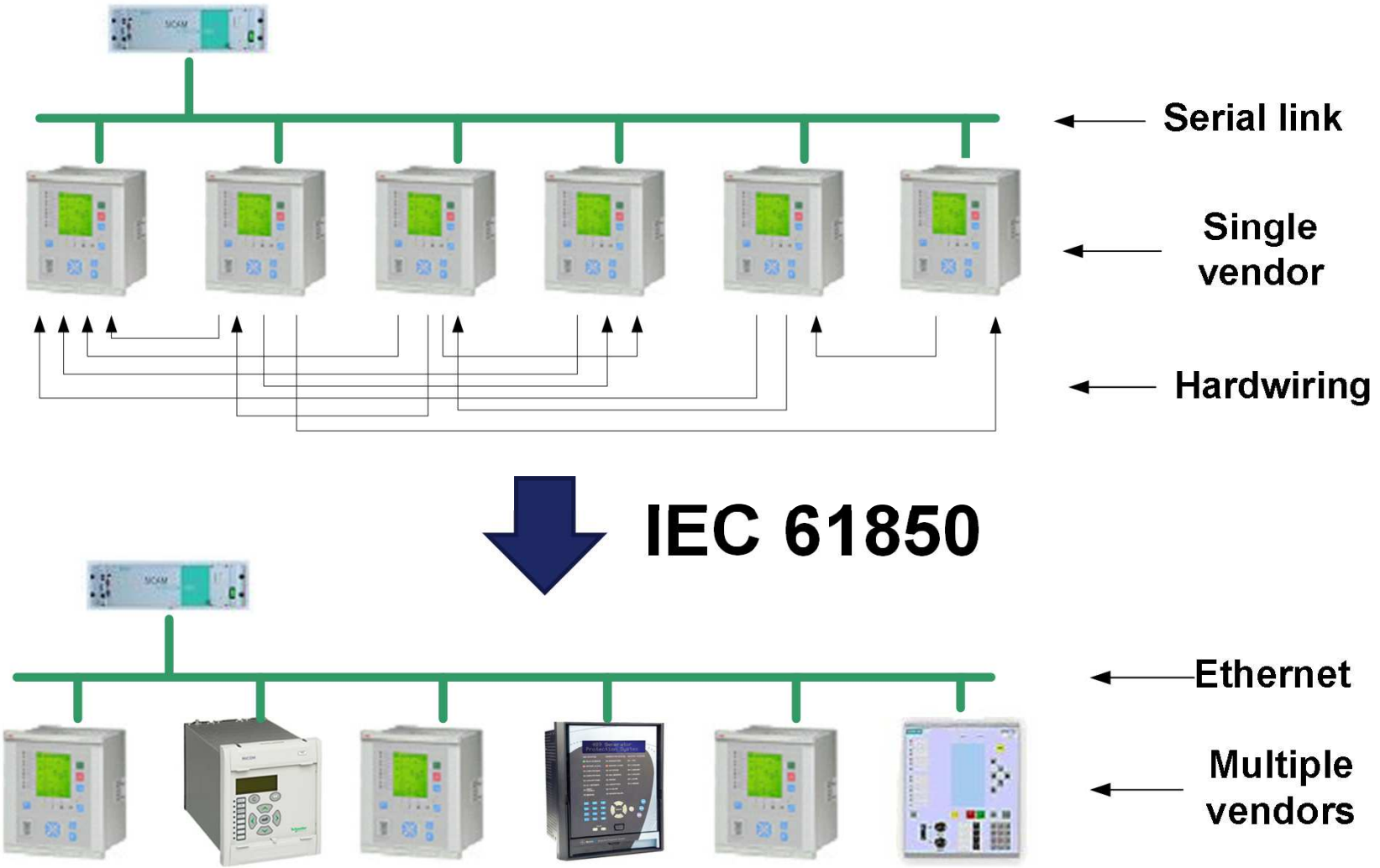
Sadržaj

1. • Uvod
2. • Arhitektura IEC 61850 sustava
3. • Informacijsko modeliranje
4. • Komunikacijski servisi
5. • Implementacijski zahtjevi
6. • Konfiguracija sustava

Integracija i automatizacija EES-a

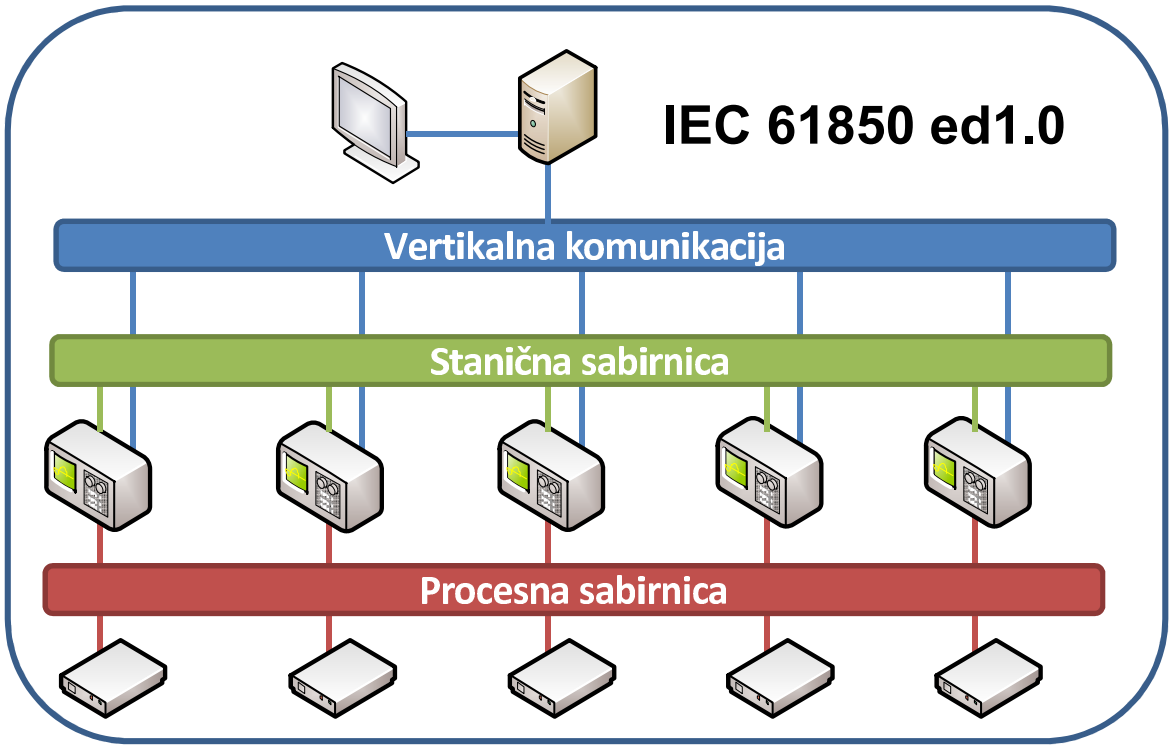


IEC 61850 – Motivacija



IEC 61850 – Arhitektura

- Više od komunikacijskog protokola
- Automatizacijska arhitektura
- Tehnološki neovisan pristup
- Načela upravljanja
- Razvoj proširenja
- Nove domene
- Globalna prihvaćenost

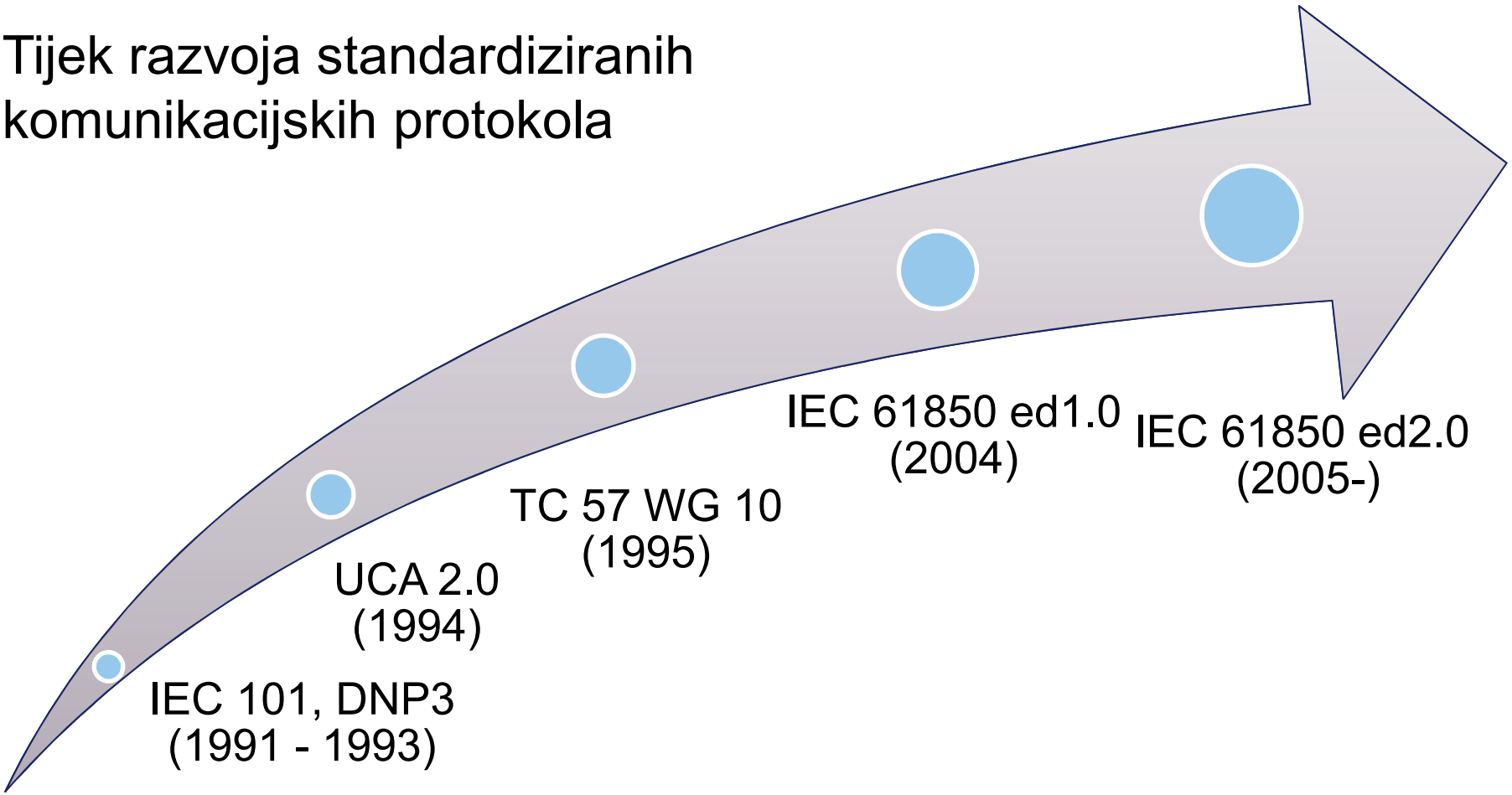


IEC 61850 – Osnove prednosti

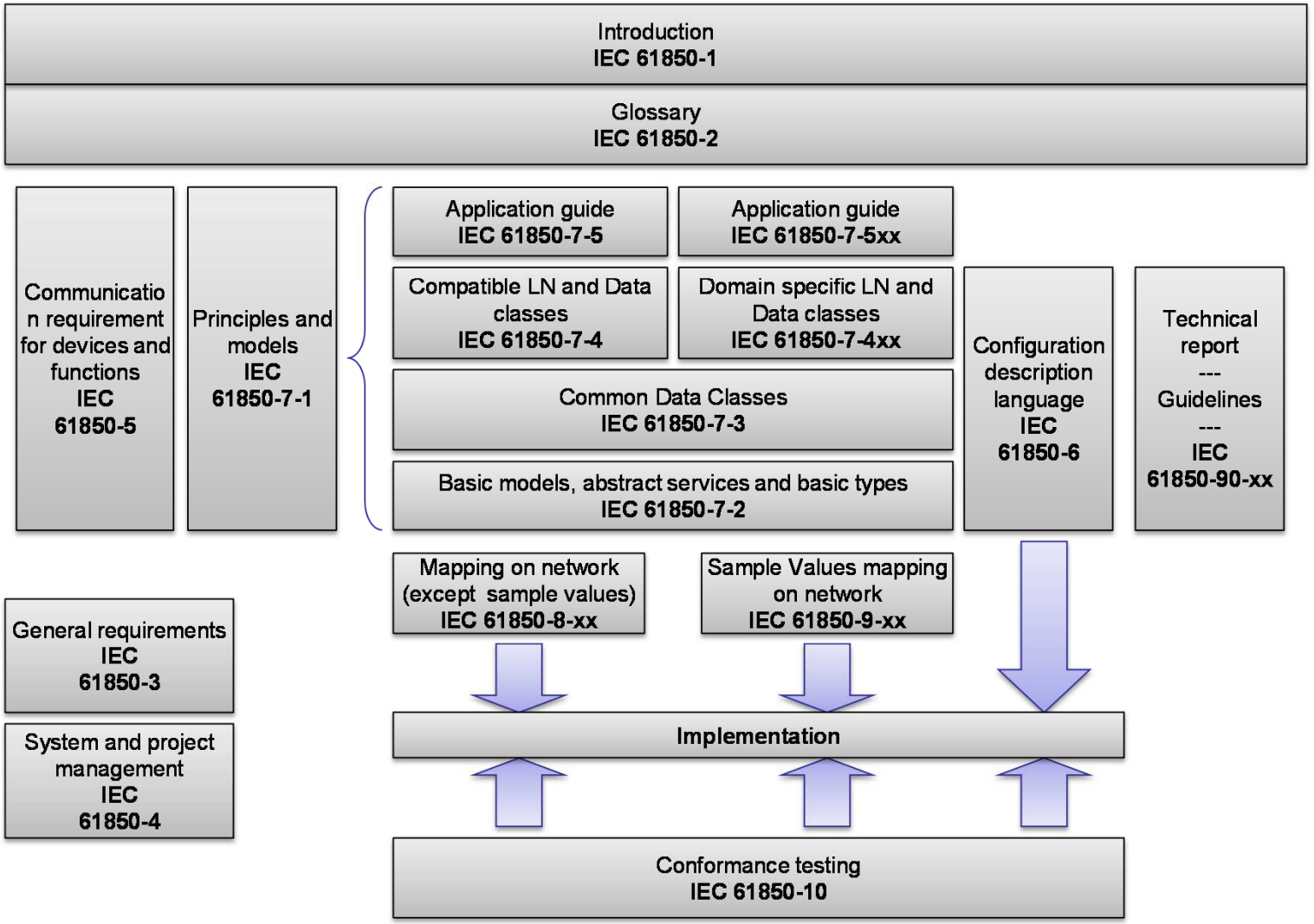
- Jedinstveno rješenje za komunikaciju u EES-u
- Interoperabilnost opreme
- Globalna prihvaćenost
- Brža i jeftinija integracija novih sustava
- Jedinstvena semantika procesnih podataka
- Primjena izvan domene trafostanica
- IEC 61850 je arhitektura, a ne tehnologija !

IEC 61850 – Povijesni razvoj

Tijek razvoja standardiziranih komunikacijskih protokola

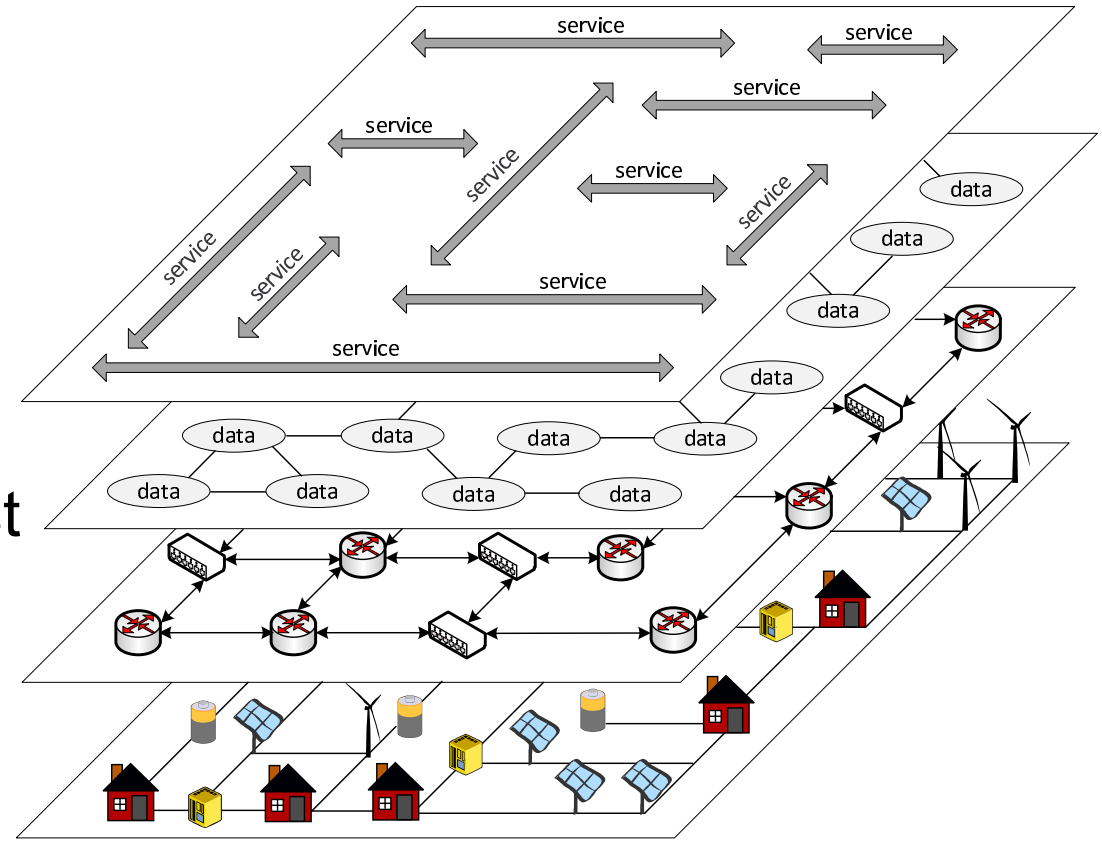


IEC 61850 – Odnosi među dokumentima

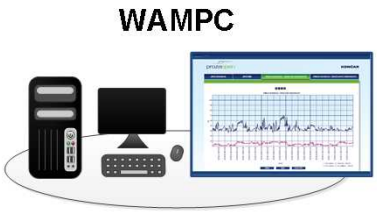


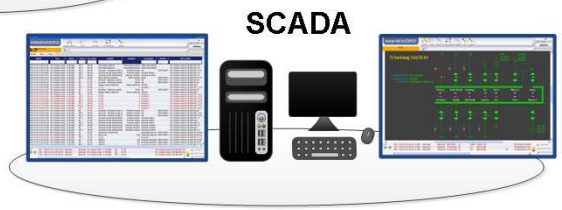
Standardizacija integracijskih sučelja

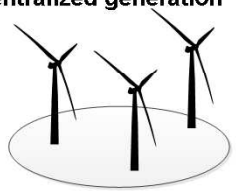
- Nove upravljačke arhitekture
- Velik broj proizvođača
- Višeslojna struktura
- Integracijski preduvjeti
- Tehnološka i platformska neovisnost
- Dugotrajna održivost
- Jedinstveni pristup

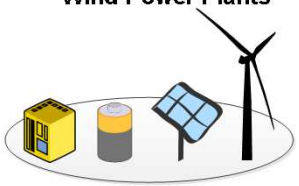


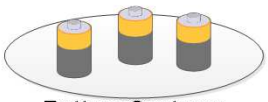
IEC 61850 ed.1







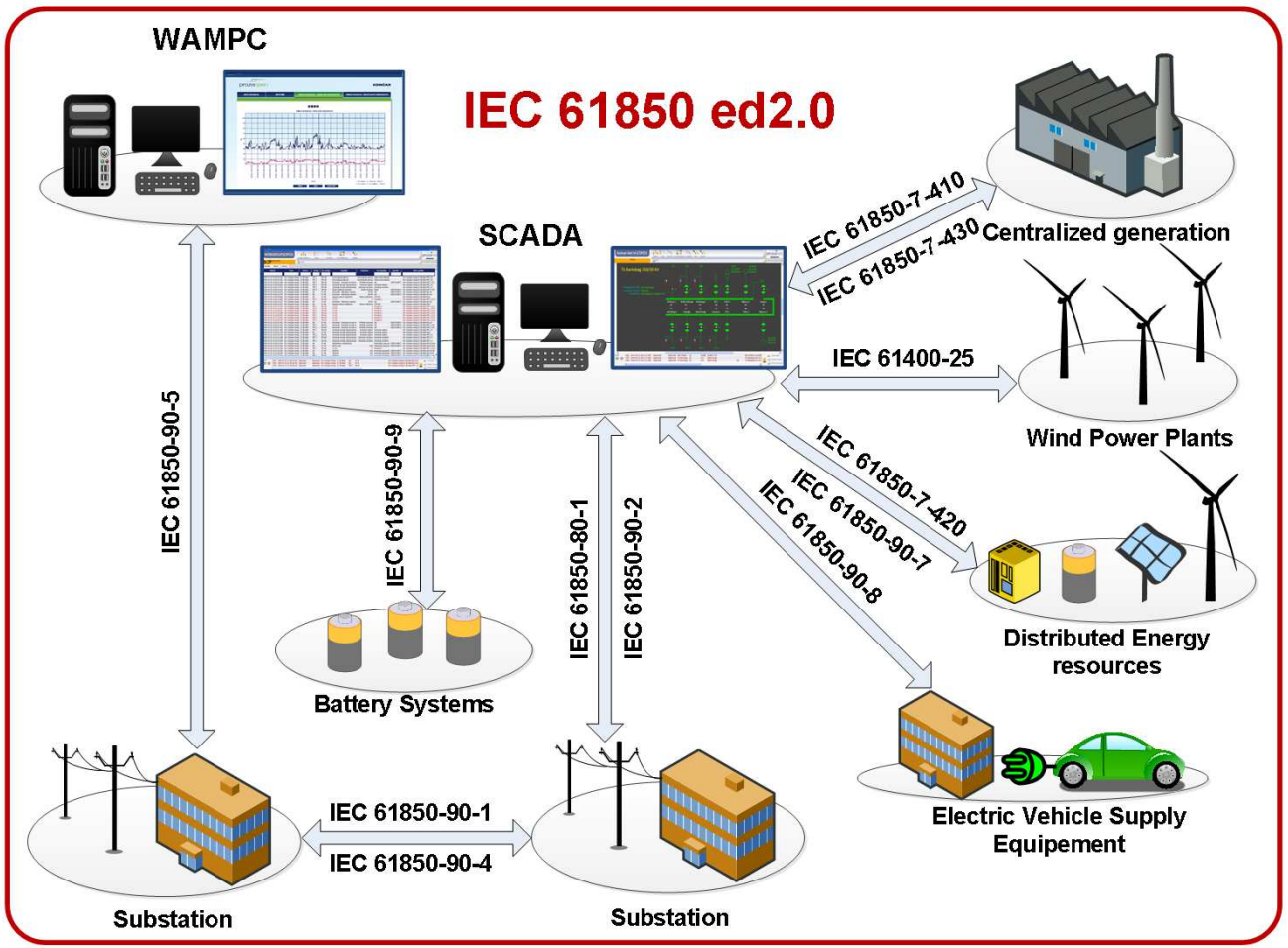




IEC 61850 ed1.0

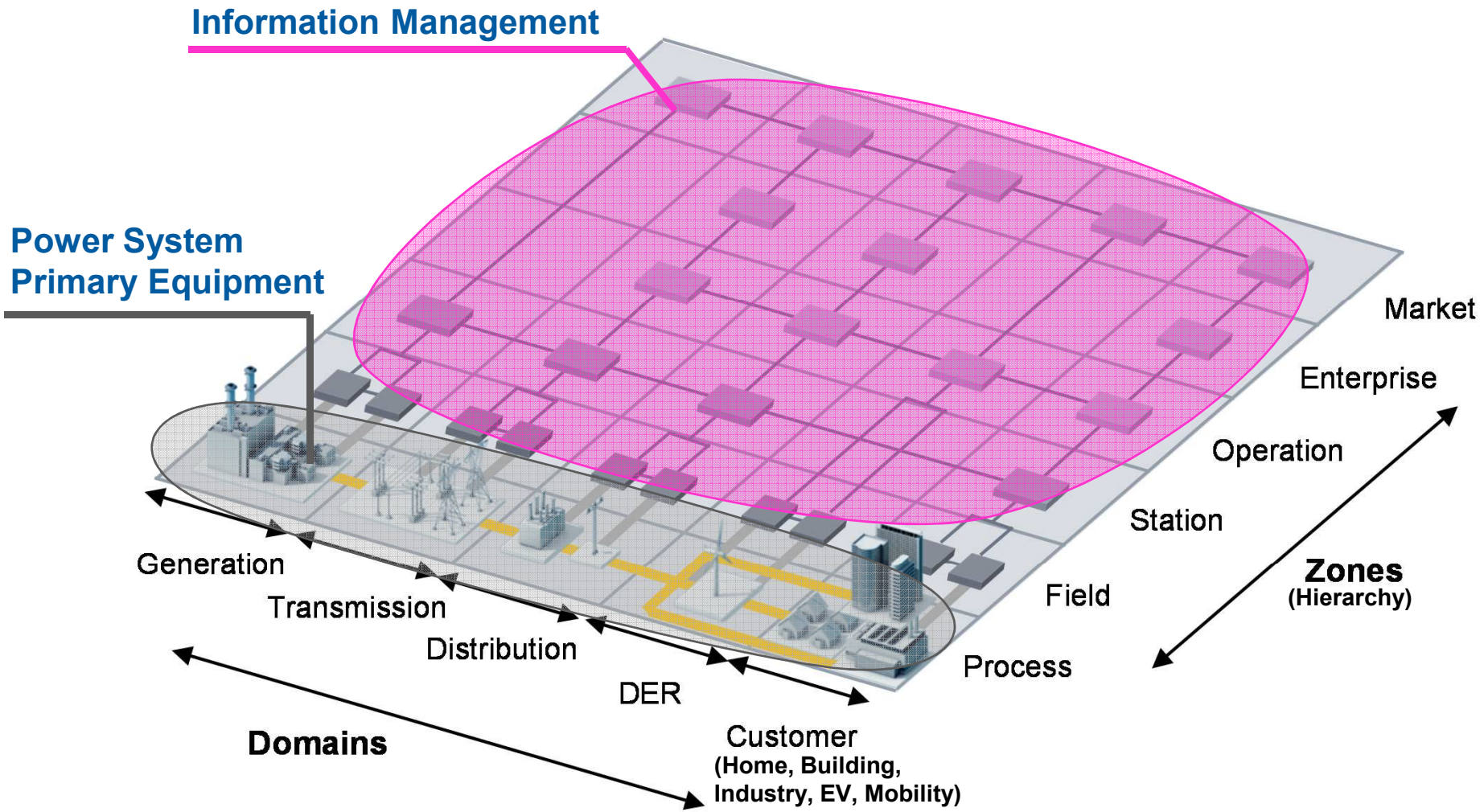
- 1995.-2004.
- 3 radne grupe
- 14 dokumenata
- 1400 stranica

IEC 61850 ed.2



IEC 61850 ed1.0	IEC 61850 ed2.0
1995.-2004.	2005-???
3 radne grupe	5 radnih grupa
14 dokumenata	30 + dokumenata
1400 stranica	2500 + stranica

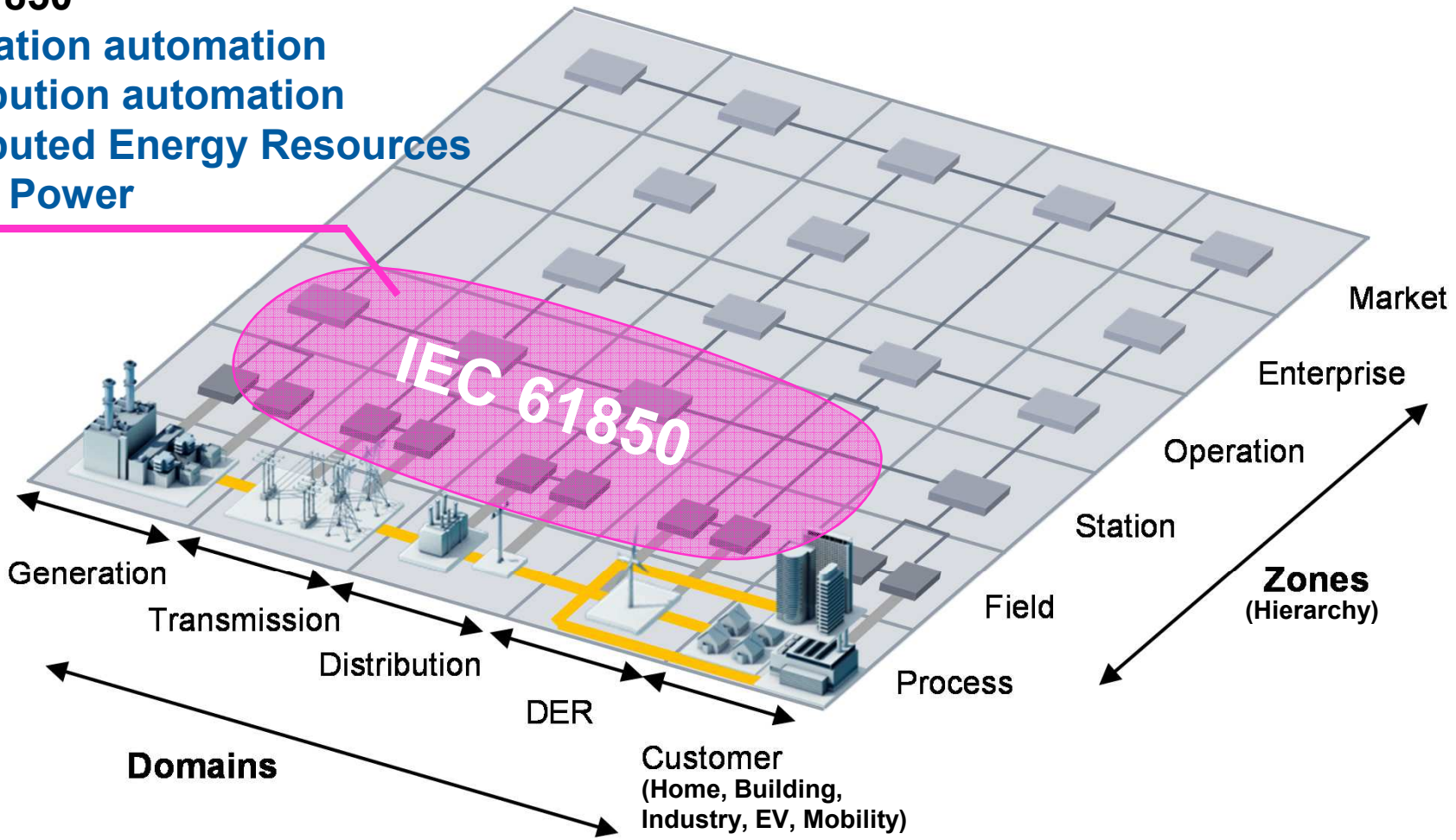
Smart Grid domene



Smart Grid domene – IEC 61850

IEC 61850

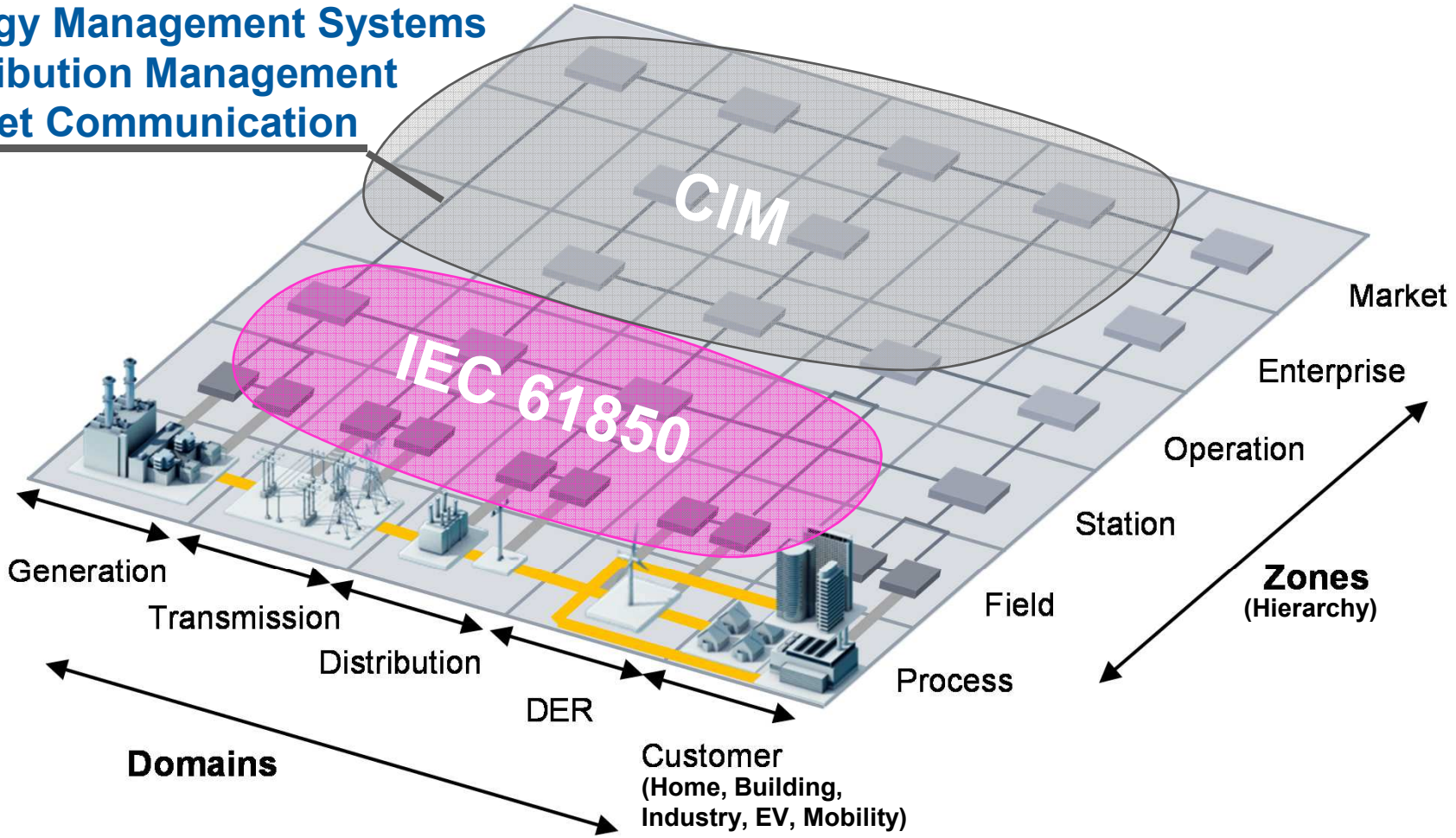
Substation automation
Distribution automation
Distributed Energy Resources
Hydro Power



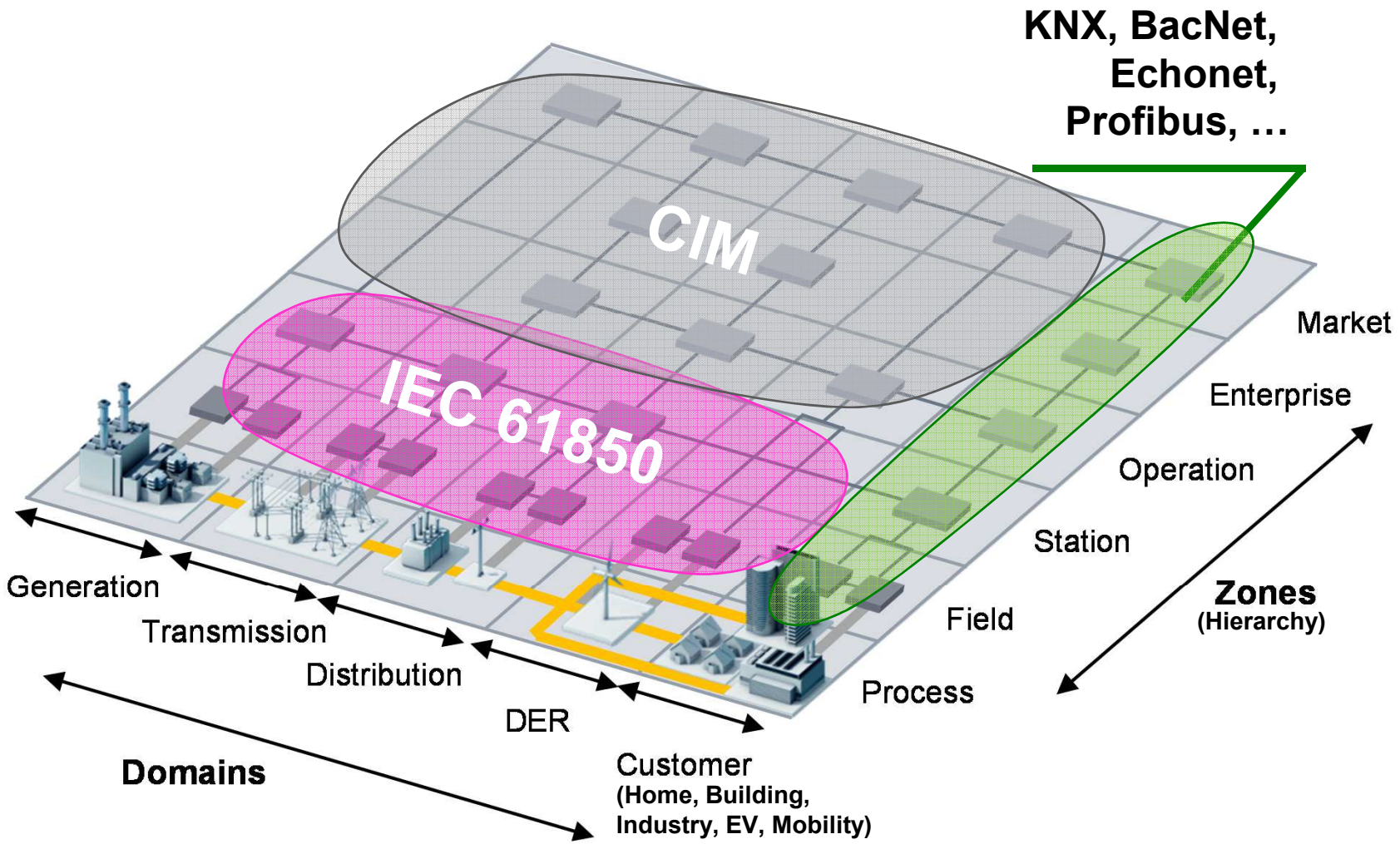
Smart Grid domene – CIM

CIM (IEC 61968, IEC 61970, IEC 62325)

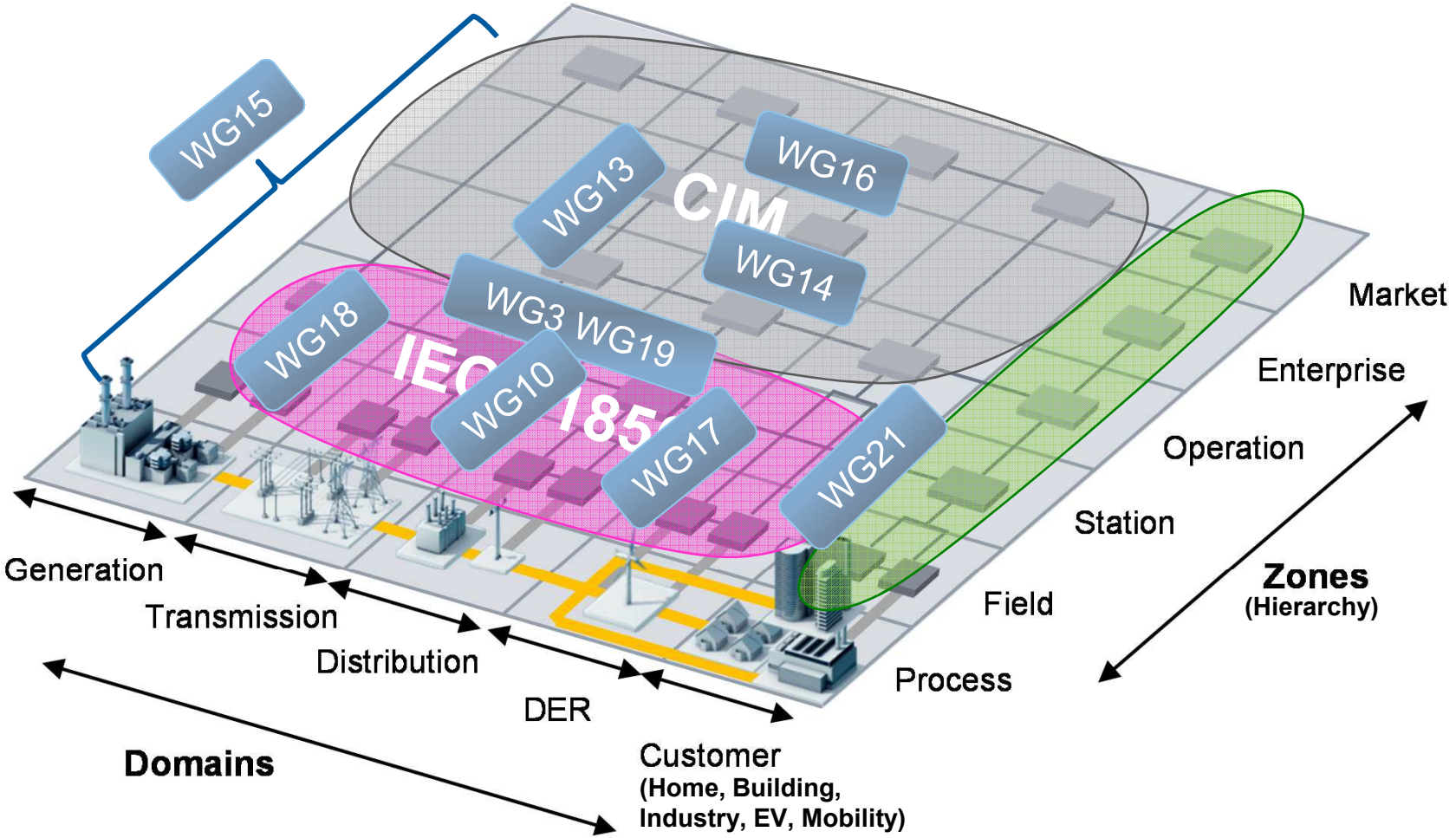
Energy Management Systems
Distribution Management
Market Communication



Smart Grid domene – Automatizacija



Smart Grid domene – IEC radne grupe

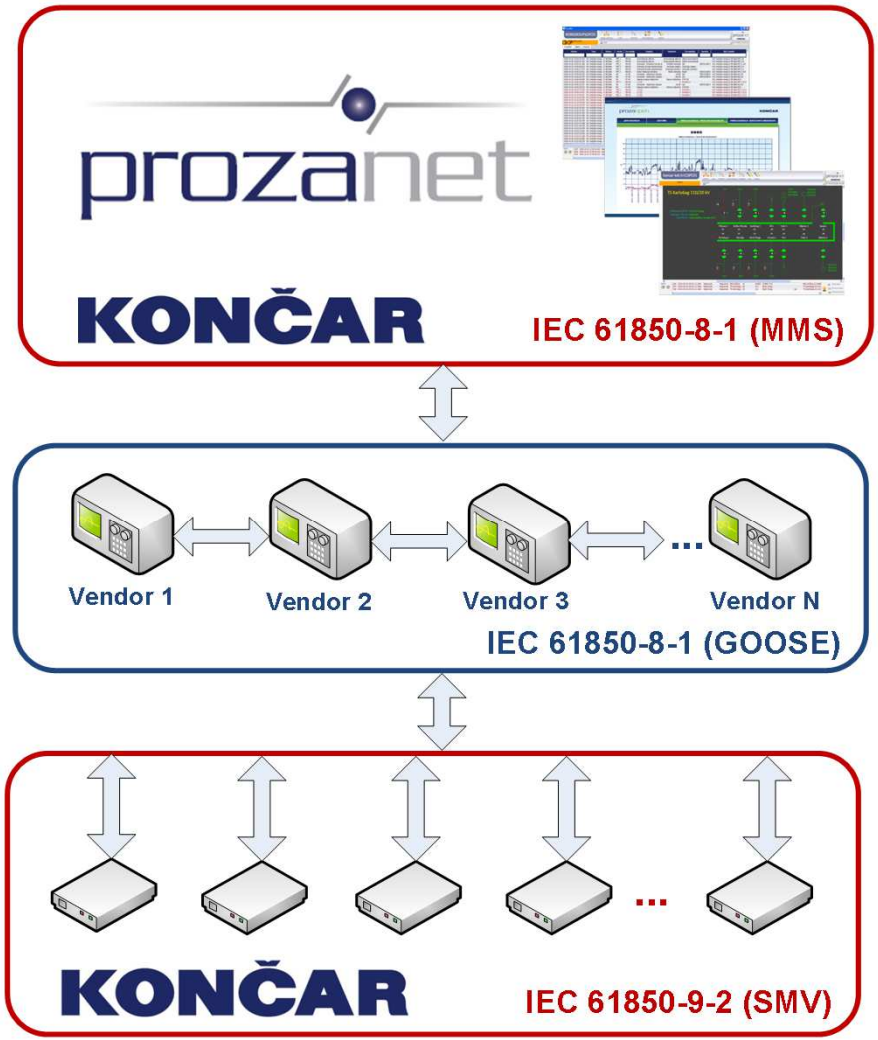


KONČAR – Sudjelovanje u standardizaciji

- WG 3 - Telecontrol & Teleprotection standards
- WG 10 - IED communications & associated data models
- WG 13 - Energy management systems
- WG 15 - Data & Communication Security
- WG 17 - Communication systems for DER
- WG 18 - Communication systems for Hydroelectric power plants
- WG 19 - Interoperability within TC57 in the long term
- WG 21 - Interfaces and protocol profiles relevant to systems connected to the electrical grid

KONČAR – Sudjelovanje u standardizaciji

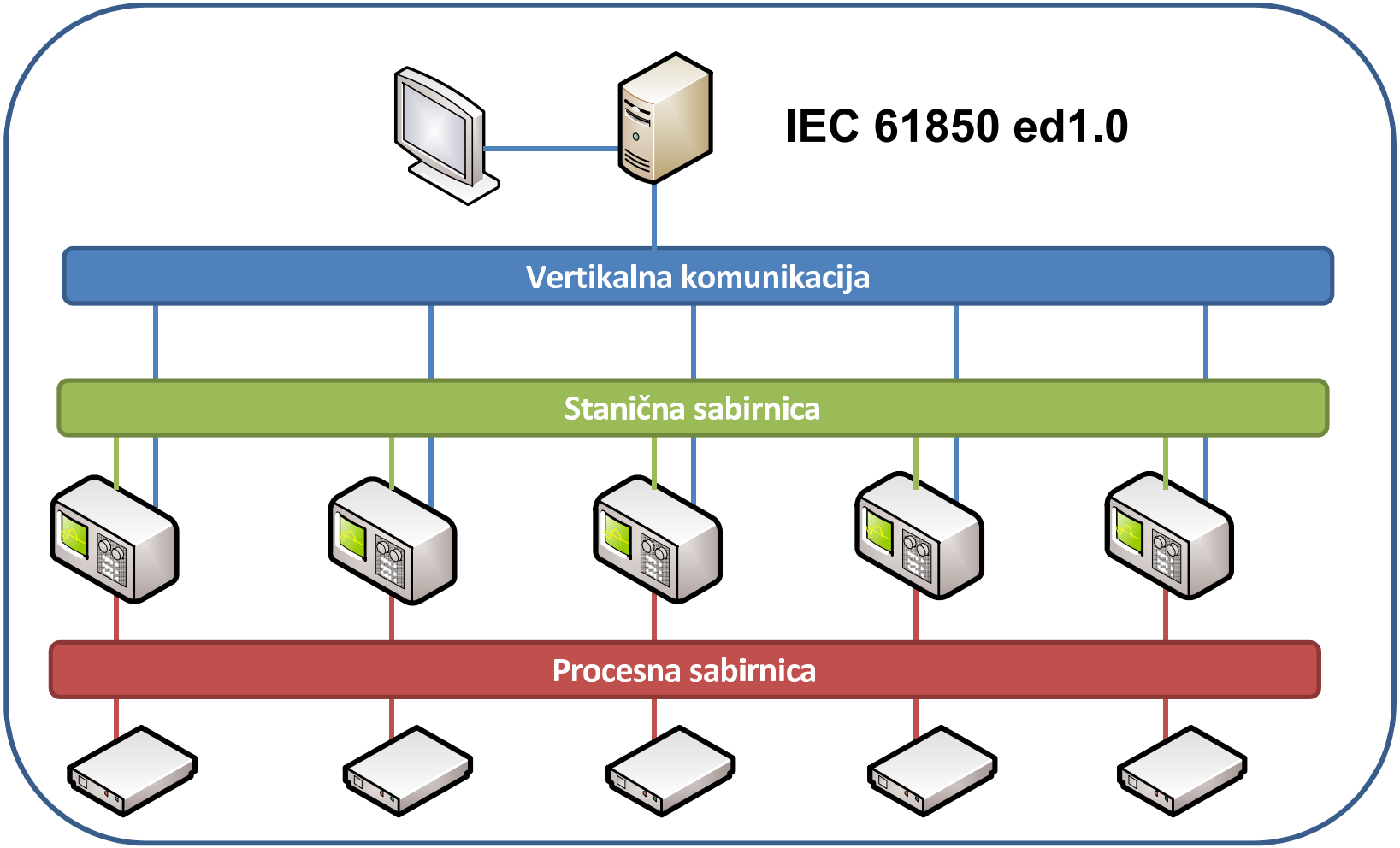
- Vlastiti razvoj
- PROZA NET SCADA
- MMS (ISO 9506)
- Automatizacija postrojenja
- Interoperabilnost
- Procesna sabirnica
- Certifikacija



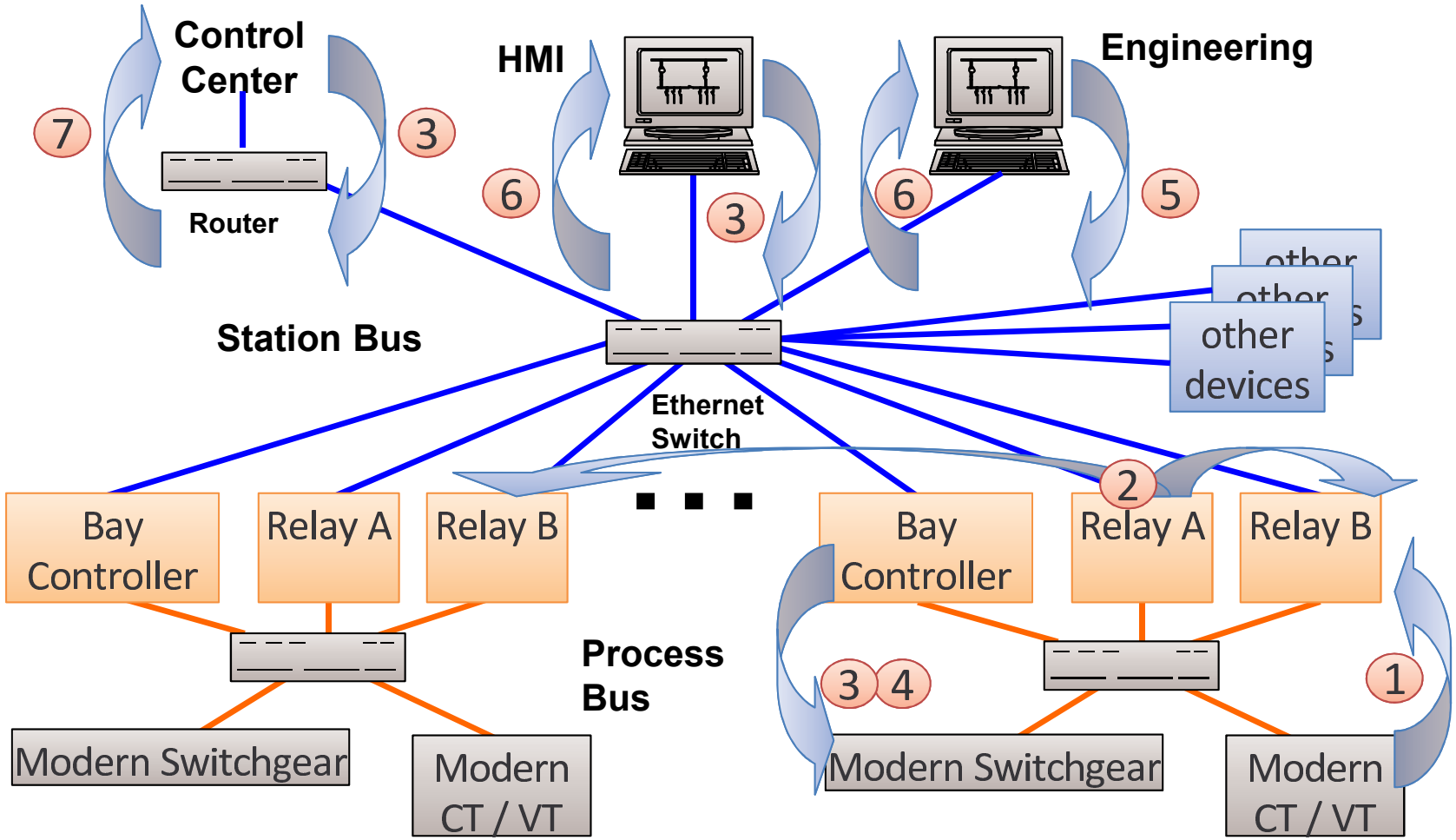
Sadržaj

1. Uvod
2. **Arhitektura IEC 61850 sustava**
3. Informacijsko modeliranje
4. Komunikacijski servisi
5. Implementacijski zahtjevi
6. Konfiguracija

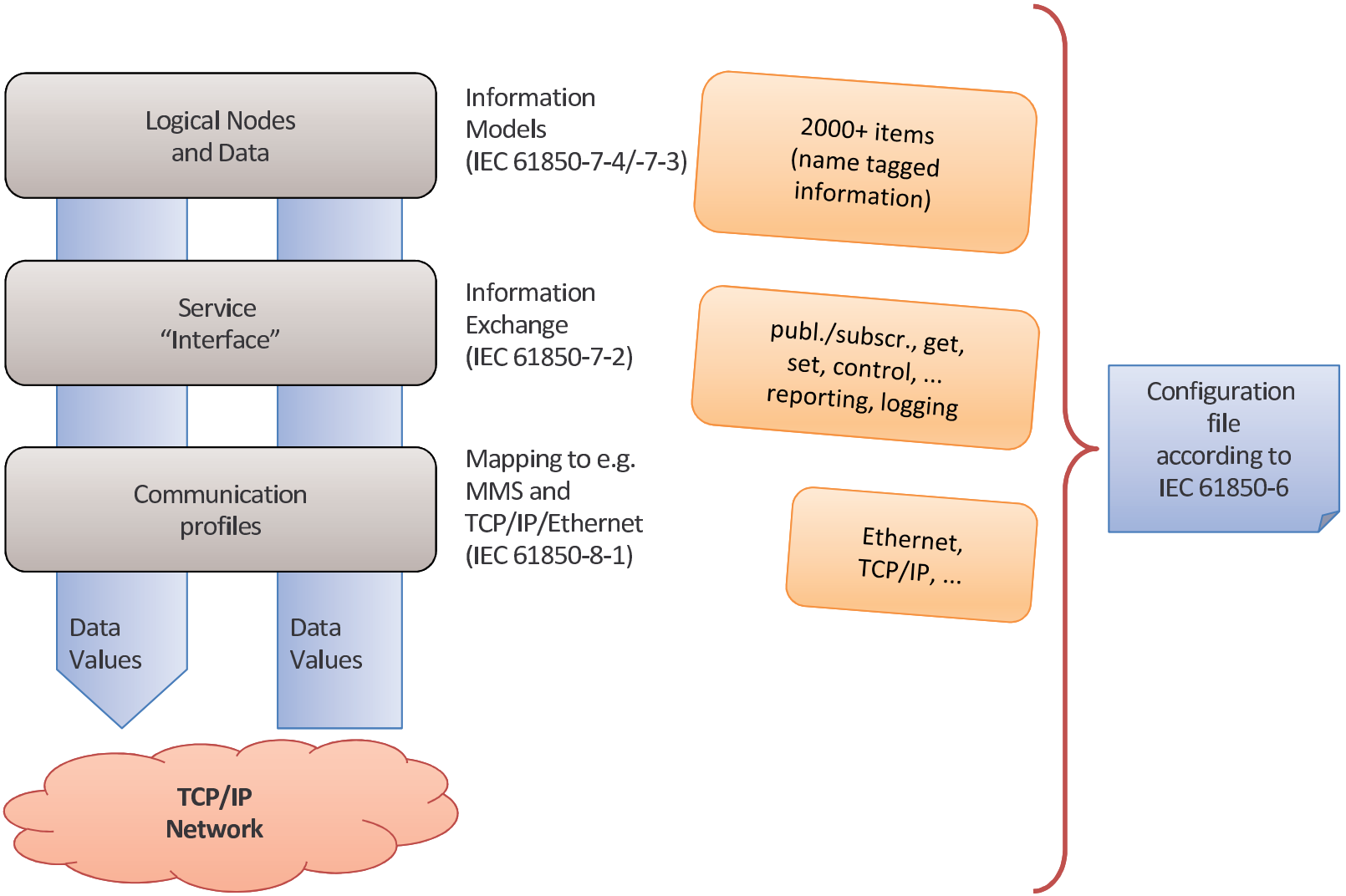
IEC 61850 – Osnovna arhitektura sustava



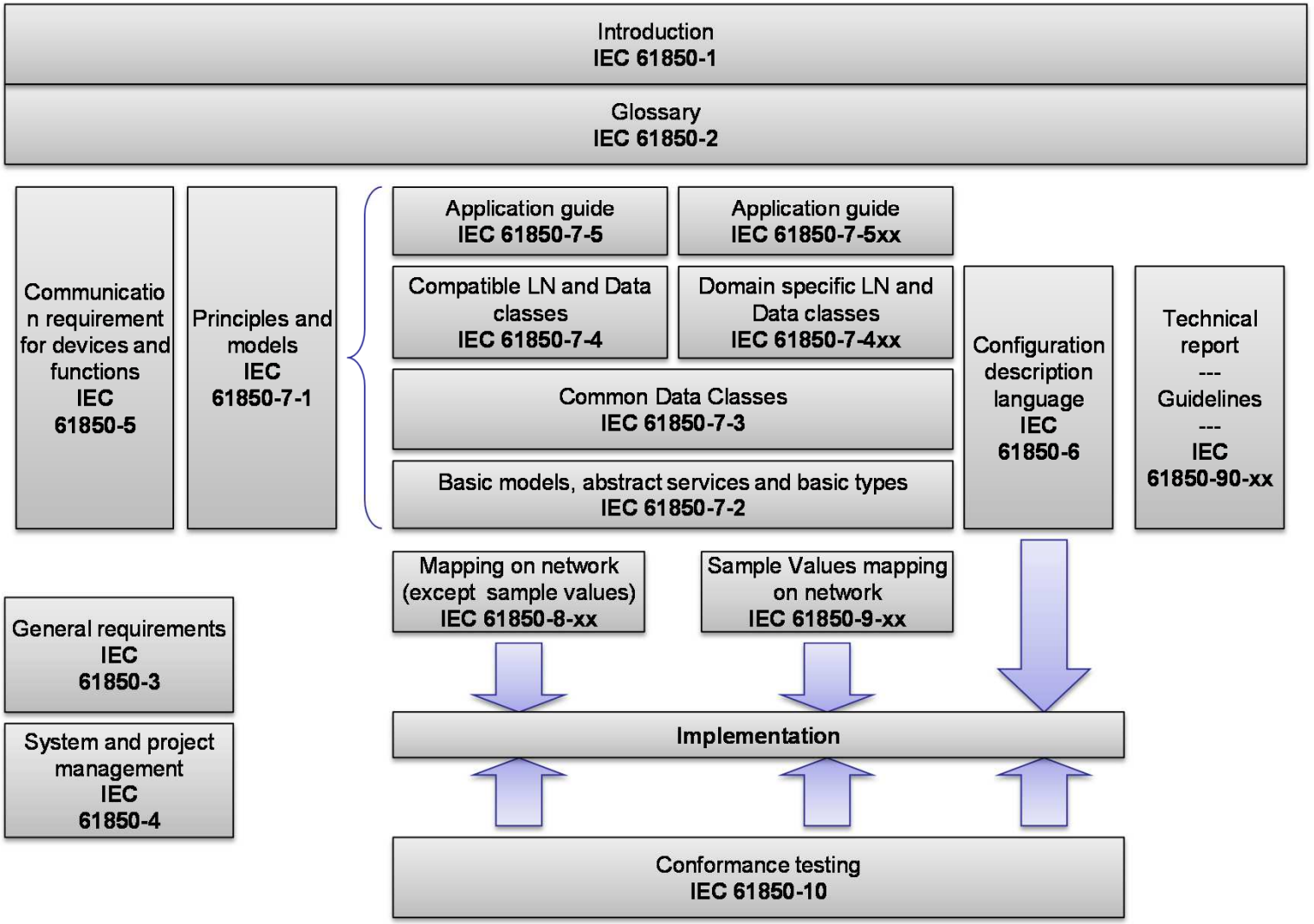
IEC 61850 – Sučelja



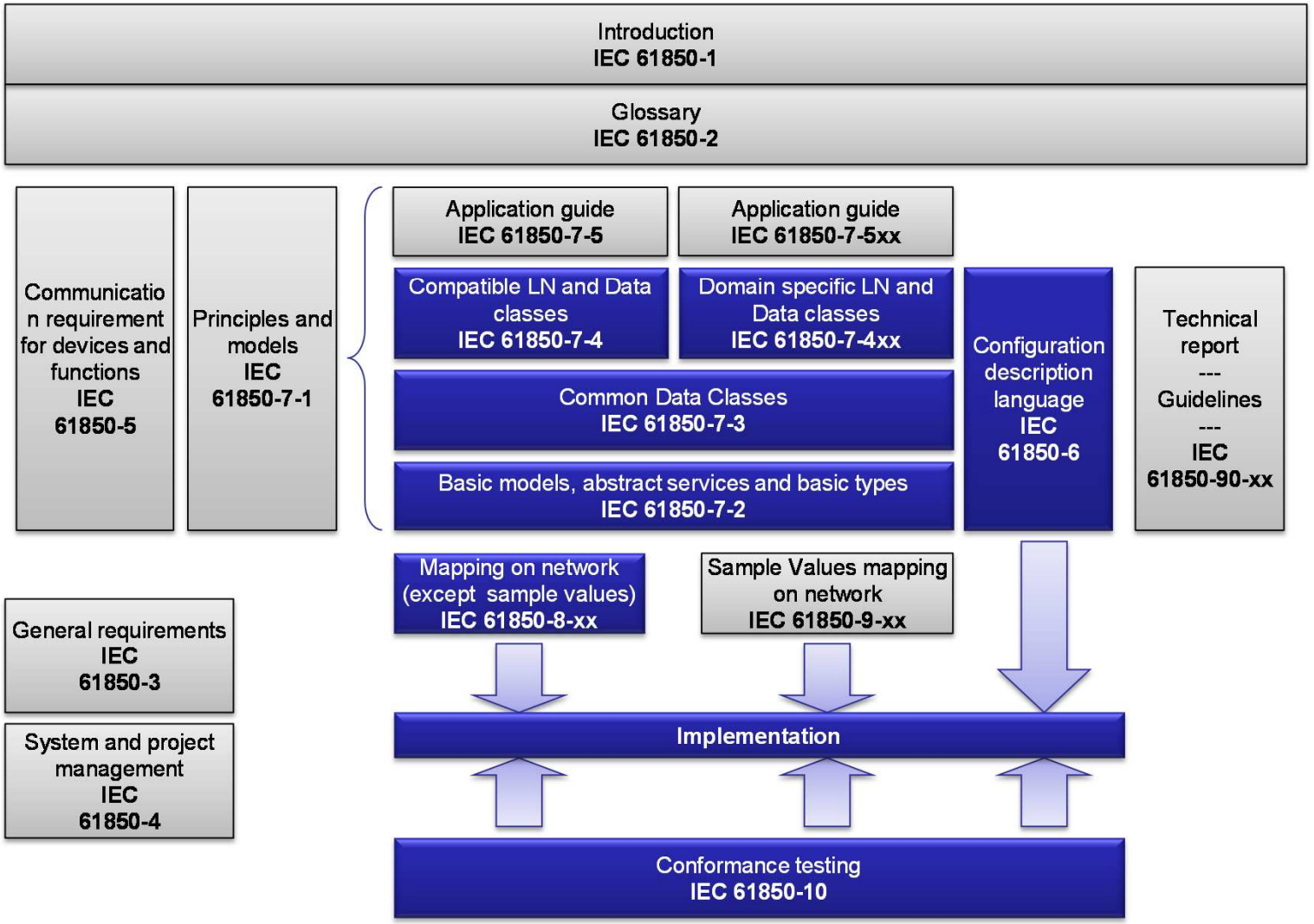
IEC 61850 – Pregled



IEC 61850 – Odnosi među dokumentima



IEC 61850 – Primjena u praksi

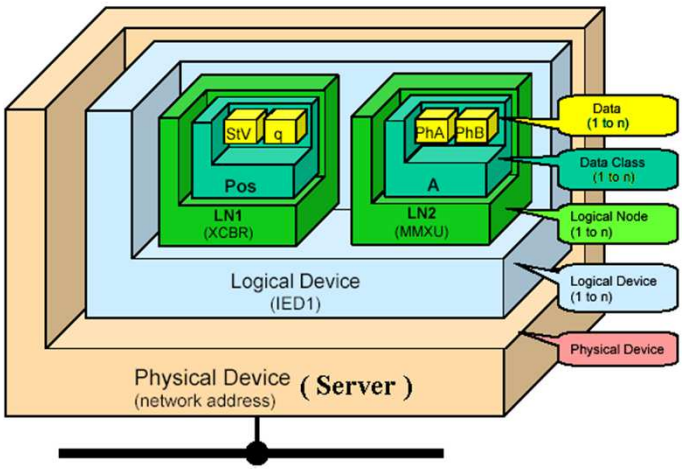


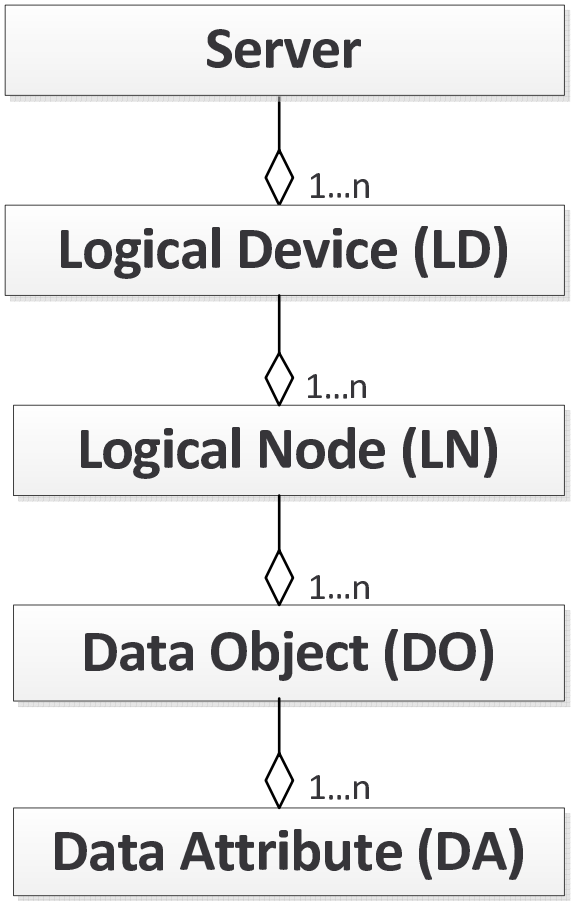
Sadržaj

1. Arhitektura
2. Arhitektura IEC 61850 sustava
3. **Informacijsko modeliranje**
4. Komunikacijski servisi
5. Implementacijski zahtjevi
6. Konfiguracija

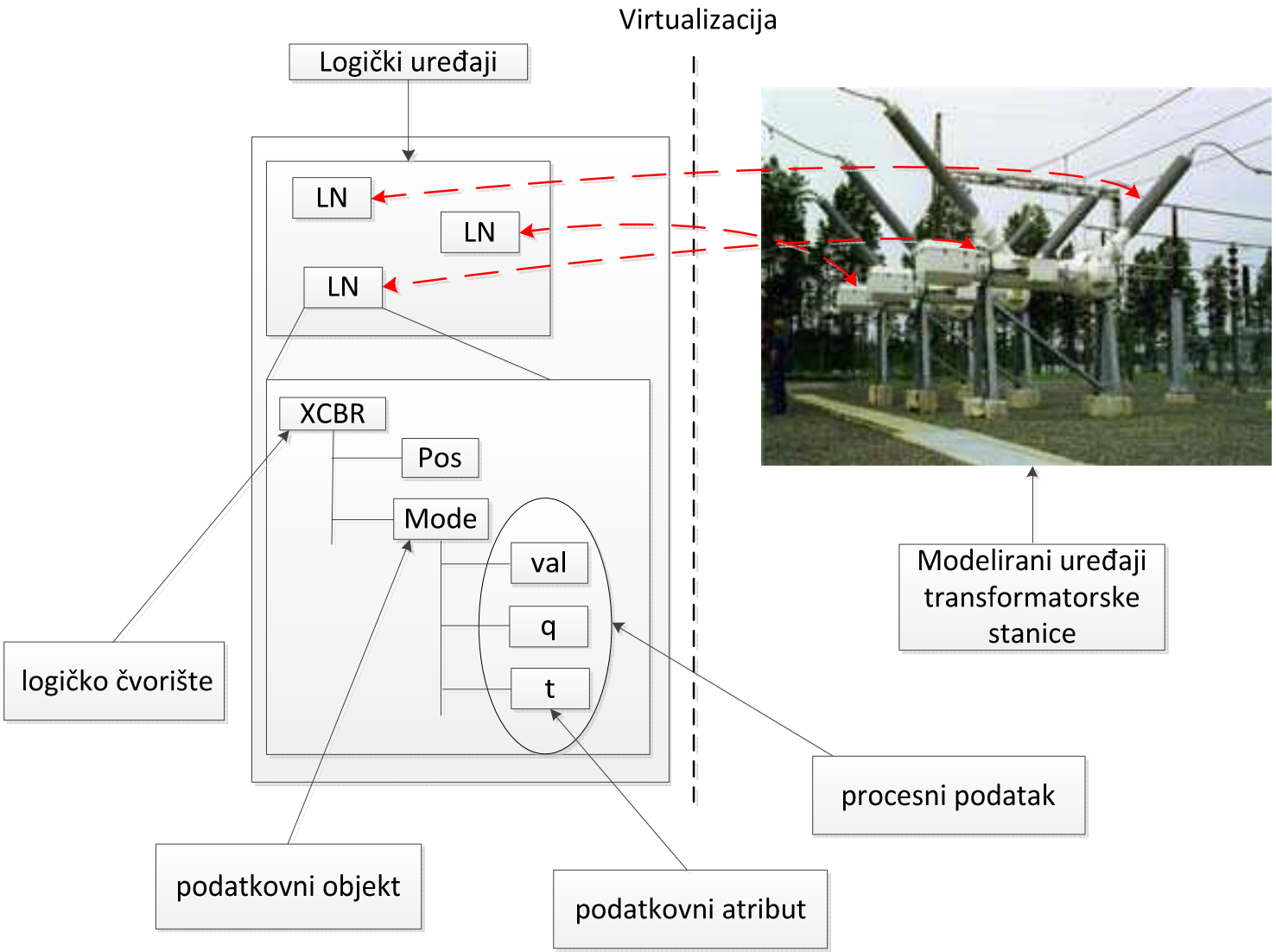
IEC 61850 – Podatkovni model

- Hijerarhijski funkcijski-orijentiran model
- Objektno orijentirano modeliranje
- IEC 61850-7-2 (Osnovni model)
- IEC 61850-7-3 (Podatkovne klase)
- IEC 61850-7-4xx (Domena)

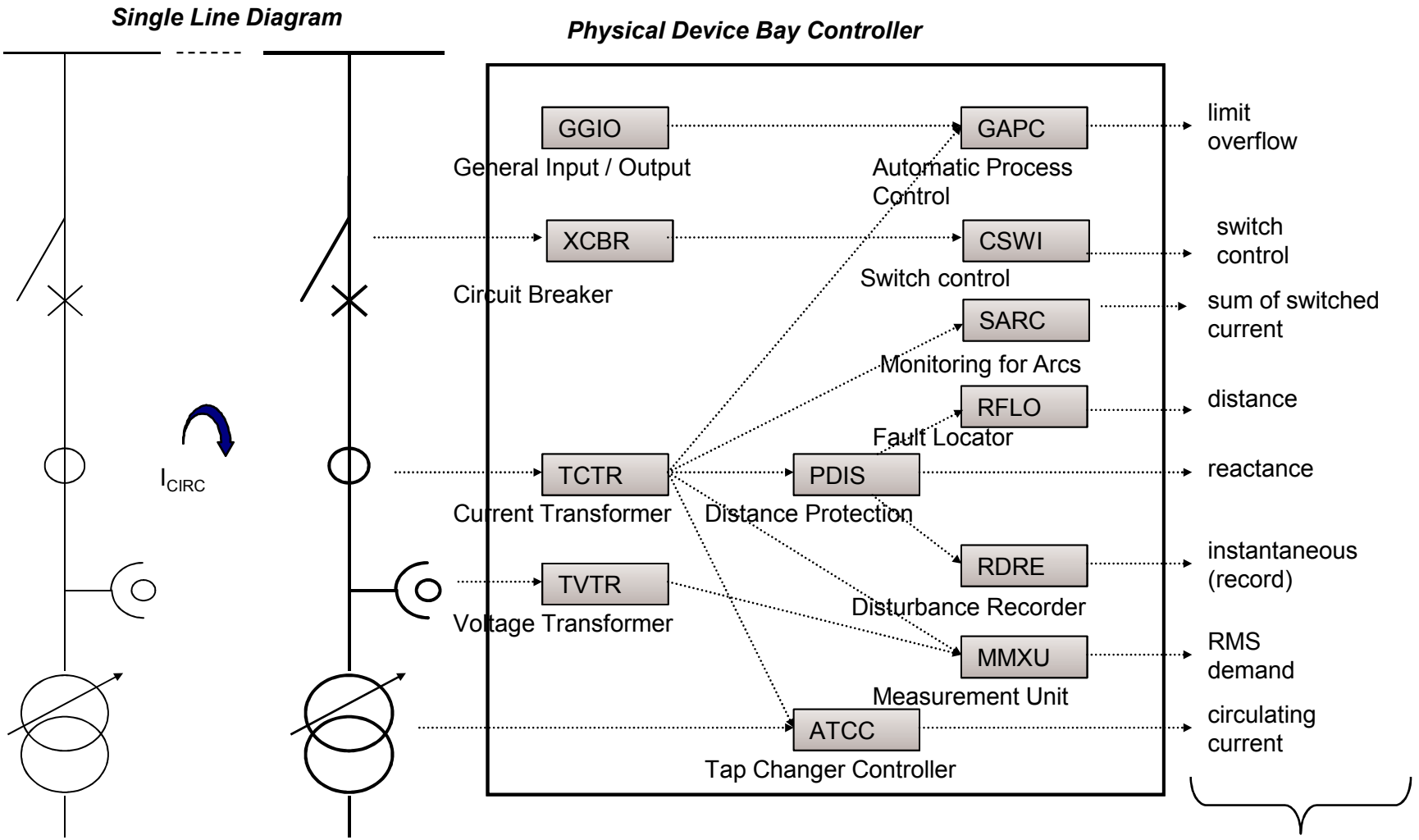




IEC 61850 – Modeliranje sustava



IEC 61850 – Modeliranje sustava



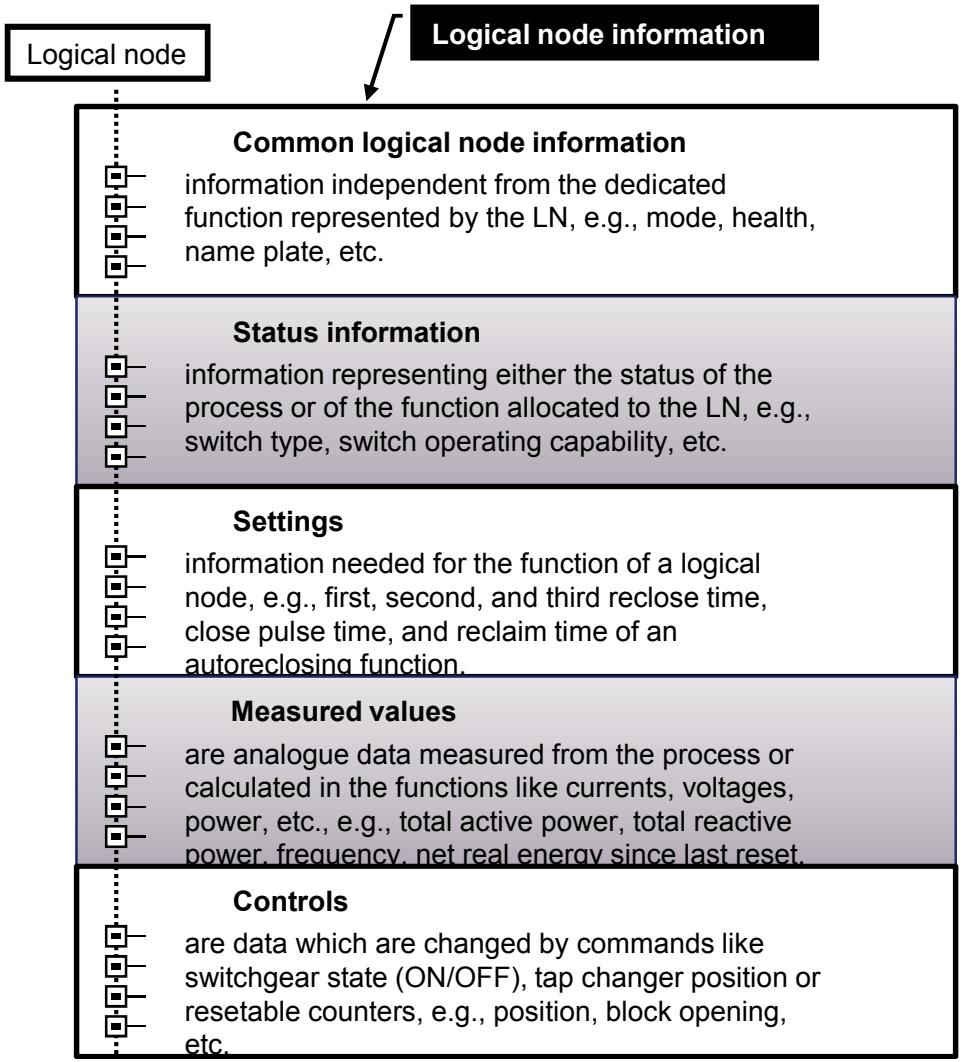
examples for some current related data

IEC 61850 – Logička čvorišta

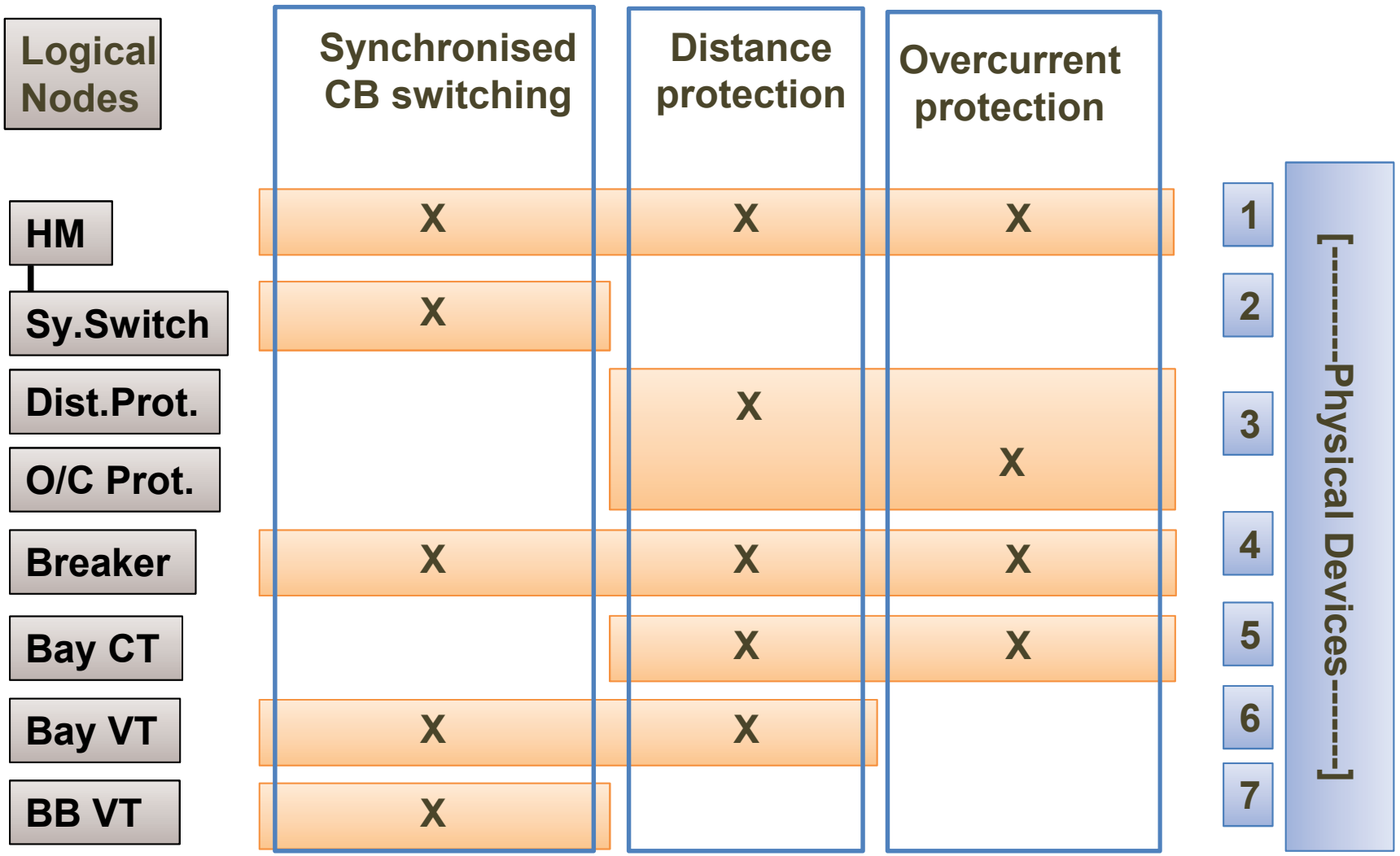
Group indicator	Logical node groups
A	Automatic Control
C	Supervisory control
D	DER
F	Functional blocks
G	Generic Function References
H	Hydro power
I	Interfacing and Archiving
K	Mechanical and non-electrical primary equipment
L	System Logical Nodes
M	Metering and Measurement
P	Protection Functions
Q	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 – Logička čvorišta

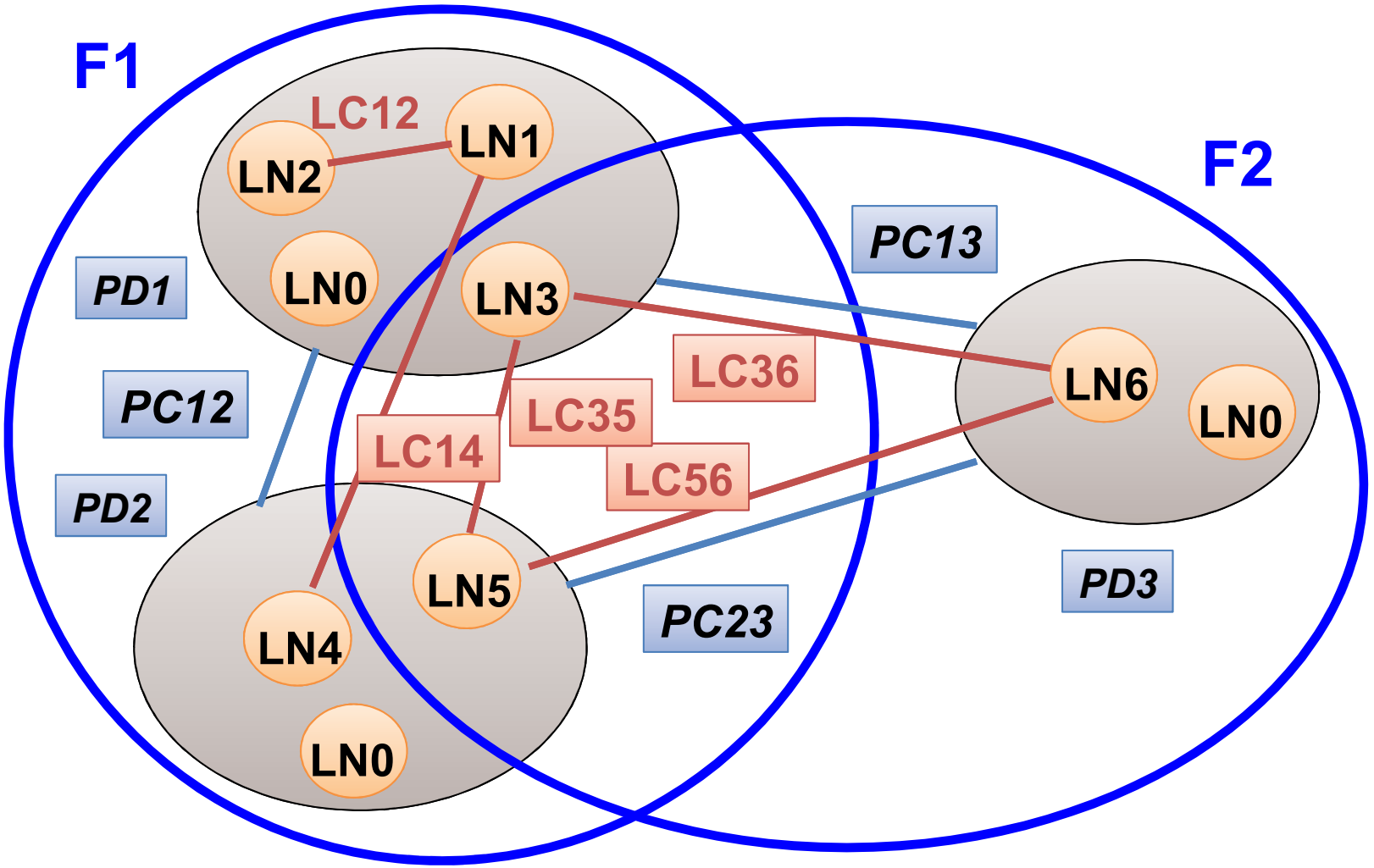
- Semantika procesnih podataka
- X(grupa)+ YYY(funkcija)



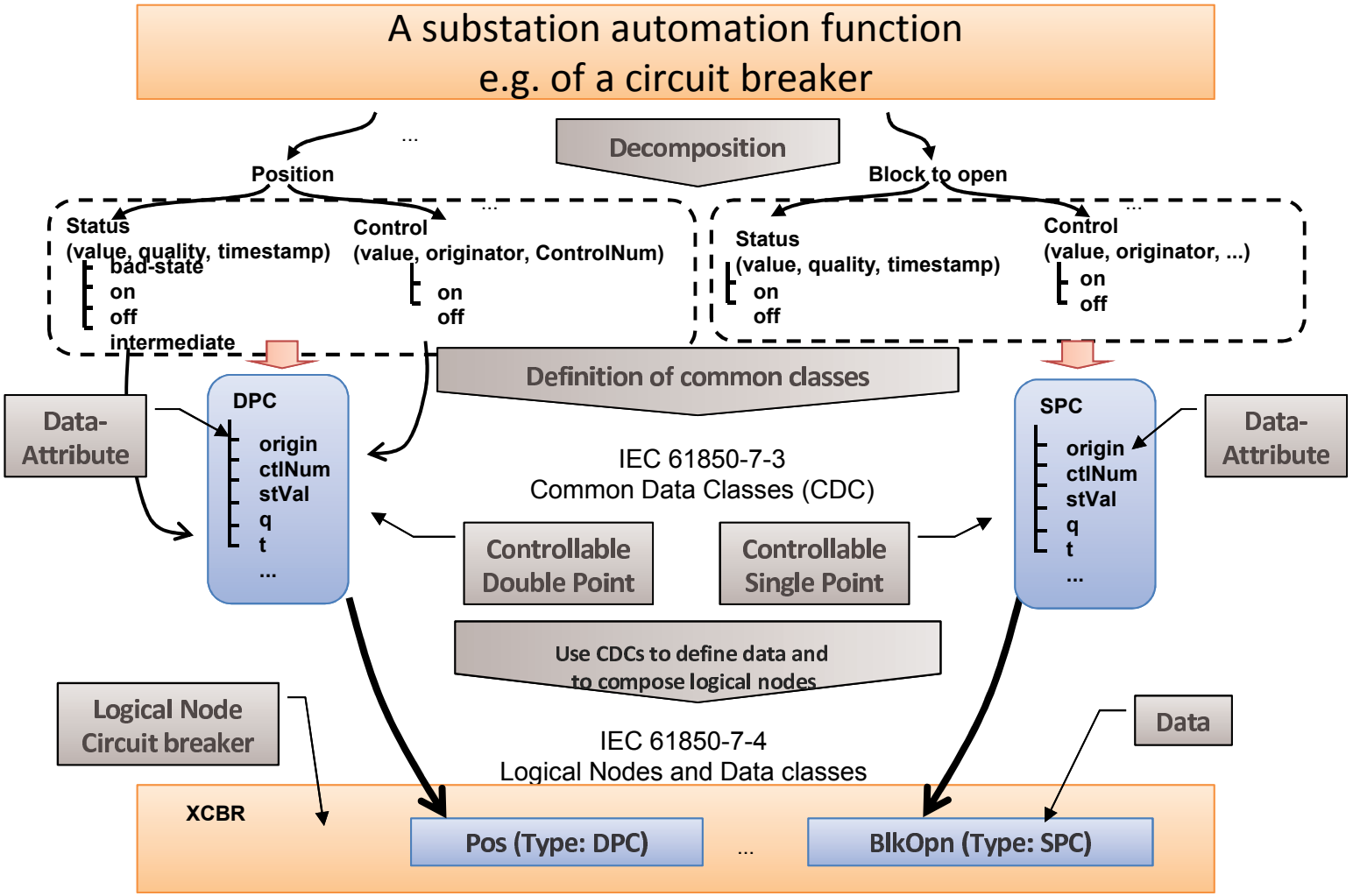
IEC 61850 – Dekompozicija funkcija



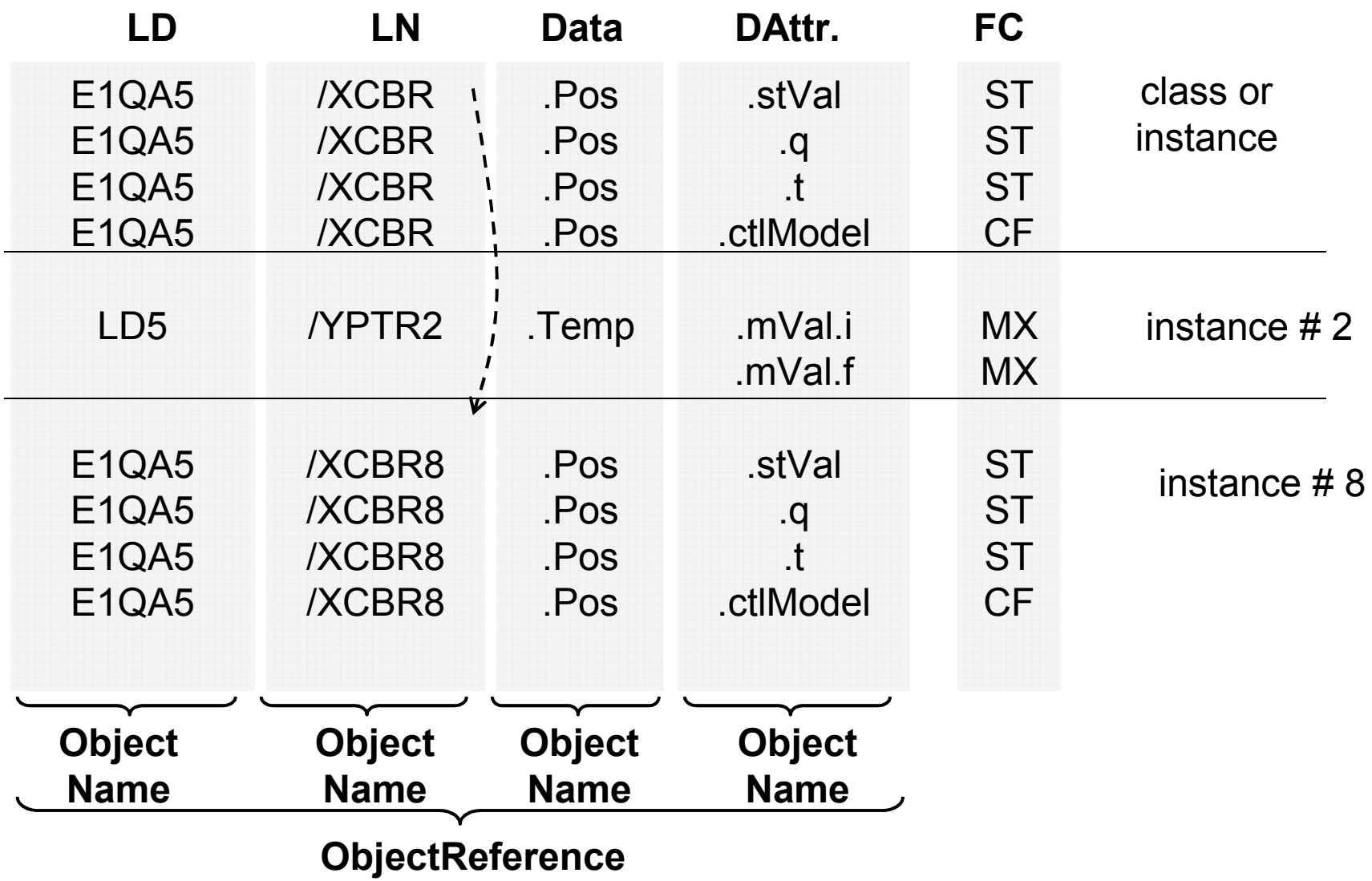
IEC 61850 – Dekompozicija funkcija



IEC 61850 – Modeliranje sustava



IEC 61850 – Modeliranje podataka



IEC 61850 – Logička čvorišta

Logical Node: Circuit breaker			Name: XCBR
Data-Class	**DataName**	**Common Data Class (CDC)**	**M/O**
Basic Logical Node information			
Mode	Mod	ENC - Controllable Integer Status	O
Behaviour	Beh	ENS - Integer Status	M
Health	Health	ENS - Integer Status	O
Name plate	NamPlt	LPL - Logical node name plate	O
Local control behaviour	Loc	SPS - Single point status	M
External equipment health	EEHealth	ENS - Integer Status	O
External equipment name plate	EEName	DPL - Device name plate	O
Operation counter	OpCnt	INS - Integer Status	M
Controllable Data			
Switch position	Pos	**DPC - Controllable Double Point**	M
Block opening	BlkOpn	SPC - Controllable Single Point	M
Block closing	BlkCls	SPC - Controllable Single Point	M
Charger motor enabled	ChMotEna	SPC - Controllable Single Point	O

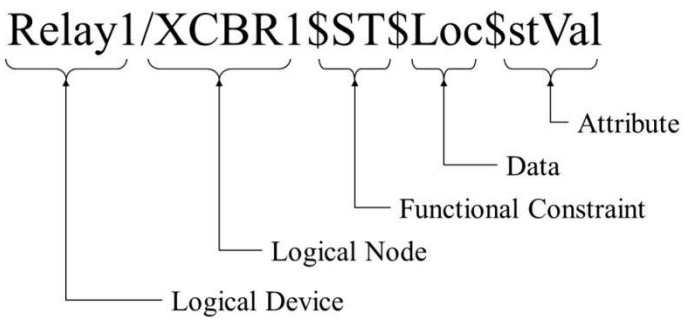
IEC 61850 – Podatkovne klase

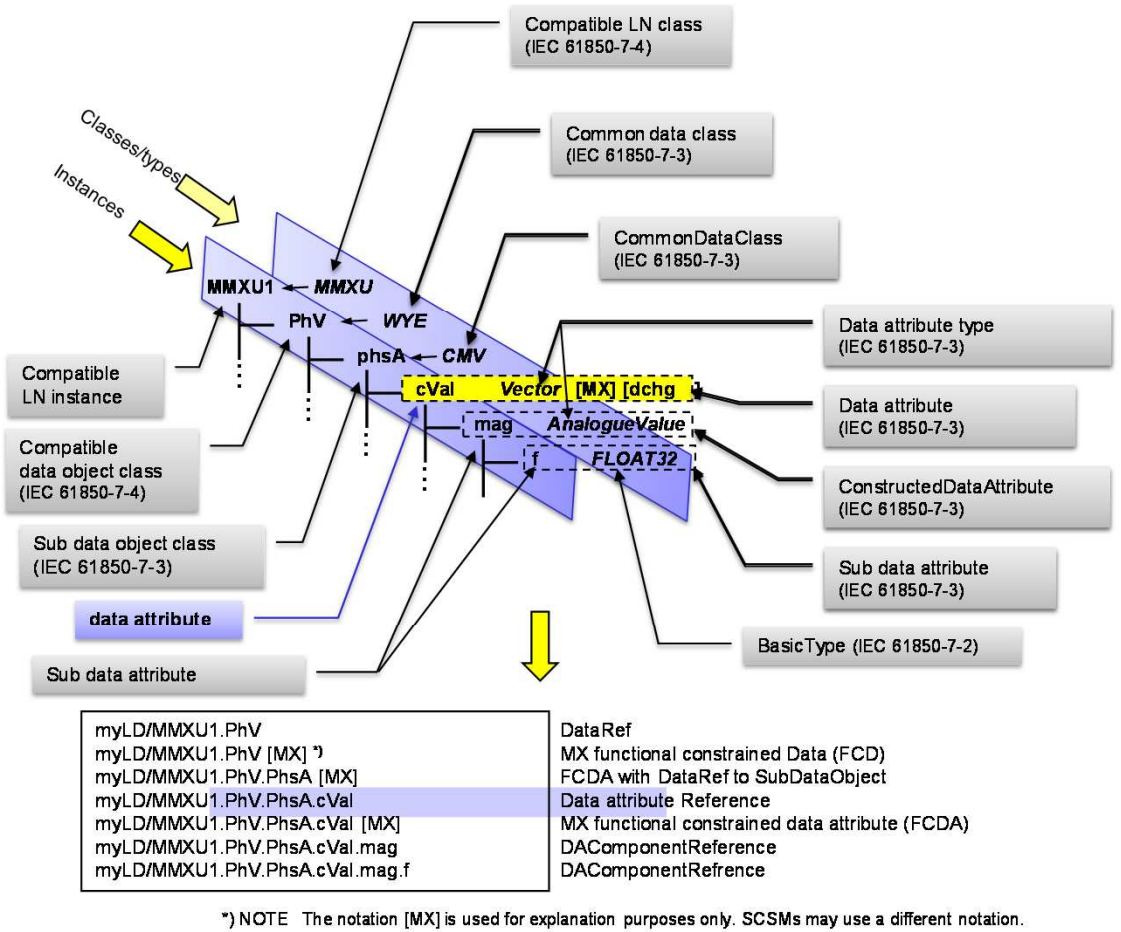
DPC class					
Data attribute name	**Type**	**FC**	**TrgOp**	**Value/Value range**	**M/O/C**
DataName	Inherited from GenDataObject Class or from GenSubDataObject Class (see IEC 61850-7-2)				
DataAttribute					
status and control mirror					
origin	Originator	ST			AC_CO_O
ctlNum	INT8U	ST		0..255	AC_CO_O
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		O
opRcvd	BOOLEAN	OR	dchg		O
opOk	BOOLEAN	OR	dchg		O
tOpOk	TimeStamp	OR			O
substitution and blocked					
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
blkEna	BOOLEAN	BL			O
configuration, description and extension					
pulseConfig	PulseConfig	CF	dchg		AC_CO_O
ctlModel	CtlModels	CF	dchg		M
sboTimeout	INT32U	CF	dchg		AC_CO_O
sboClass	SboClasses	CF	dchg		AC_CO_O
operTimeout	INT32U	CF	dchg		AC_CO_O
d	VISIBLE STRING255	DC		Text	O

IEC 61850 – Aplikacijski servisi

Services (see IEC 61850-7-2)			
The following services are inherited from IEC 61850-7-2. They are specialised by restricting the service to attributes with a functional constraint as specified below.			
Service model of IEC 61850-7-2	**Service**	**Service applies to Attr with FC**	**Remark**
GenCommonDataClass model	SetDataValues GetDataValues GetDataDefinition GetDataDirectory	DC, CF, SV, BL ALL ALL ALL	
Data set model	GetDataSetValues SetDataSetValues	ALL DC, CF, SV, BL	
Reporting model GSE model Sampled values model	Report SendGOOSEMessage SendGSSEMessage SendMSVMessage SendUSVMessage	ALL ST, MX ST ST, MX ST, MX	as specified within the data set that is used to define the content of the message
Control model	Select SelectWithValue Cancel Operate CommandTermination TimeActivatedOperate		
parameters for control services			
Service parameter name	**Service parameter type**	**Value/Value range**	
ctlVal	BOOLEAN	off (FALSE) | on (TRUE)	

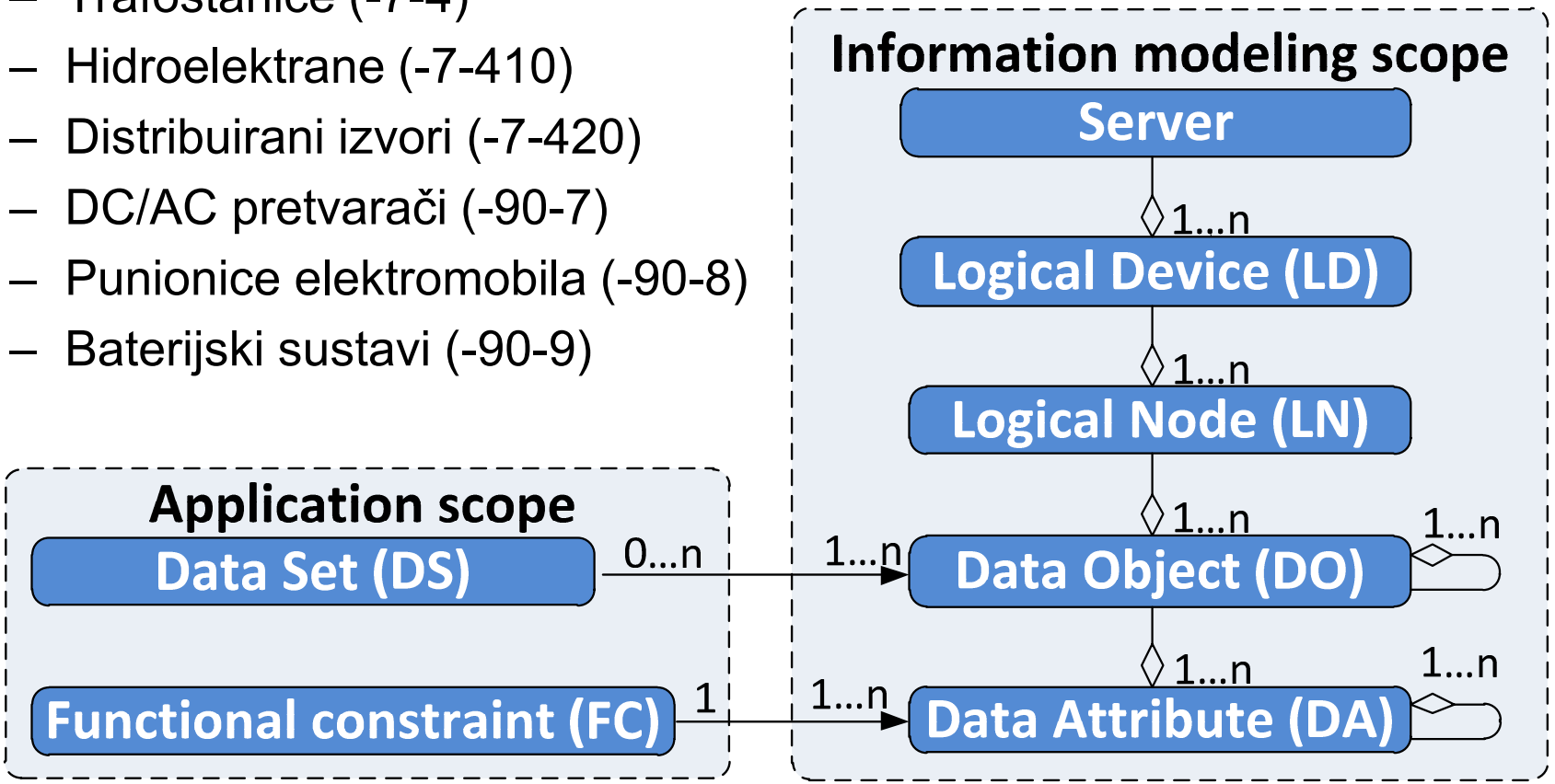
IEC 61850 – Primjer podatkovnog atributa



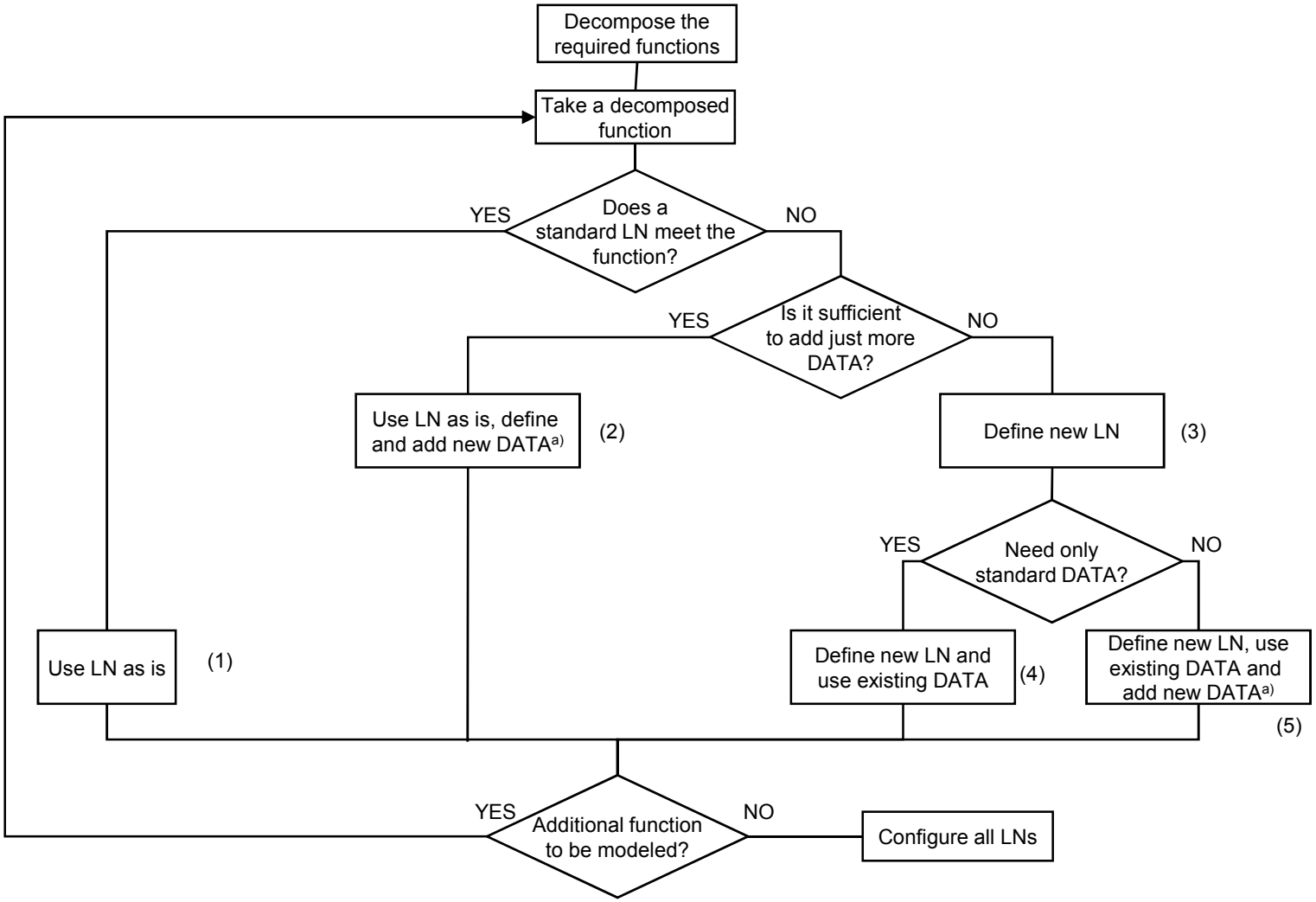


IEC 61850 – Podatkovni model (proširenja)

- Domenska proširenja
  - Trafostanice (-7-4)
  - Hidroelektrane (-7-410)
  - Distribuirani izvori (-7-420)
  - DC/AC pretvarači (-90-7)
  - Punionice elektromobila (-90-8)
  - Baterijski sustavi (-90-9)



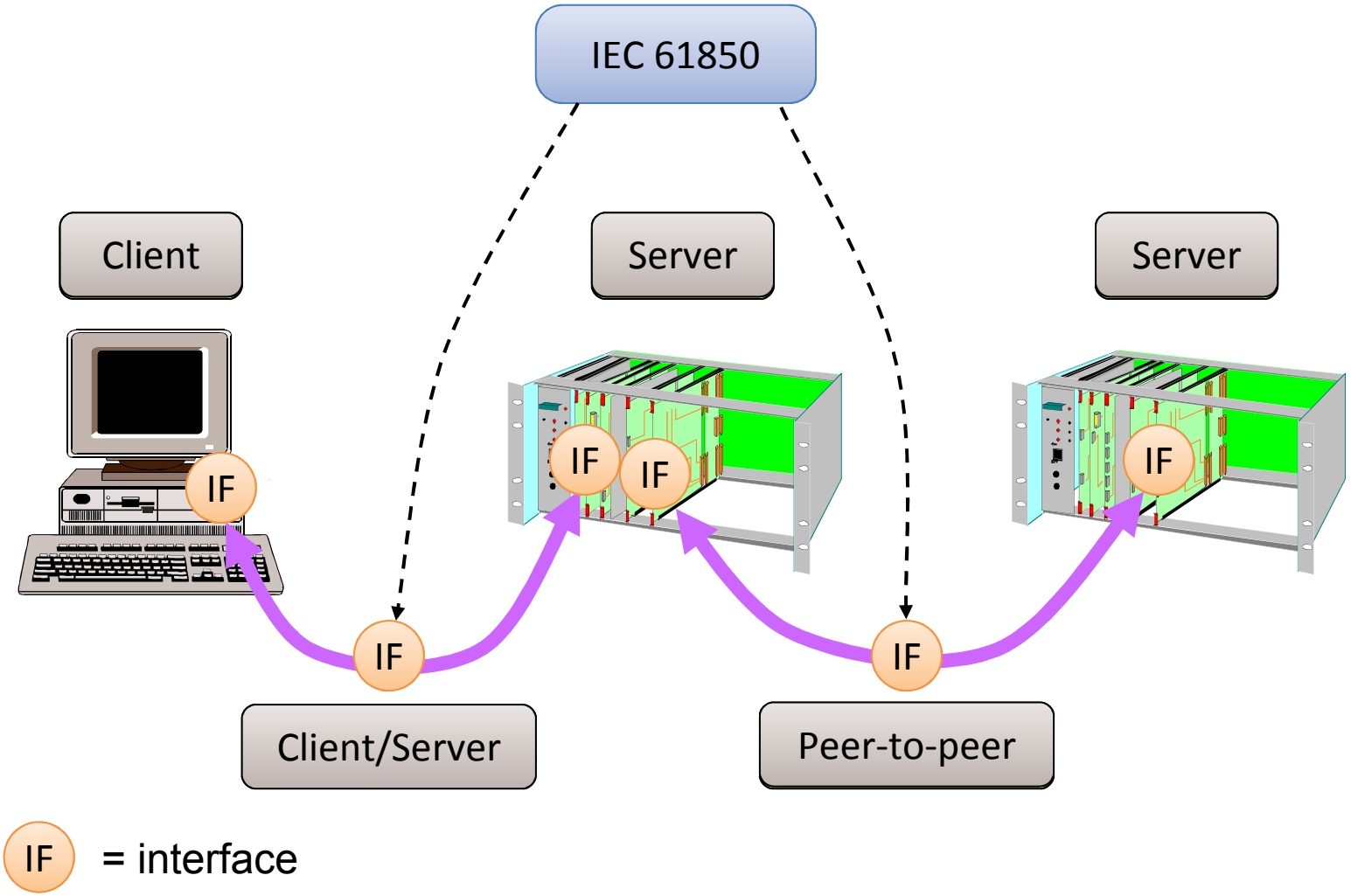
IEC 61850 – Pravila proširenja modela



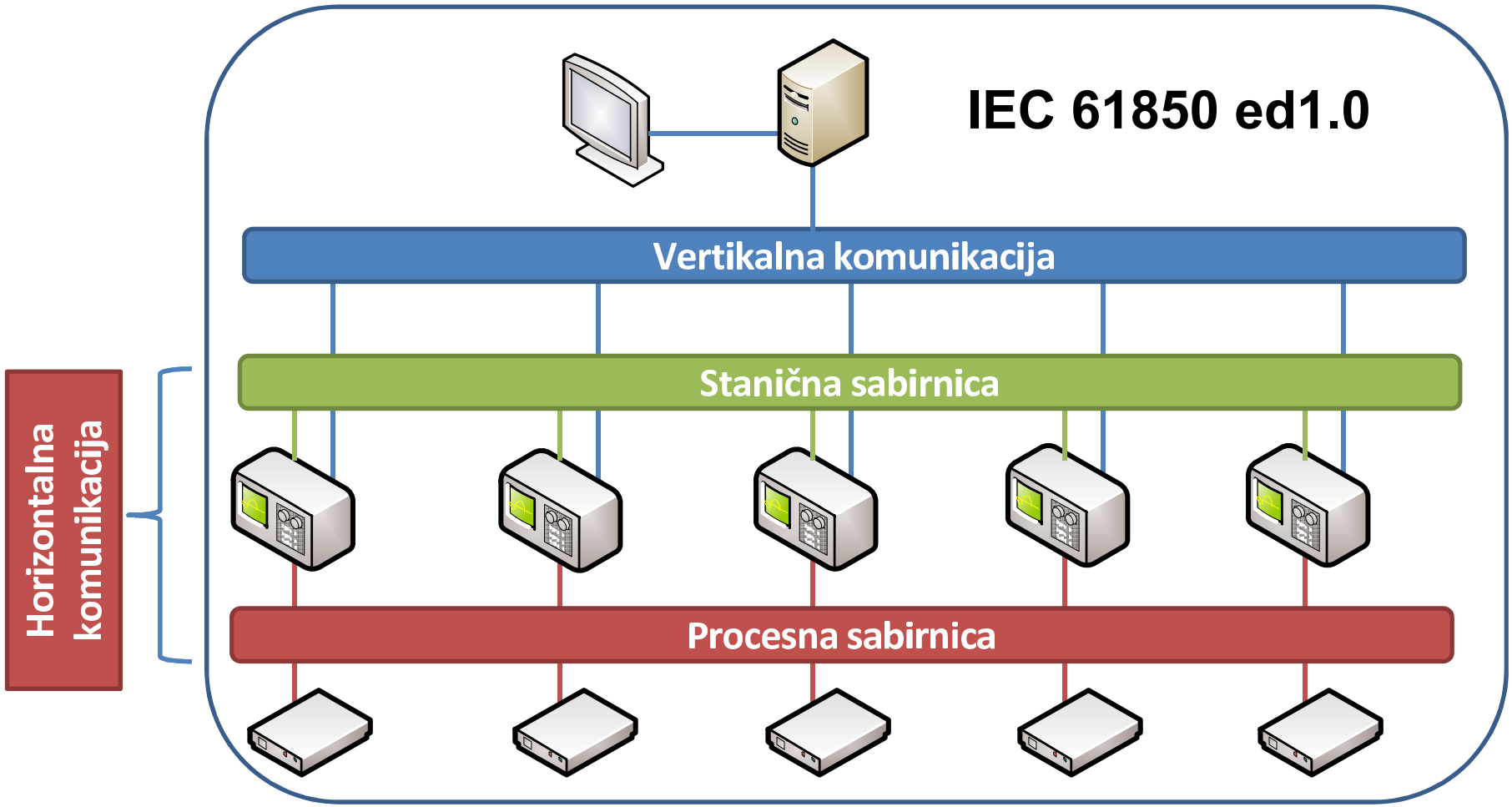
Sadržaj

1. Arhitektura
2. Arhitektura IEC 61850 sustava
3. Informacijsko modeliranje
4. **Komunikacijski servisi**
5. Implementacijski zahtjev
6. Konfiguracija

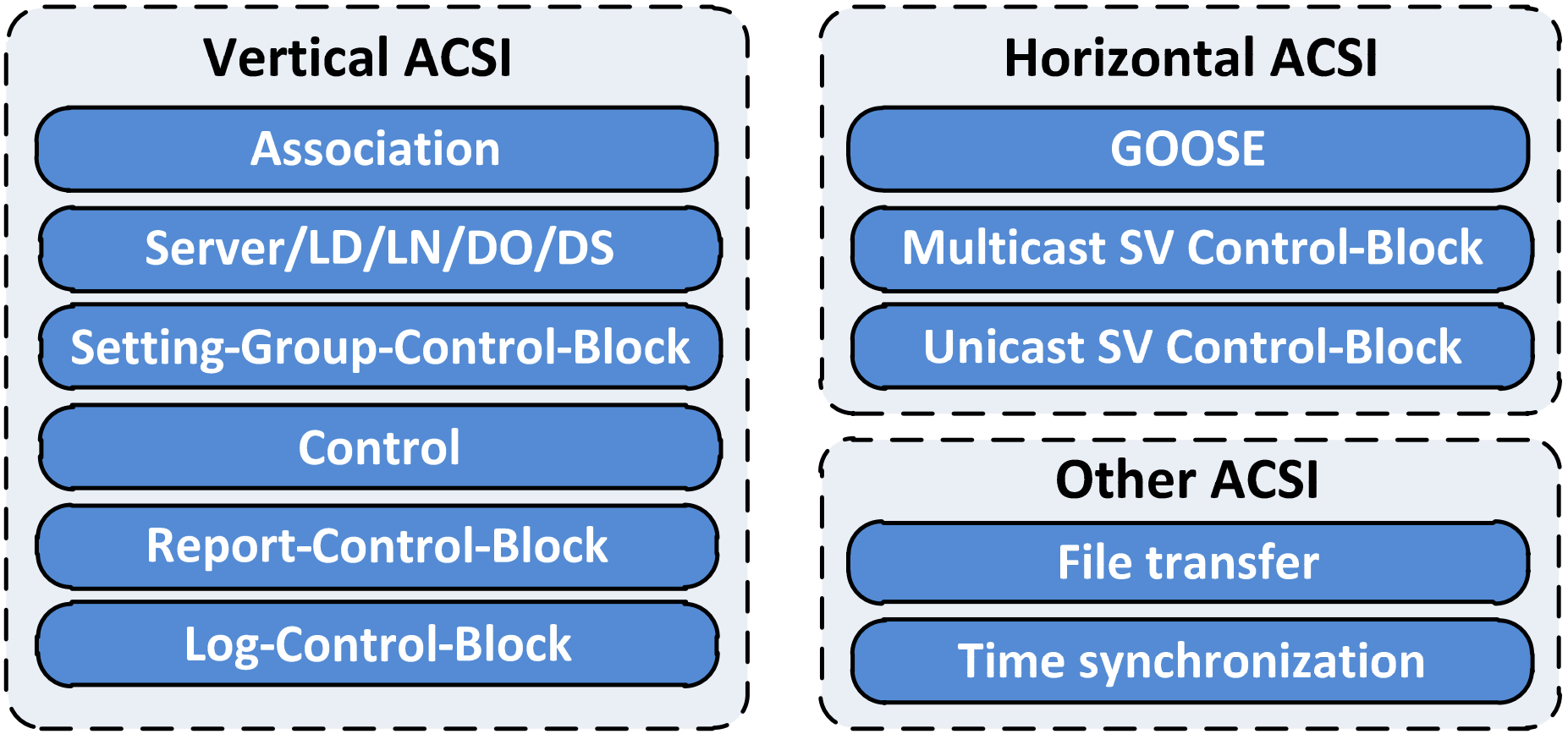
IEC 61850 – Razmjena informacija



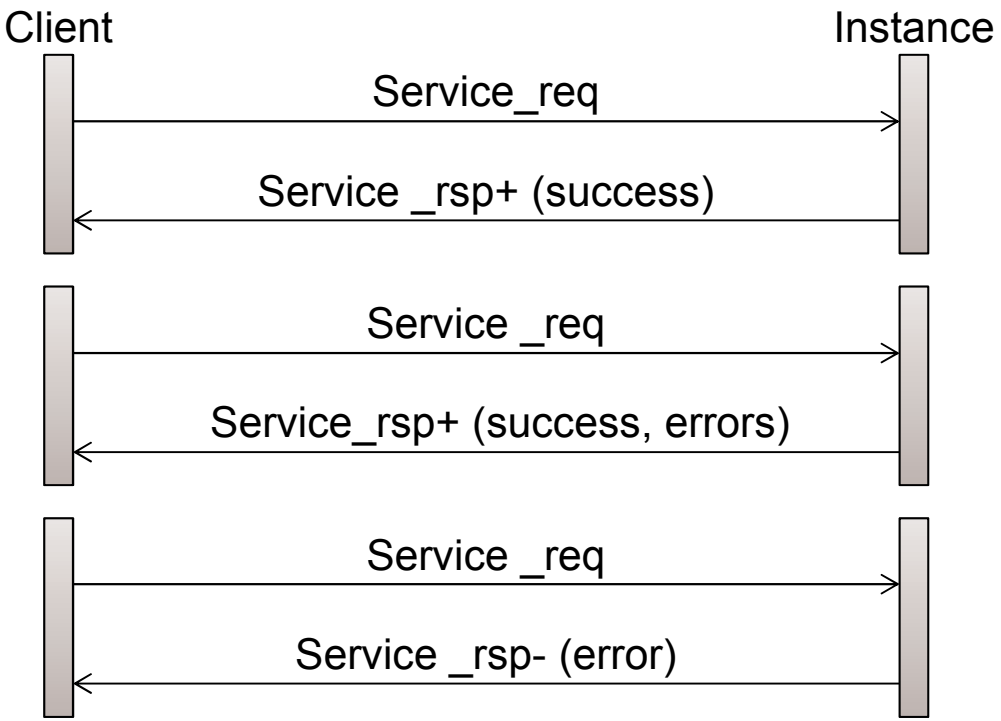
IEC 61850 – Osnovna arhitektura sustava



IEC 61850 – Razmjena informacija



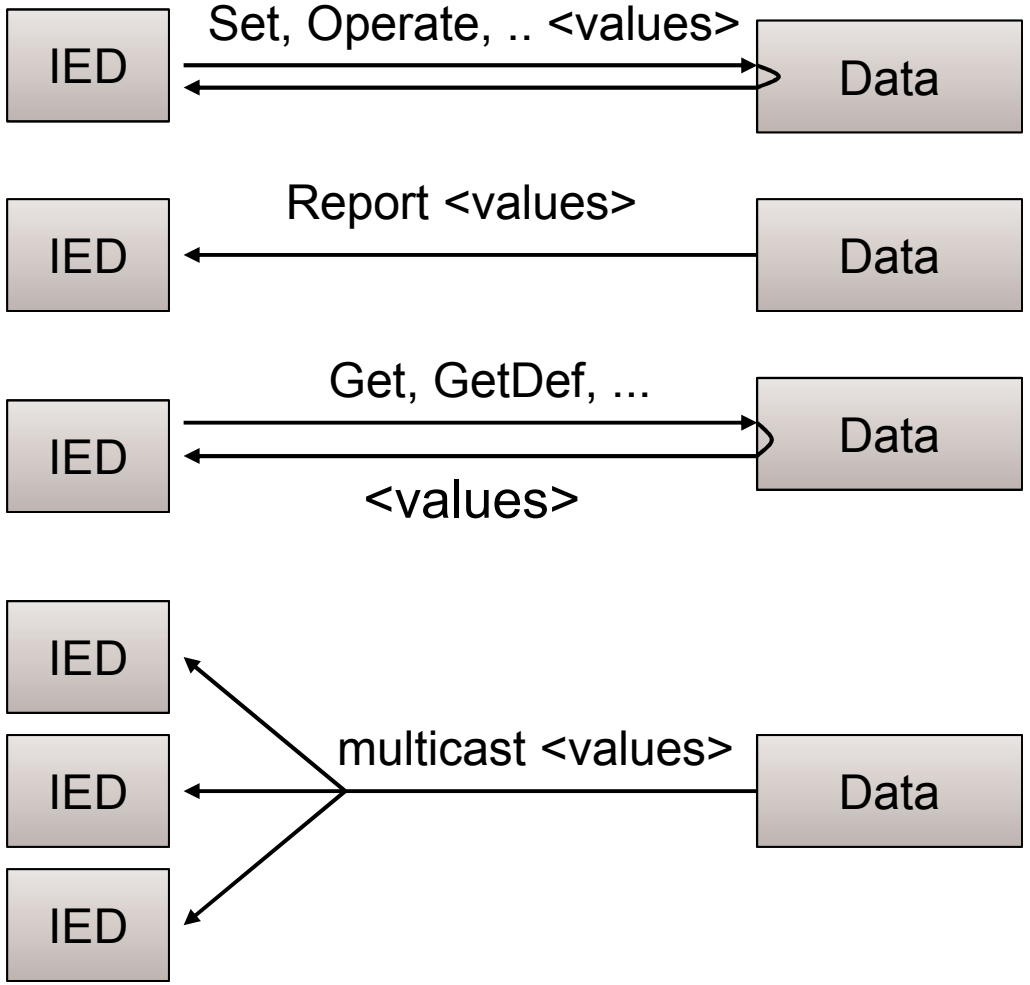
IEC 61850 – ACSI definicija



Parameter name
Request
Parameter 1...
Parameter n
Response+
Parameter 1...
Parameter n
Response−

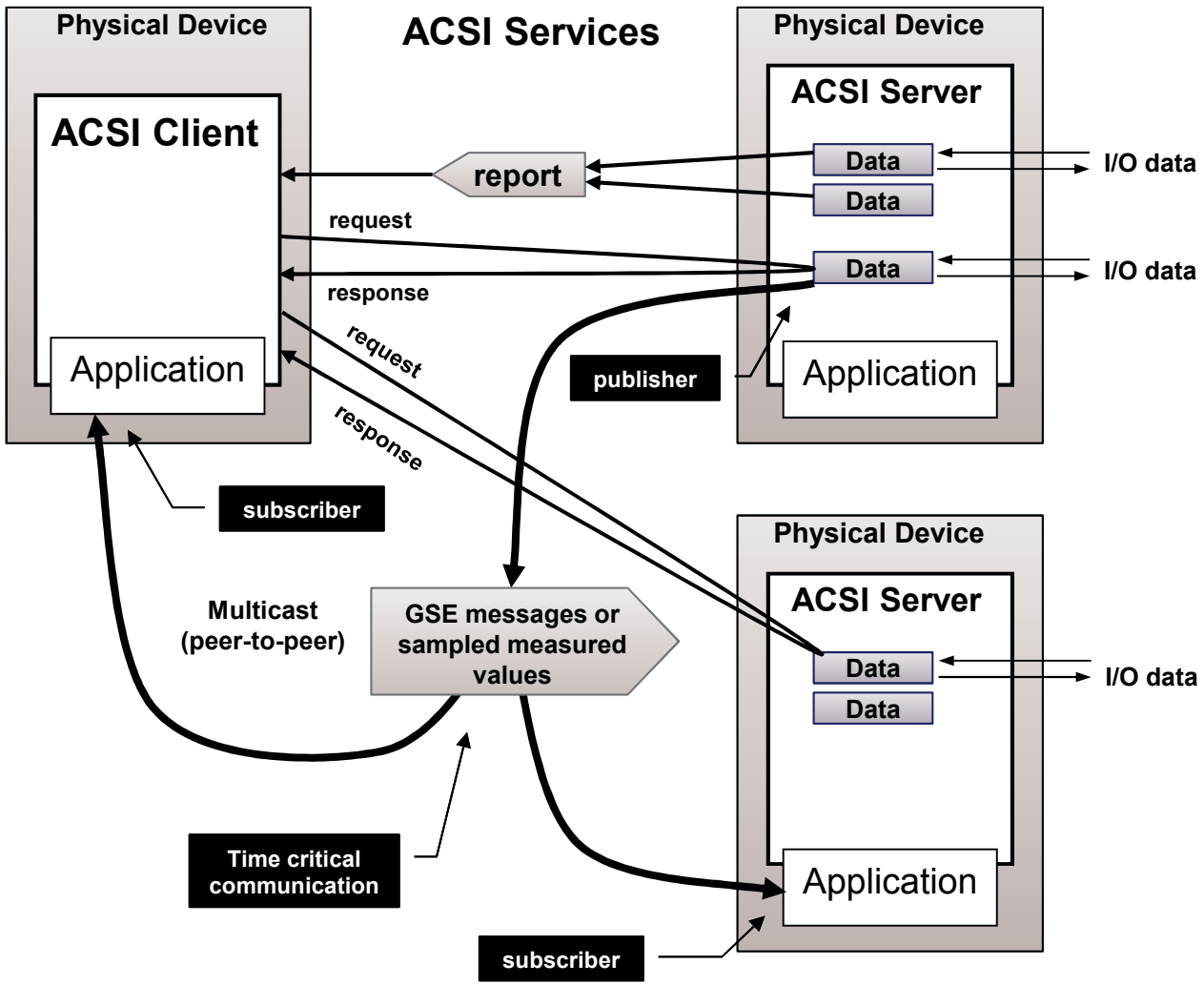
IEC 61850 – Razmjena informacija

- Primanje:
  - spontano
  - na zahtjev
  - na pretplatu
- Slanje:
  - na zahtjev
  - na pretplatu

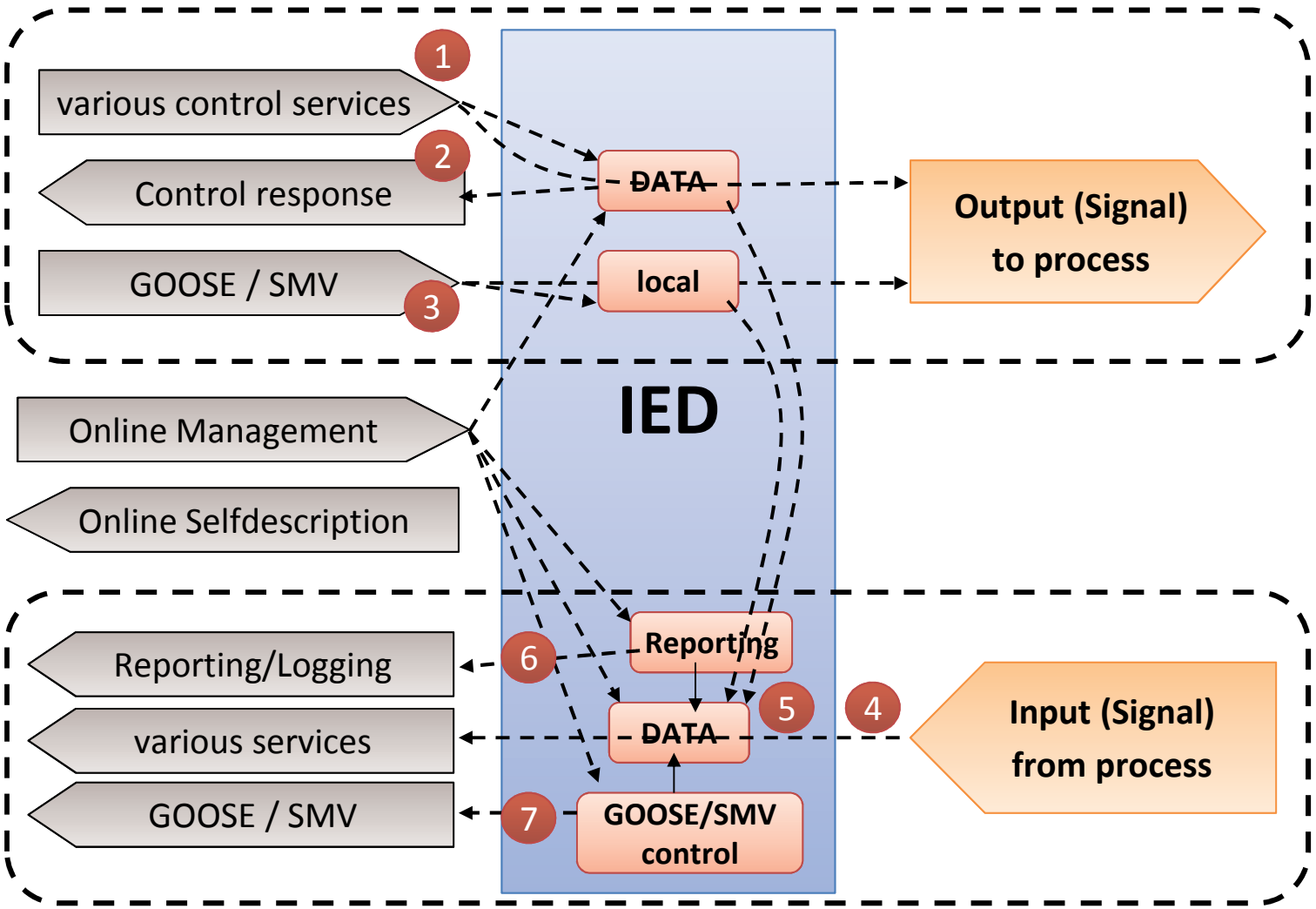


IEC 61850 – Razmjena informacija

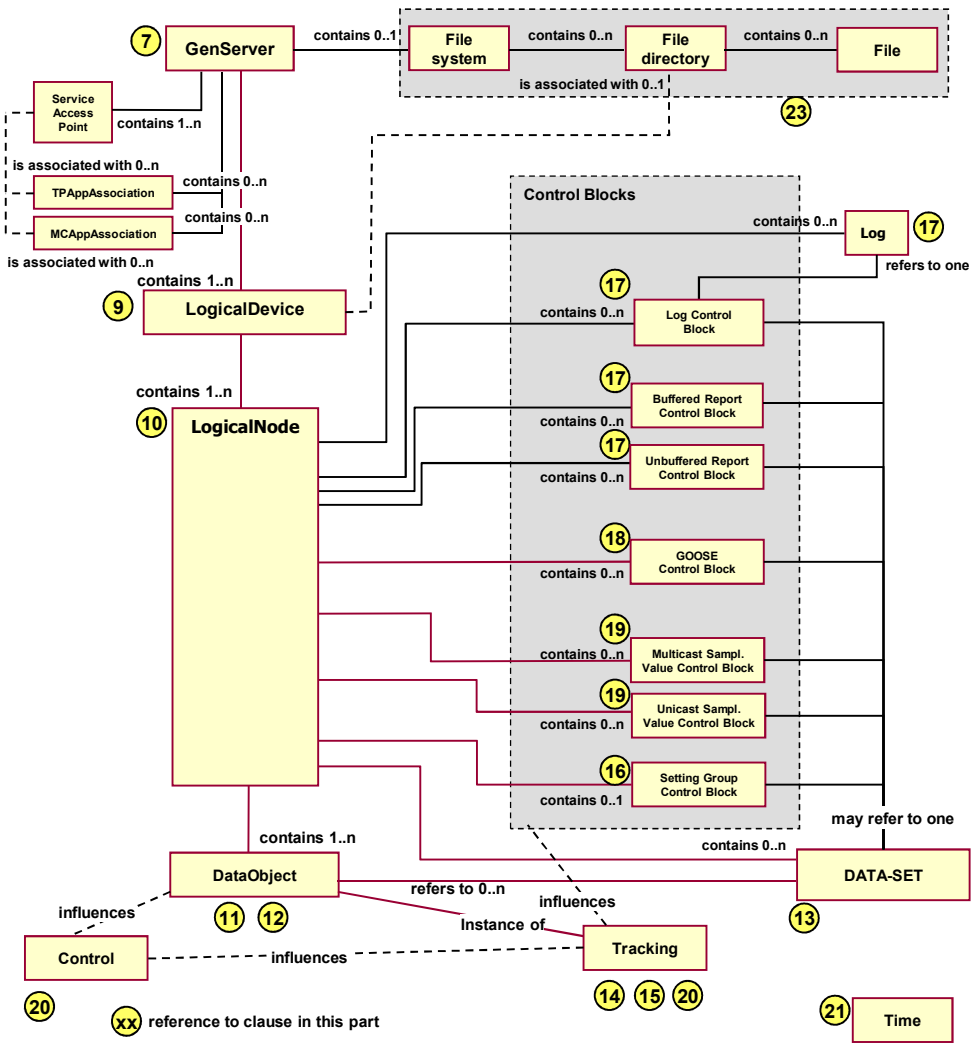
- Vertical ACSI:
  - clijent/server
- Horizontal ACSI:
  - publish/subscribe



IEC 61850 – Razmjena informacija

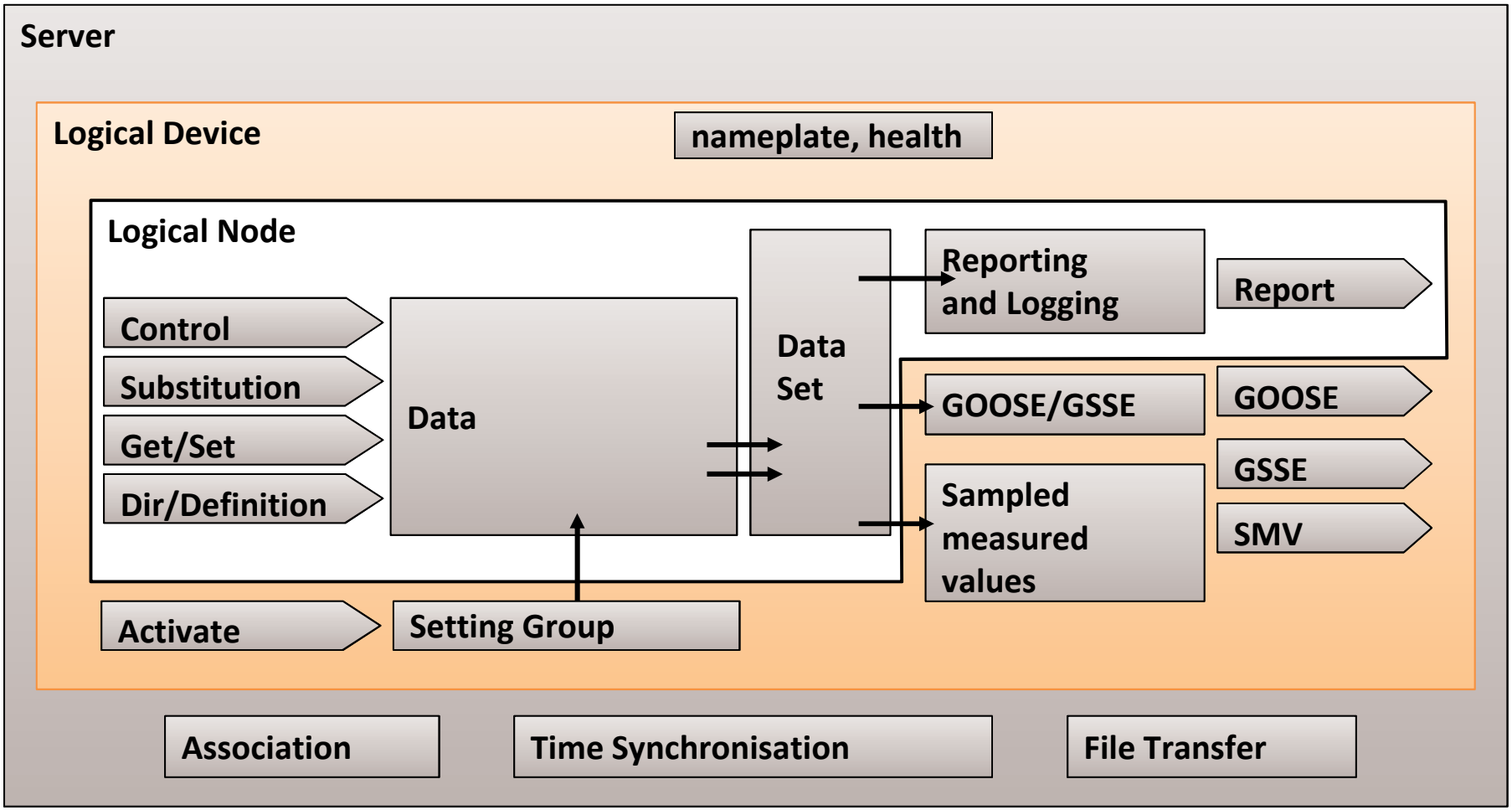


IEC 61850 – Informacijski model + ACSI servisi

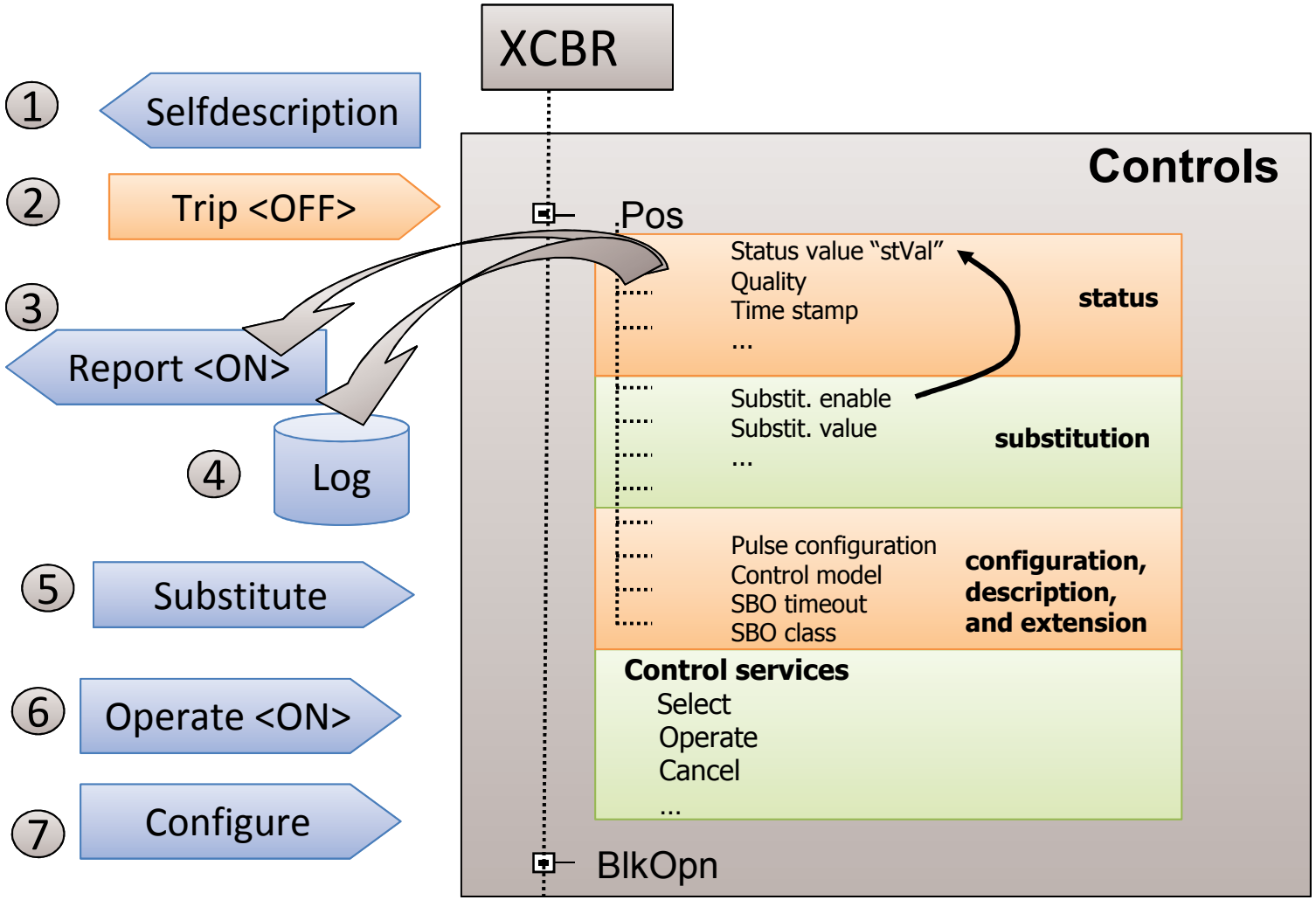


ACSI Services (7-2)
LogicalDeviceDirectory
GetAllDataValues
GetDataValues
SetDataValues
GetDataDirectory
GetDataDefinition
GetDataSetValues
SetDataSetValues
CreateDataSet
DeleteDataSet
GetDataSetDirectory
Report (Buffered and Unbuffered)
GetBRCBValues/GetURCBValues
SetBRCBValues/SetURCBValues
GetLCBValues
SetLCBValues
QueryLogByTime
QueryLogAfter
GetLogStatusValues
Select
SelectWithValue
Cancel
Operate
Command-Termination

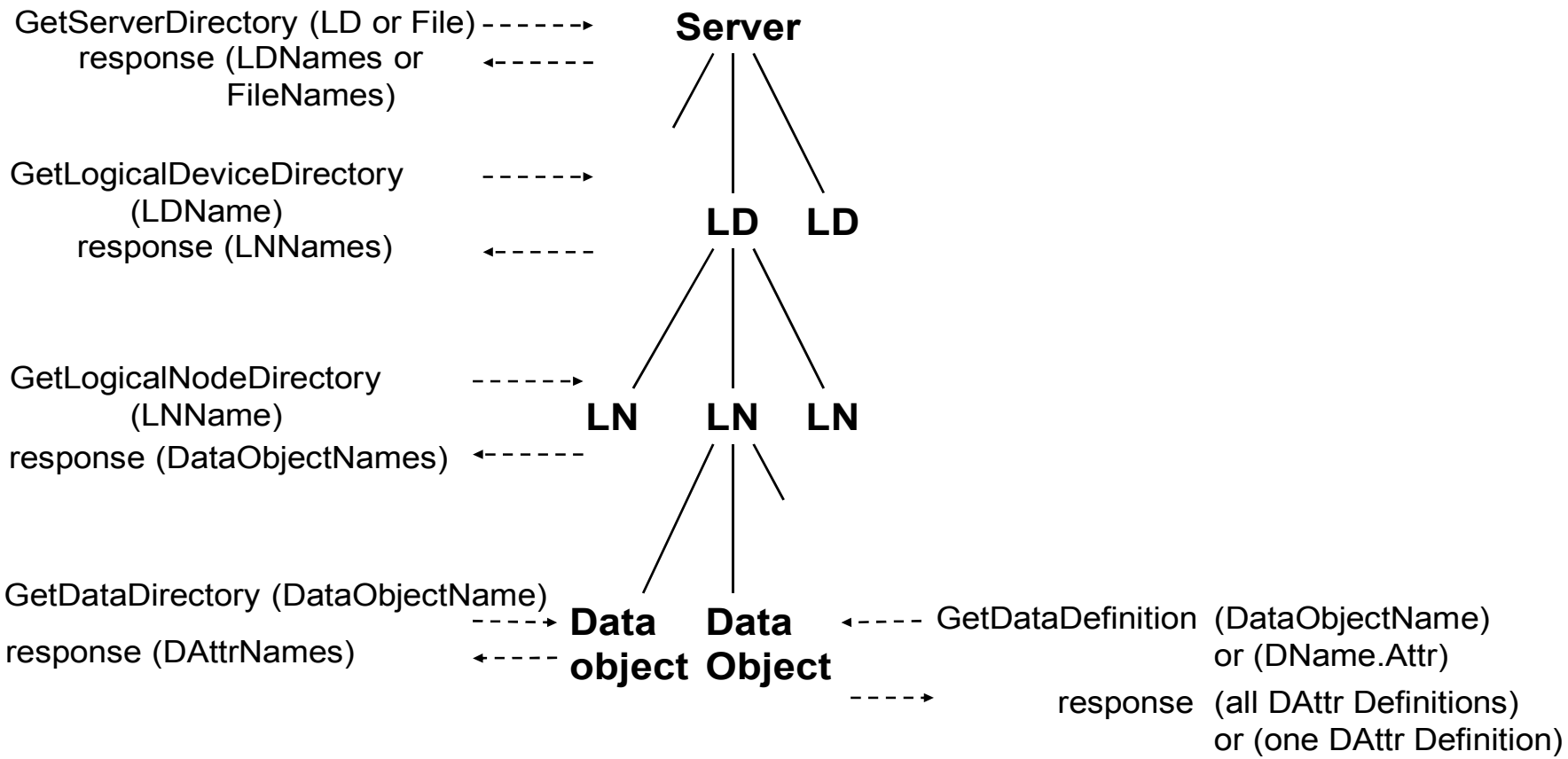
IEC 61850 – Informacijski model + ACSI servisi



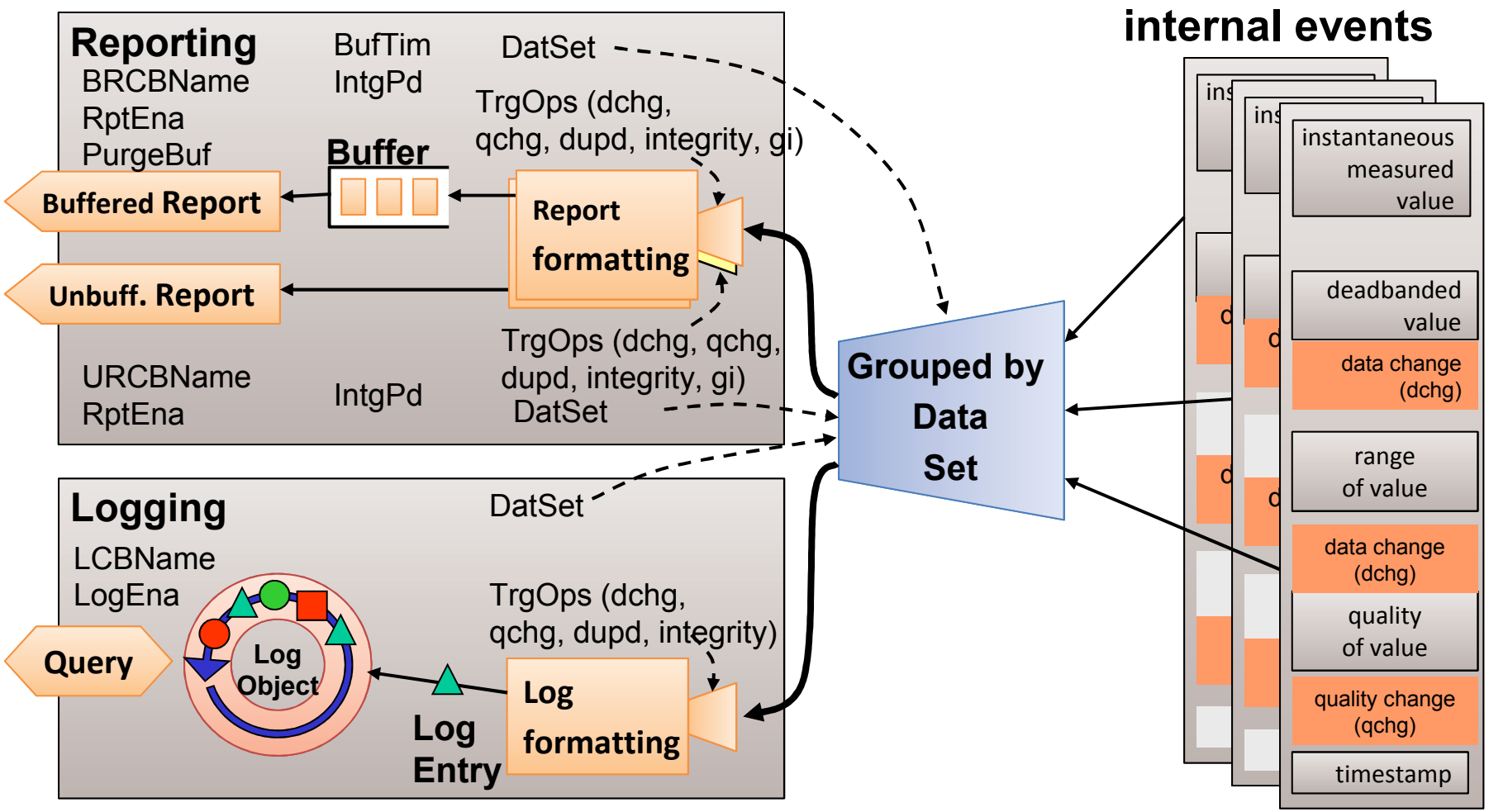
IEC 61850 – Informacijski model + ACSI servisi



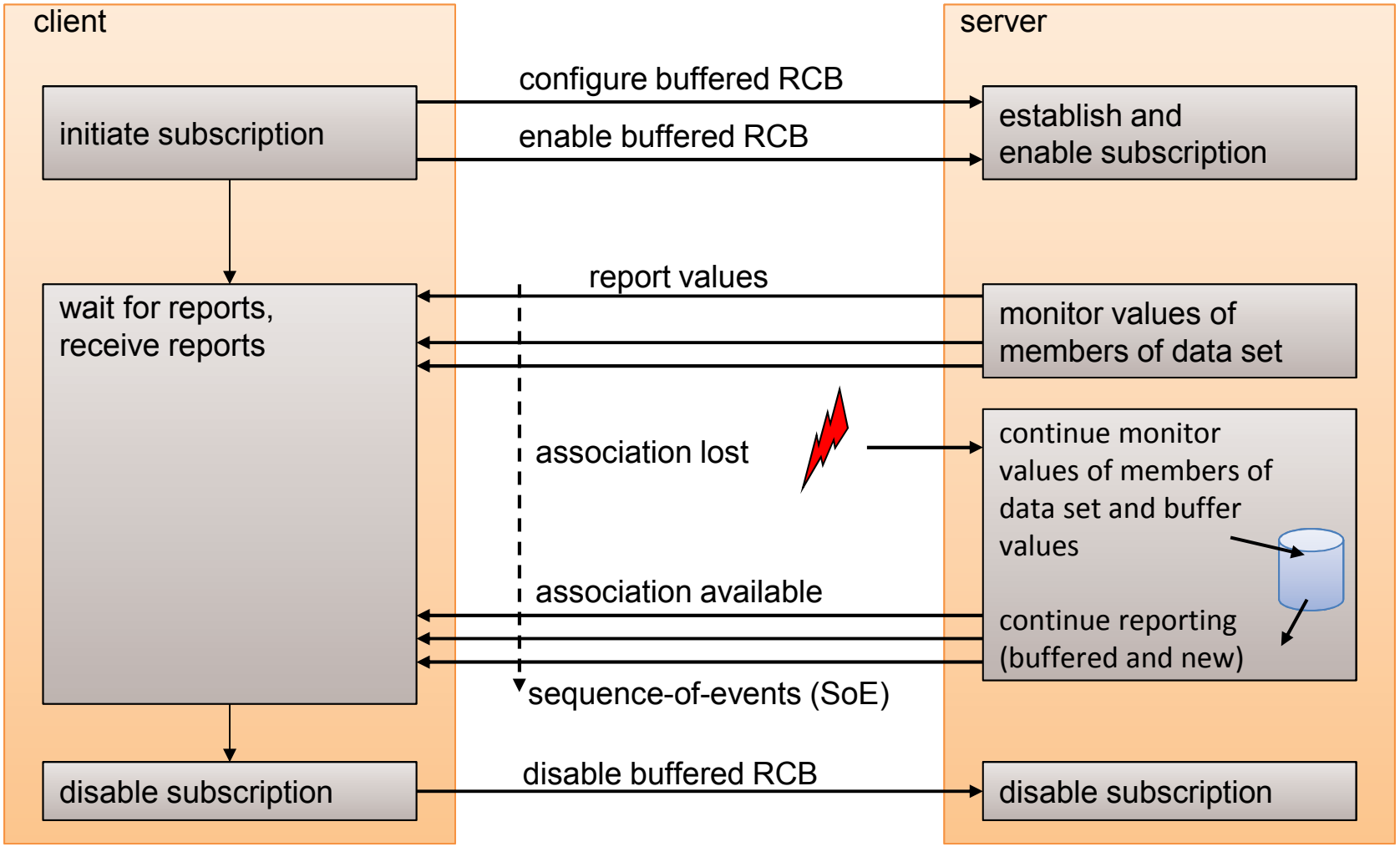
IEC 61850 – Pregled i upravljanje modelom



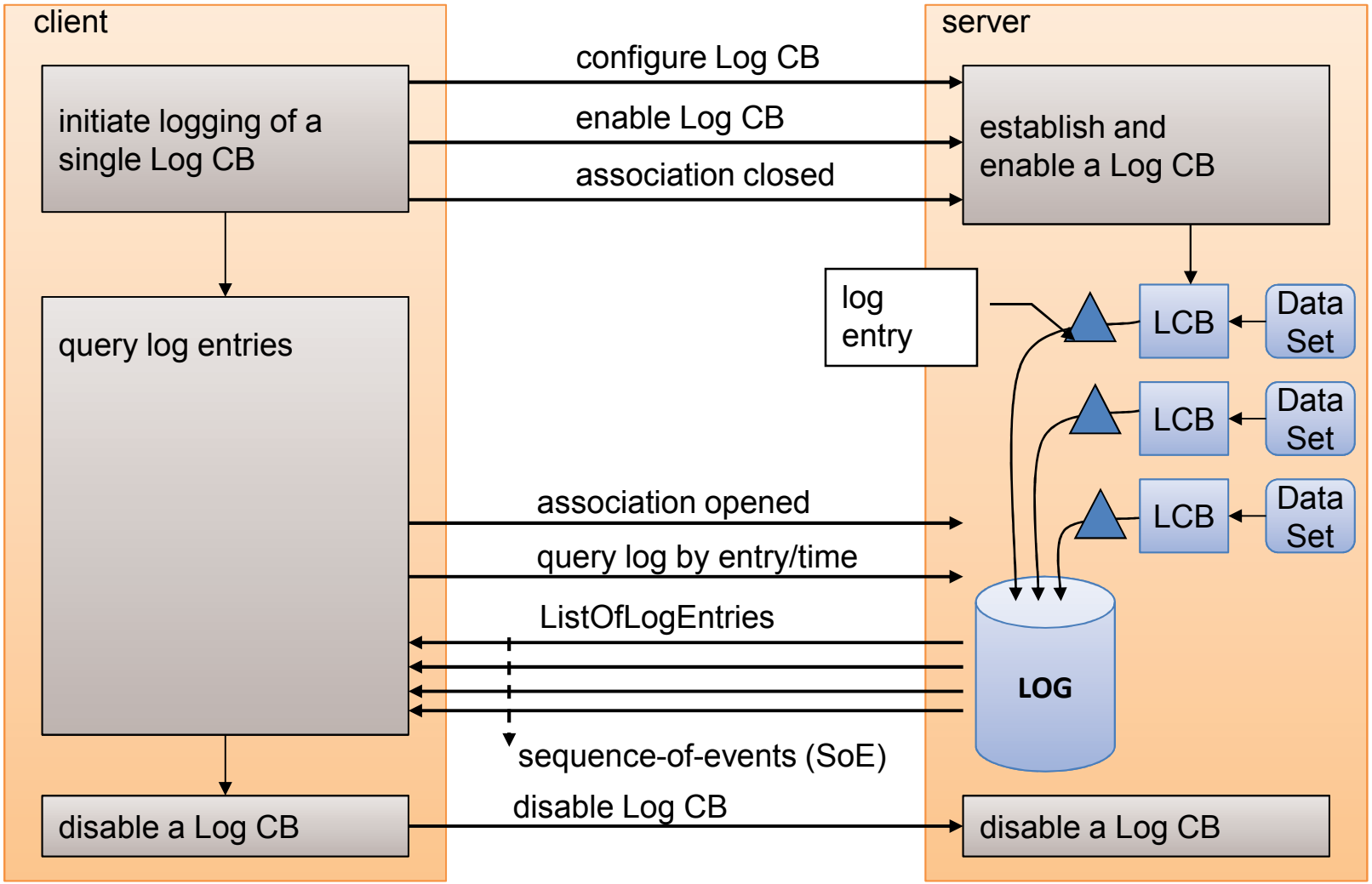
IEC 61850 – Reporting & Logging



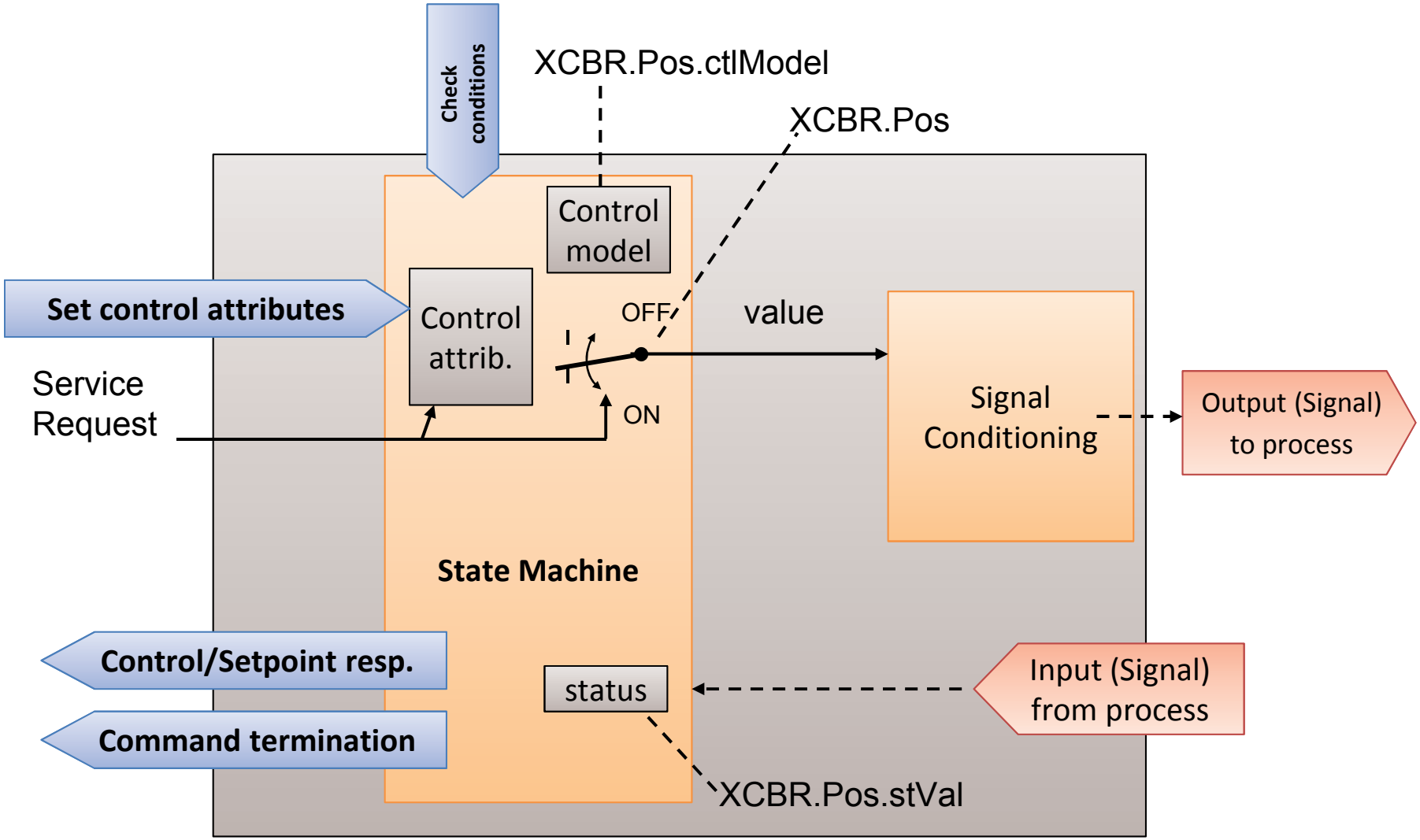
IEC 61850 – Reporting



IEC 61850 – Logging

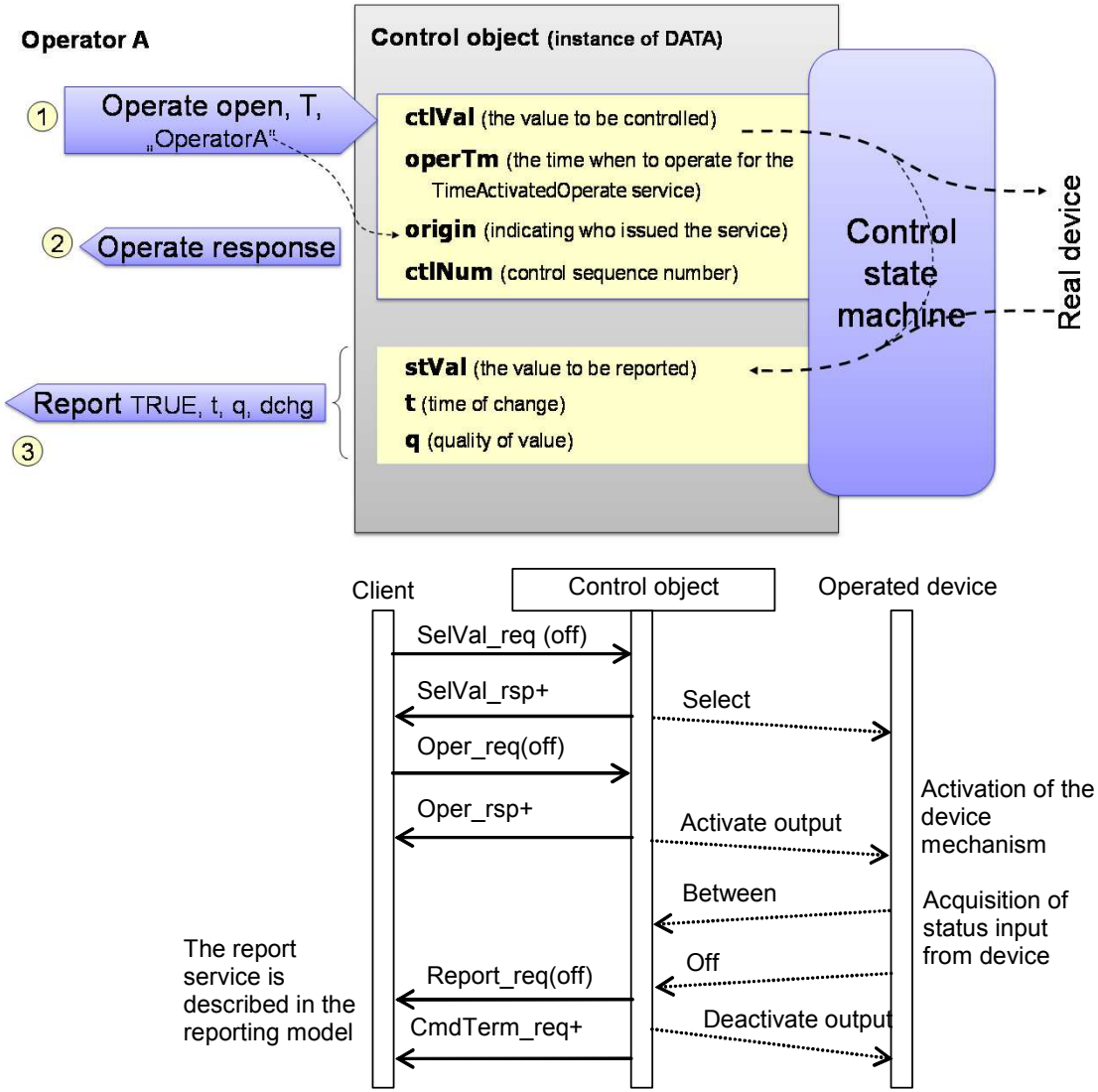


IEC 61850 – Upravljanje

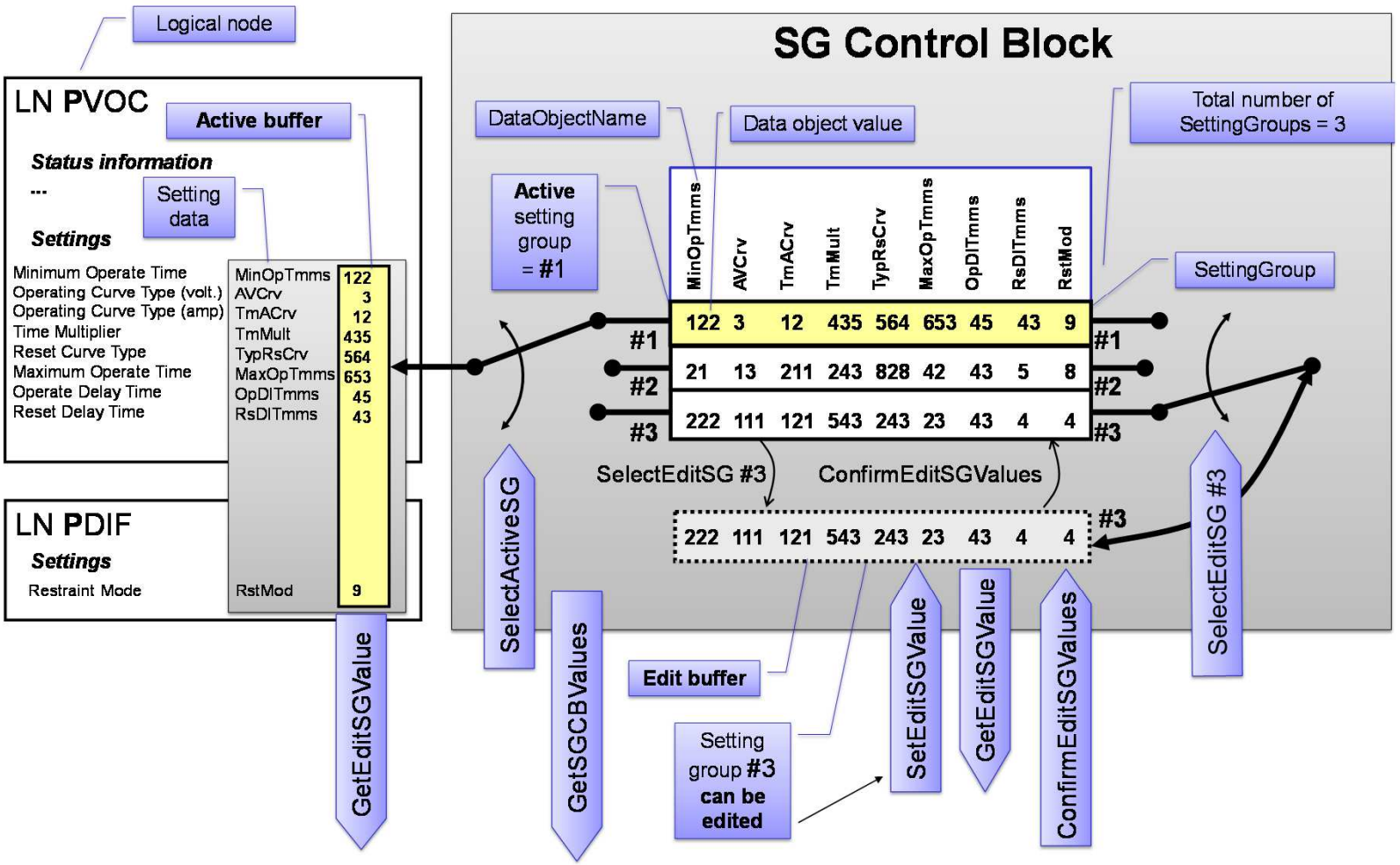


IEC 61850 – Upravljanje (detaljno)

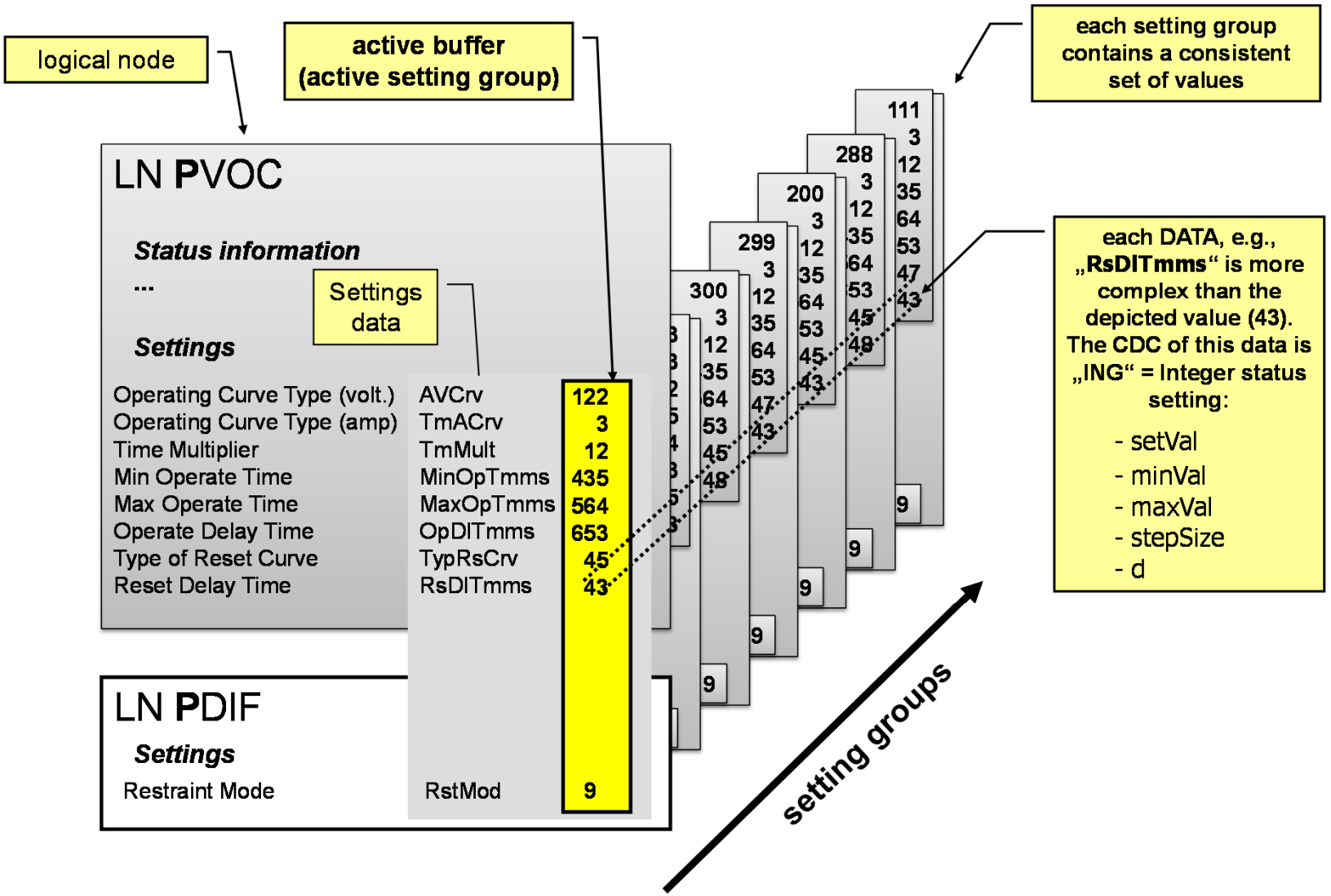
- Tipovi
- SBO / Security
- Složenosti
- Nadležnosti



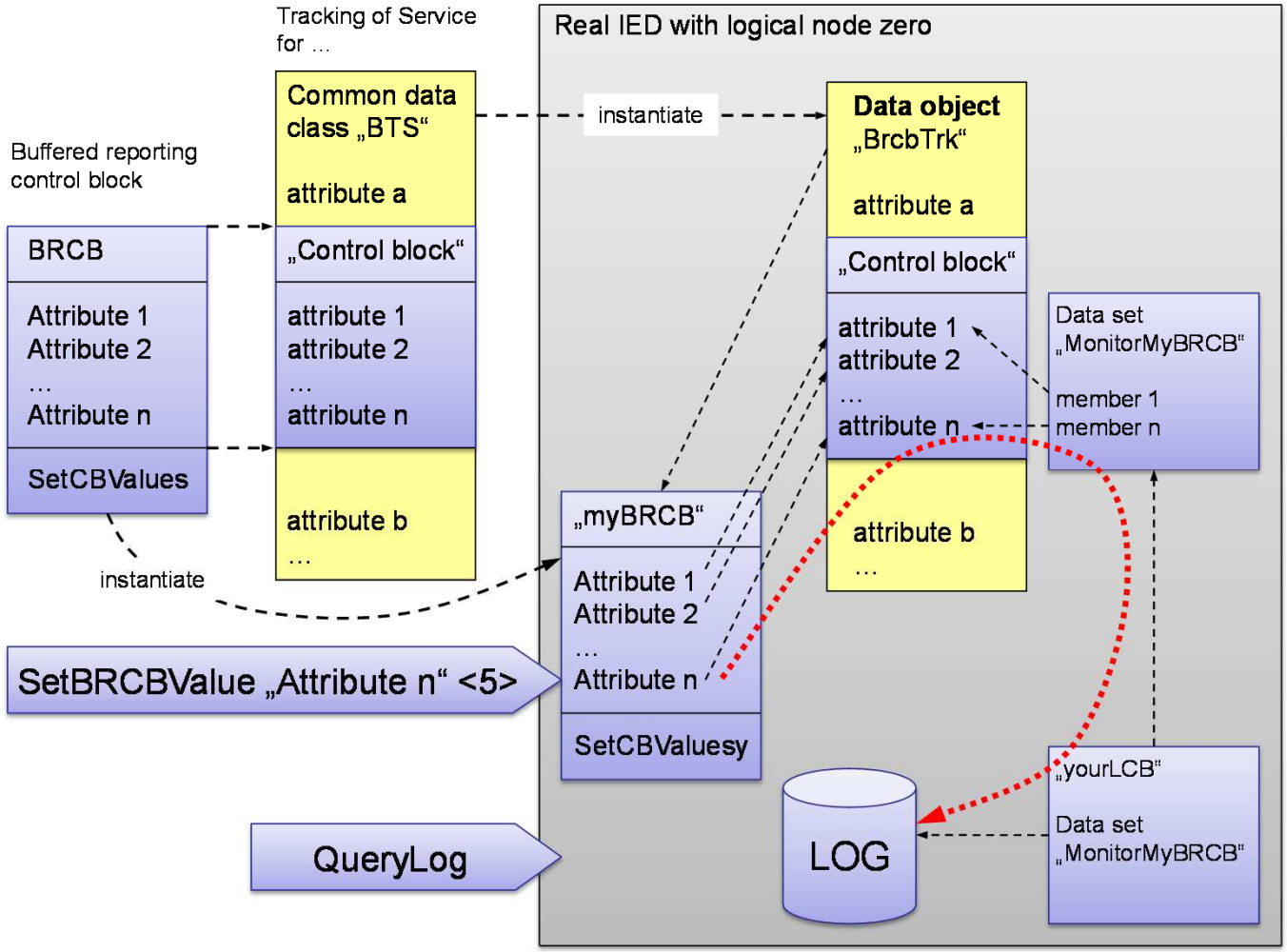
IEC 61850 – Postavne vrijednosti



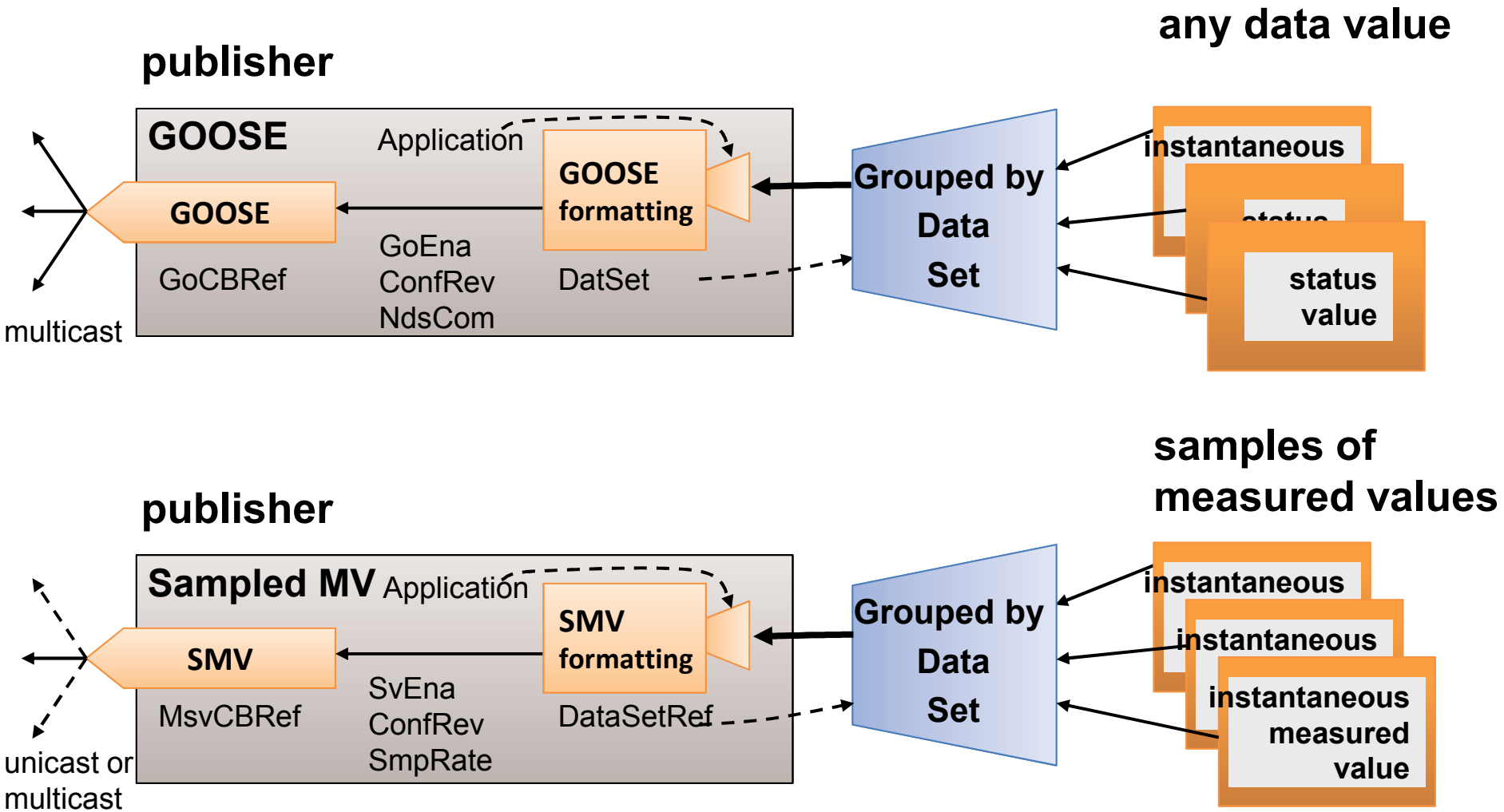
IEC 61850 – Postavne vrijednosti



IEC 61850 – Praćenje ACSI servisa

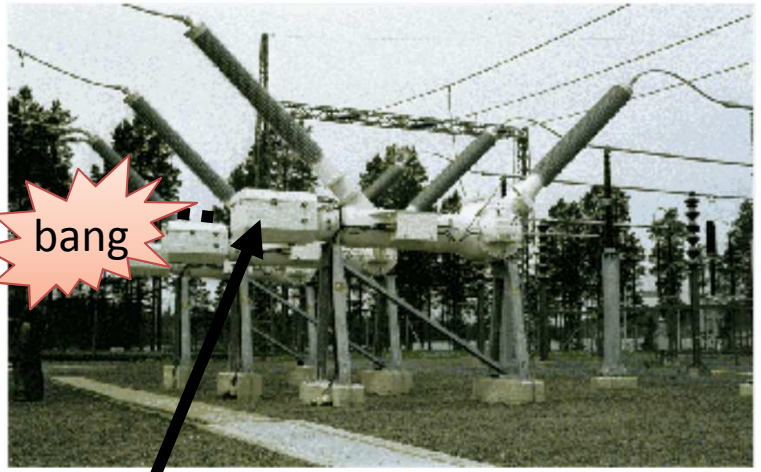


IEC 61850 – Horizontalna komunikacija



IEC 61850 – Uobičajena primjena

real devices



HMI computer

Command "Close"

Report (closed)

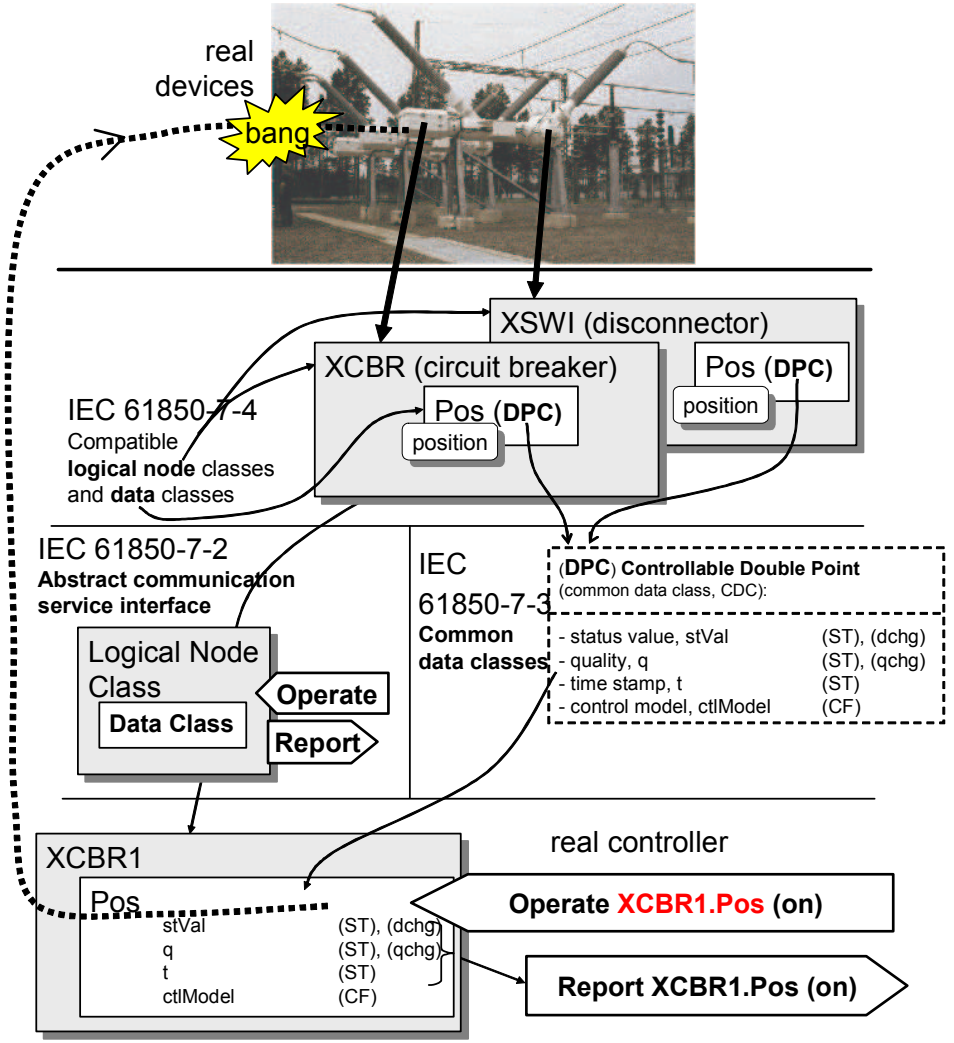
Network

Circuitbreaker1
- Position

model of circuit breaker in a real interface

IEC 61850 – Uobičajena primjena (detaljno)

- Odnos među dijelovima standarda
- Funkcionalnosti upravljanog sustava



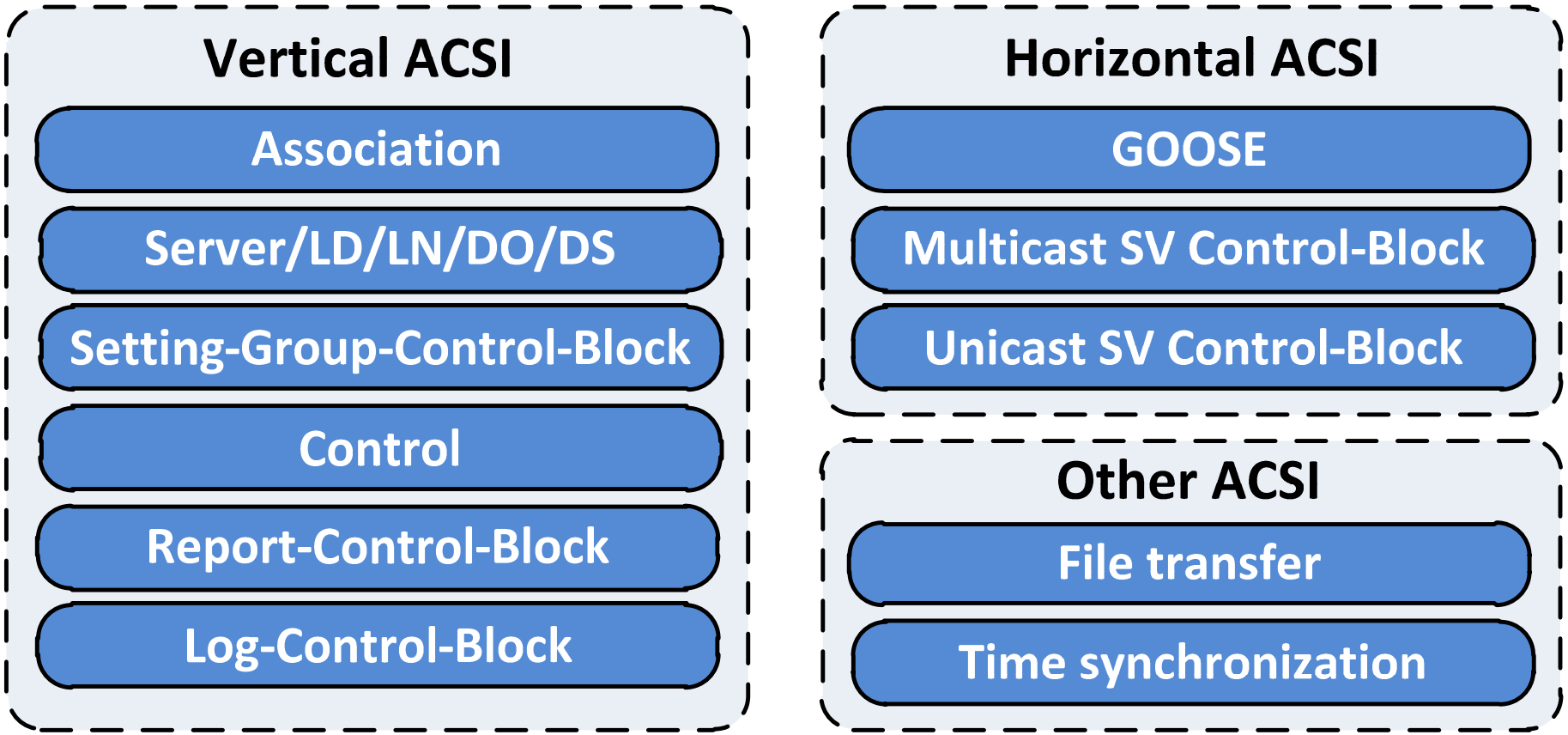
Usporedba metoda dohvata podataka

Retrieval method	Time-critical information exchange	Can lose changes (of sequence)	Multiple clients to receive information	Last change of data stored by	Typical client (but not exclusive)
Polling (GetDataValues)	NO	YES	YES	–	Browser
Unbuffered Reporting	YES	YES	NO	–	Real-time GUI
Buffered Reporting	YES	NO	NO	Server	Data concentrator
Log (used for SOE logging)	NO	NO	YES	Client	Engineering stations

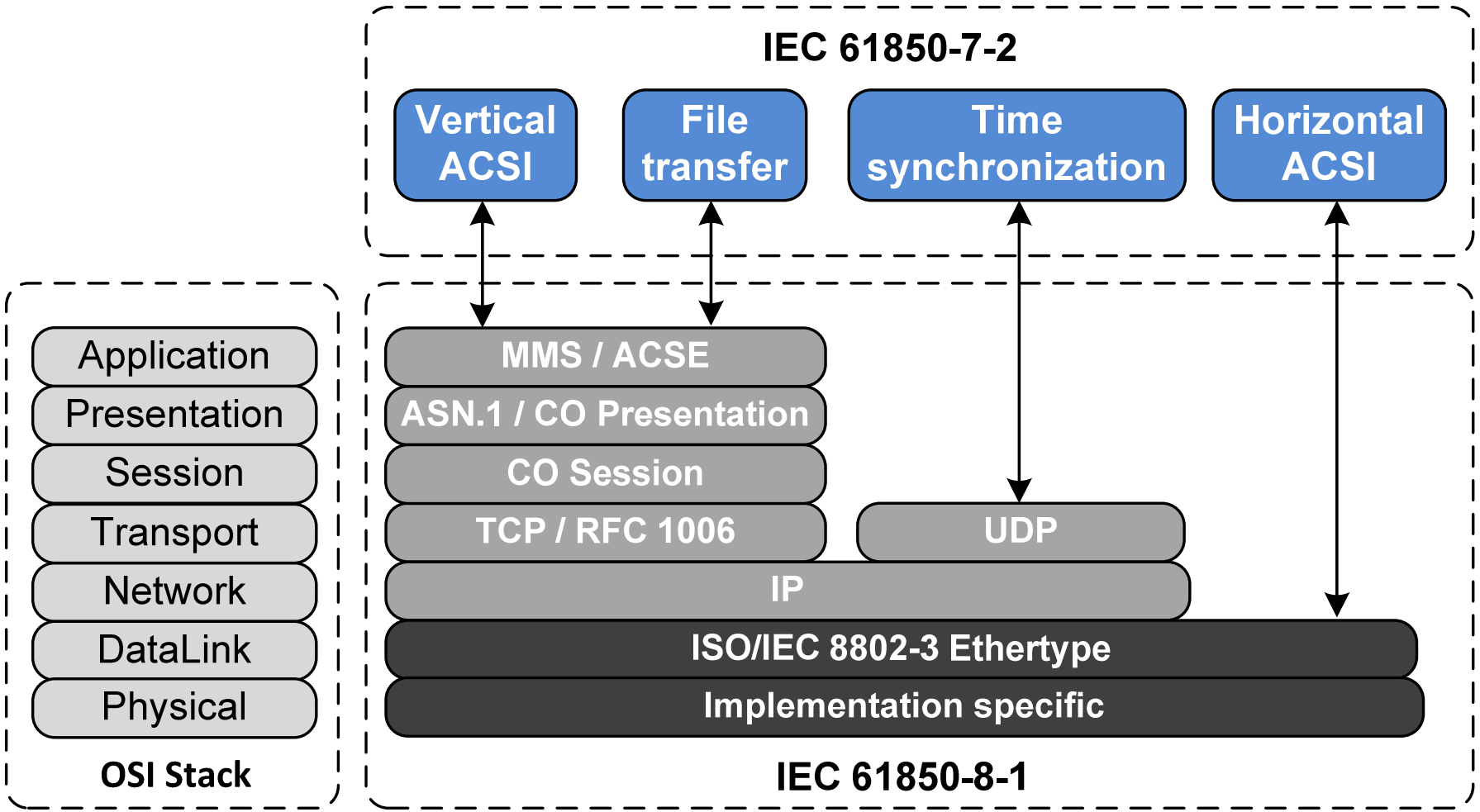
Sadržaj

1. Arhitektura
2. Arhitektura IEC 61850 sustava
3. Informacijsko modeliranje
4. Komunikacijski servisi
5. **Implementacijski zahtjevi**
6. Konfiguracija

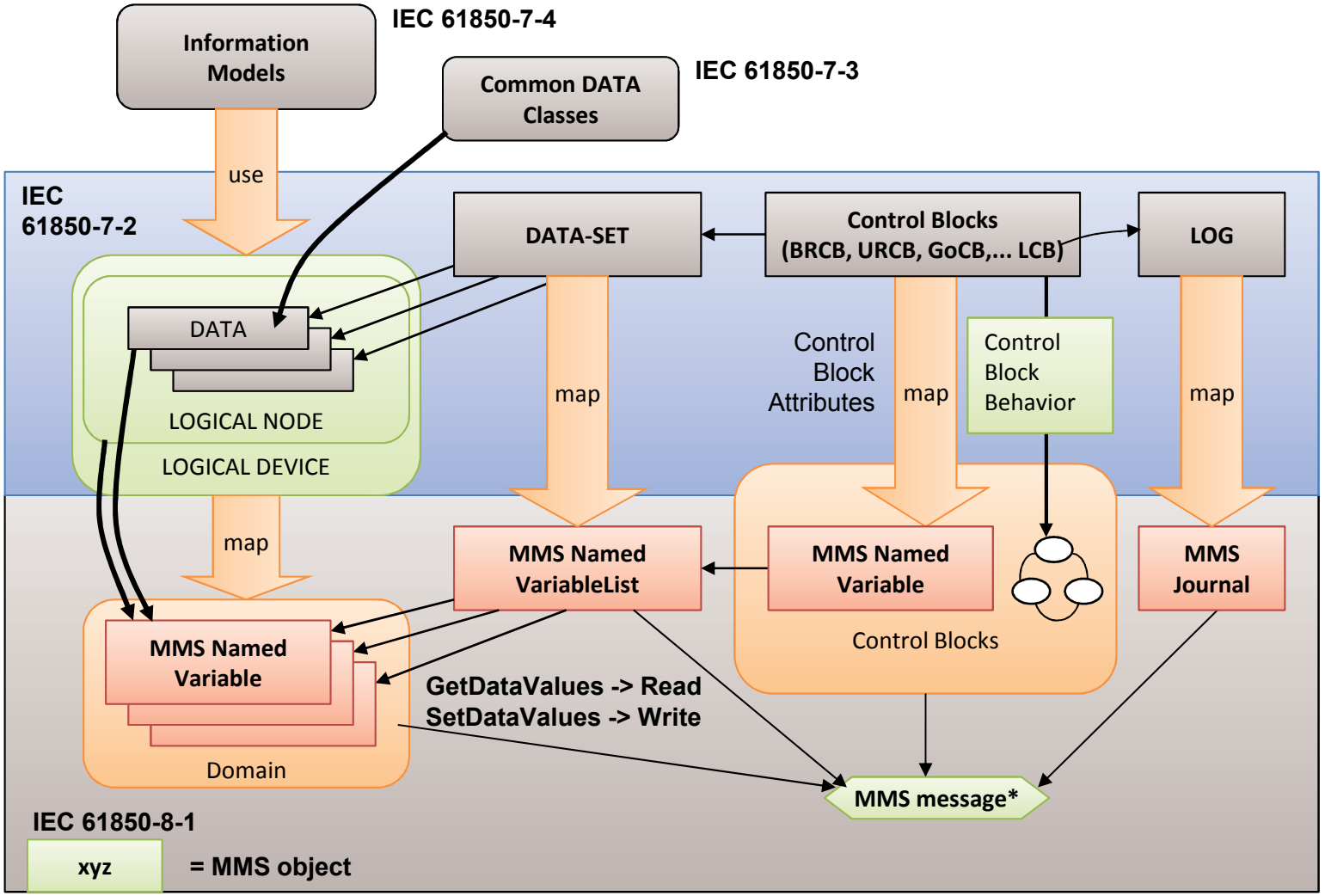
IEC 61850 – Implementacija



IEC 61850 – Implementacija



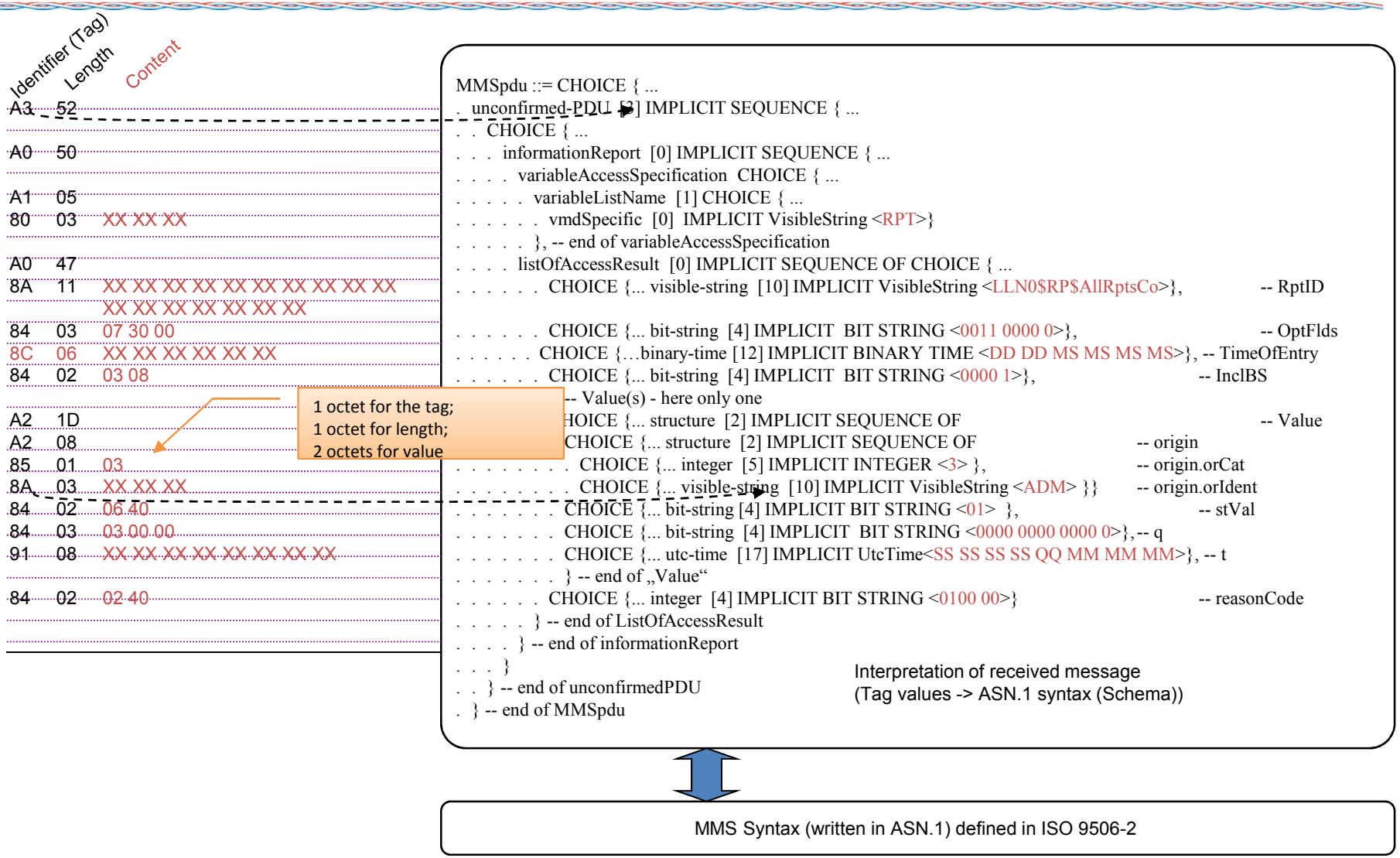
IEC 61850 – Implementacija (MMS)



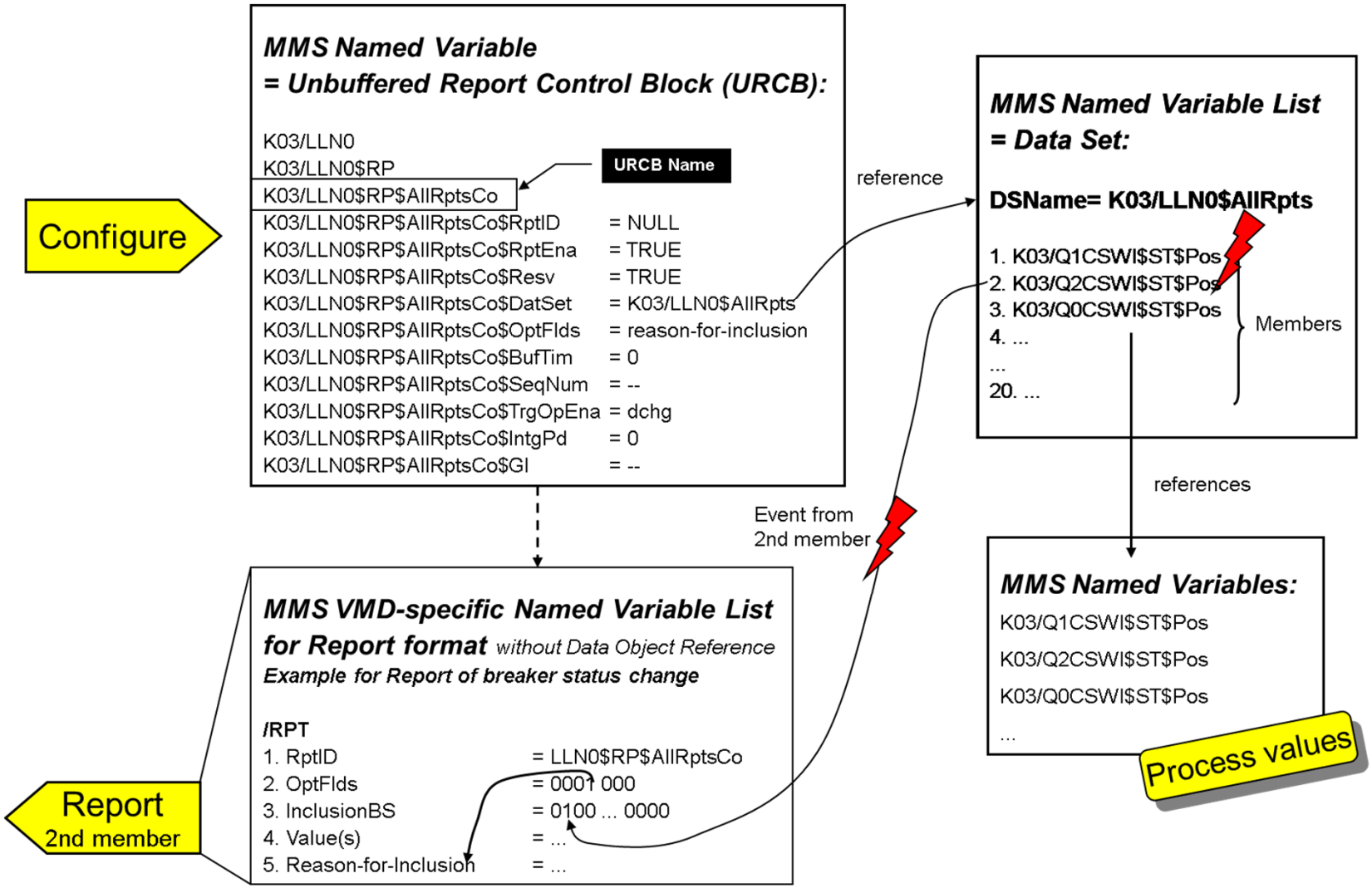
IEC 61850 – Implementacija (MMS)

What to be mapped?	Maps to
Logical device (contains logical nodes); IEC 61850-7-2	MMS domain
Logical nodes (contains data); IEC 61850-7-4	MMS named variable
Data; IEC 61850-7-4	MMS named variable (and structured components of the named variable representing the “logical node data”)
Data attribute; IEC 61850-7-3	MMS named variable (and structured components of the named variable representing the “data”)
Data set: IEC 61850-7-2	MMS named variable list
Control blocks (attributes); IEC 61850-7-2	MMS named variable
Control blocks (behaviour); IEC 61850-7-2	Needs to be programmed as defined in IEC 61850-7-2
Log; IEC 61850-7-2	MMS journal

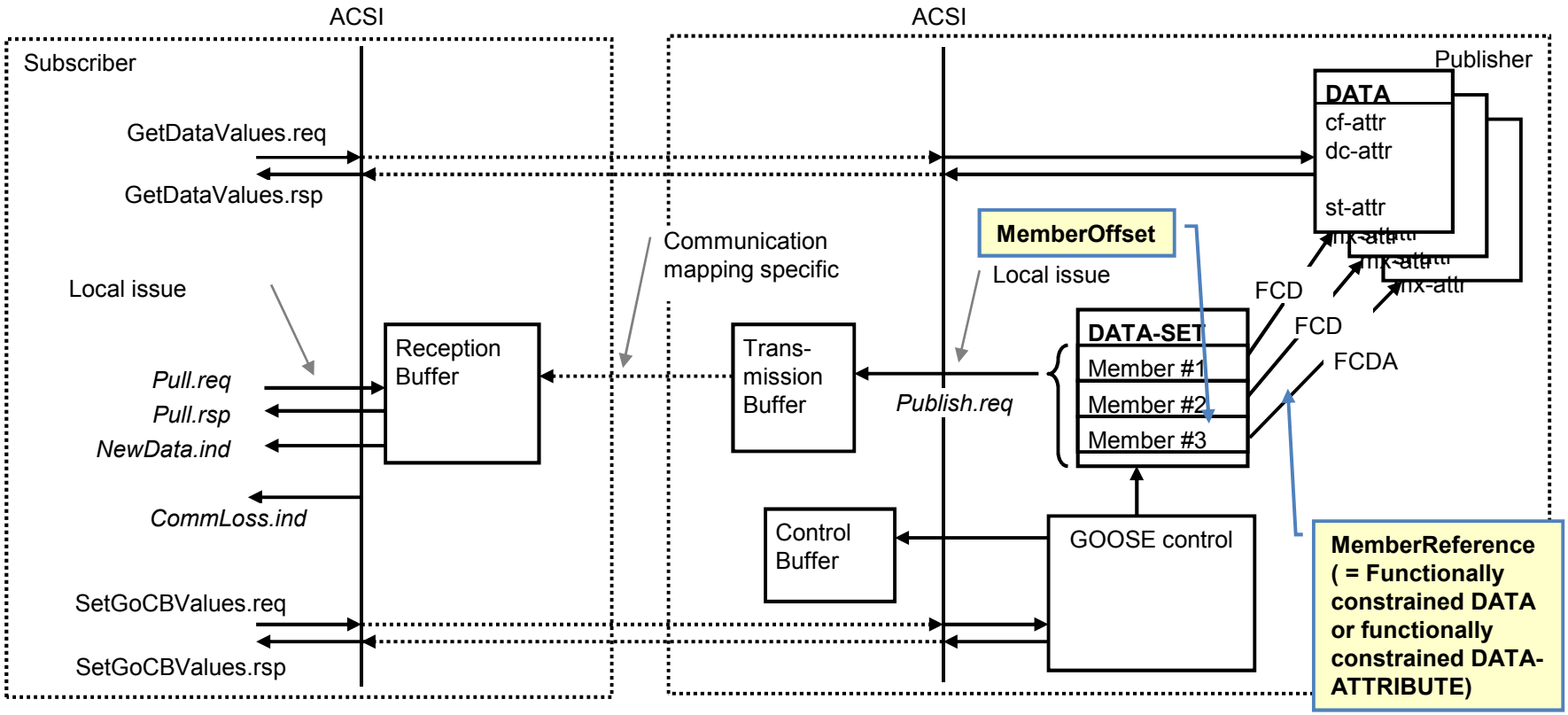
IEC 61850 – Implementacija (MMS)



IEC 61850 – Implementacija (MMS)

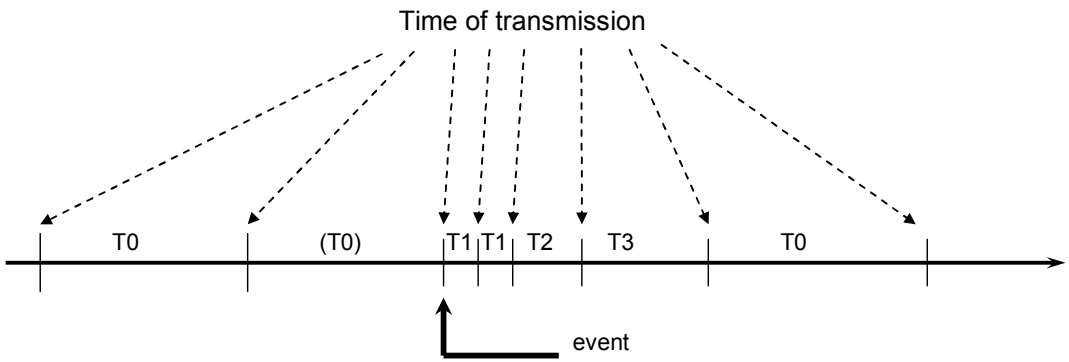


IEC 61850 – Implementacija (GOOSE)

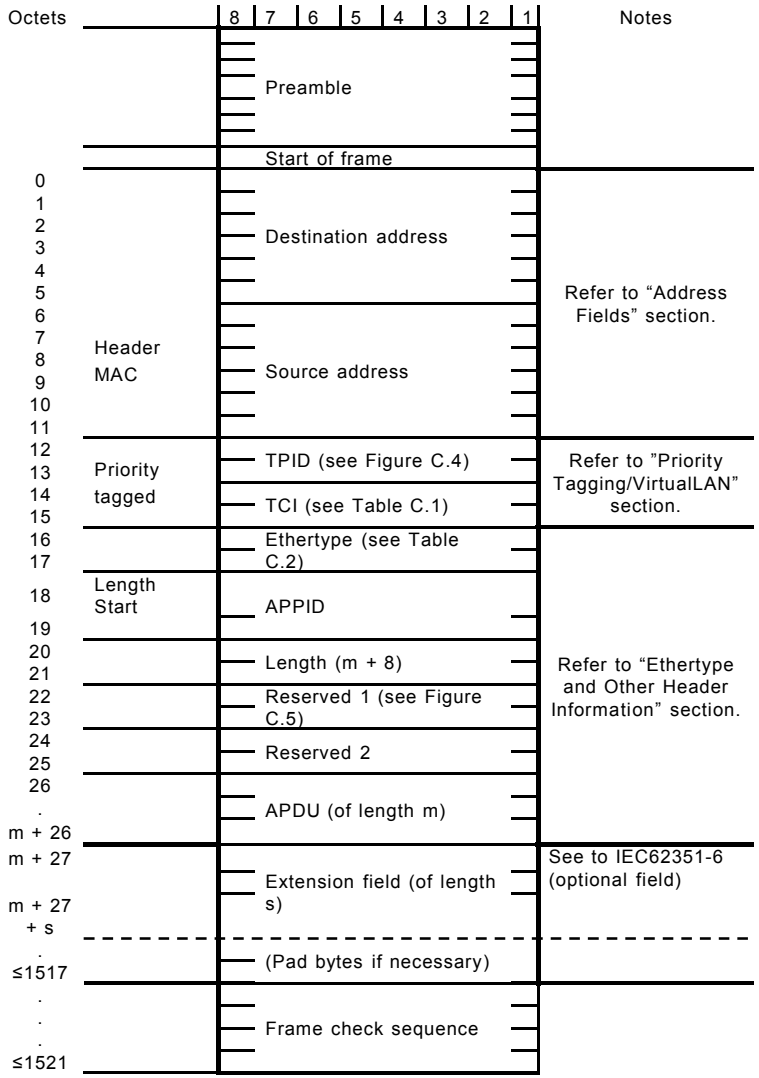


IEC 61850 – Implementacija (GOOSE)

- Multicast
- Publish/subscribe
- Cikličko slanje

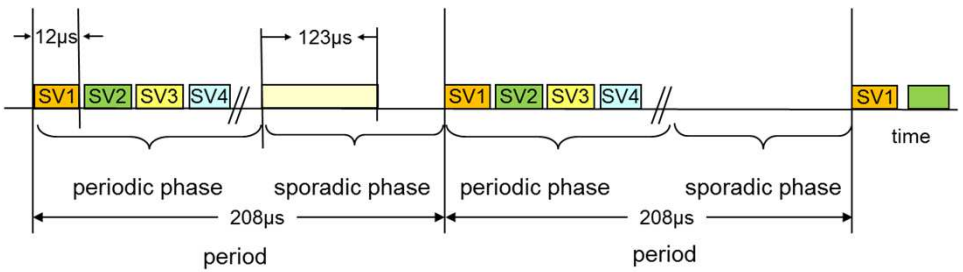


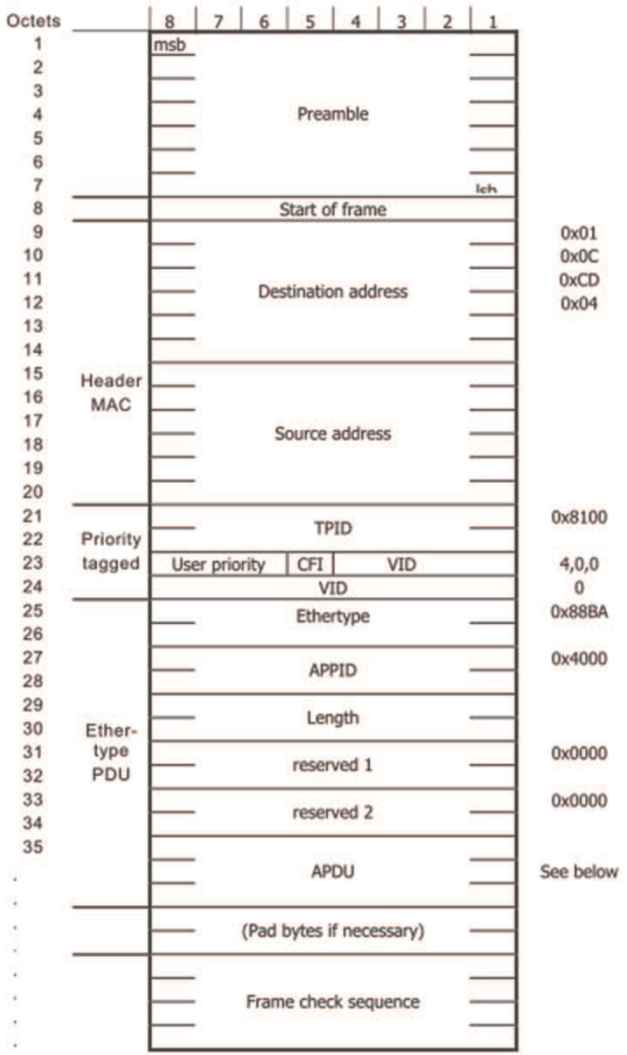
T0	retransmission in stable conditions (no event for a long time).
(T0)	retransmission in stable conditions may be shortened by an event.
T1	shortest retransmission time after the event.
T2, T3	retransmission times until achieving the stable conditions time.



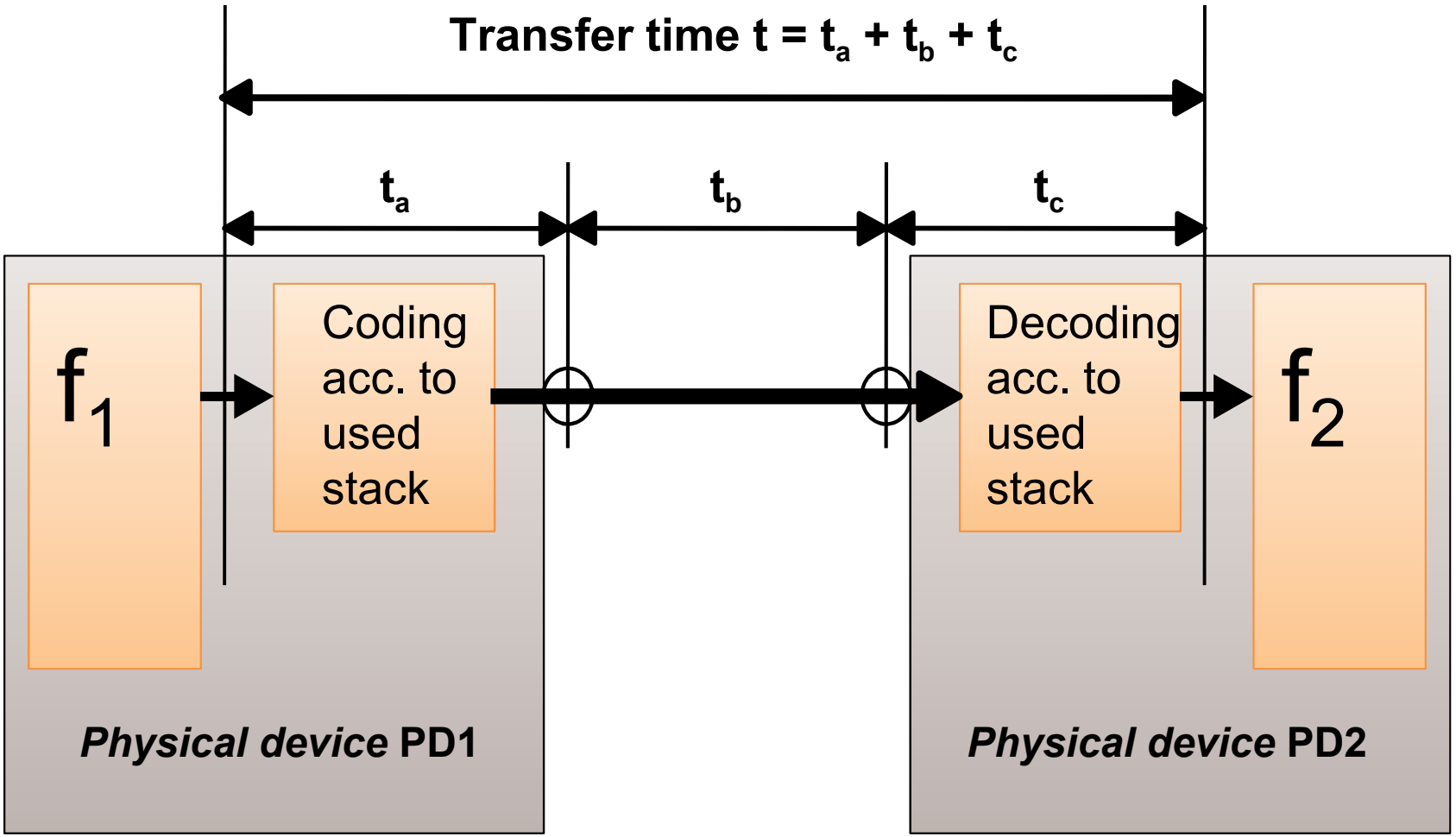
IEC 61850 – Implementacija (SMV)

- 4800 Hz za zaštitne funkcije
- 14400 Hz za mjerenje kvalitete eklektične mreže
- Multicast
- Publish/subscribe
- Cikličko slanje





IEC 61850 – Vremena dostave poruka



IEC 61850 – Vremenske klase poruka

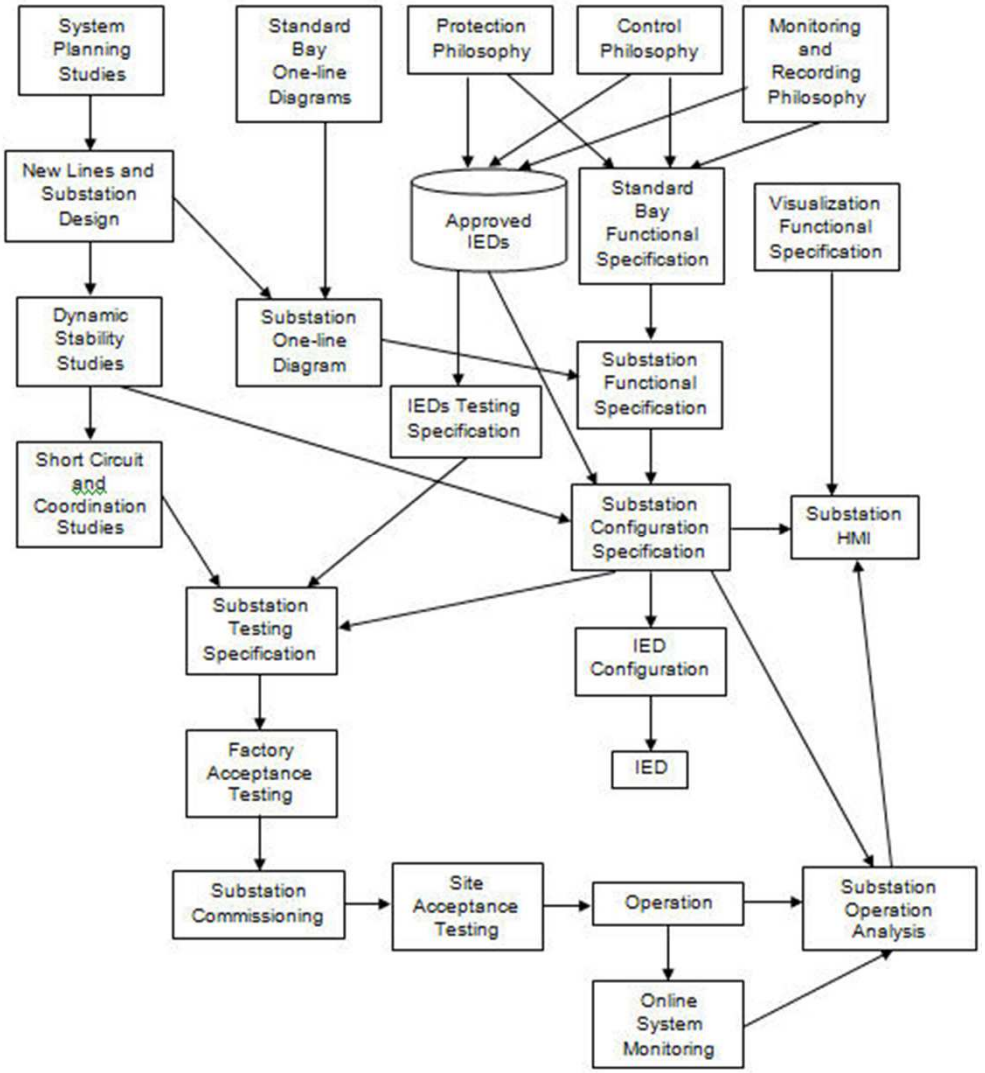
Transfer time class	Transfer time [ms]	Application examples: Transfer of
TT0	>1 000	Files, events, log contents
TT1	1 000	Events, alarms
TT2	500	Operator commands
TT3	100	Slow automatic interactions
TT4	20	Fast automatic interactions
TT5	10	Releases, Status changes
TT6	3	Trips, Blockings

Sadržaj

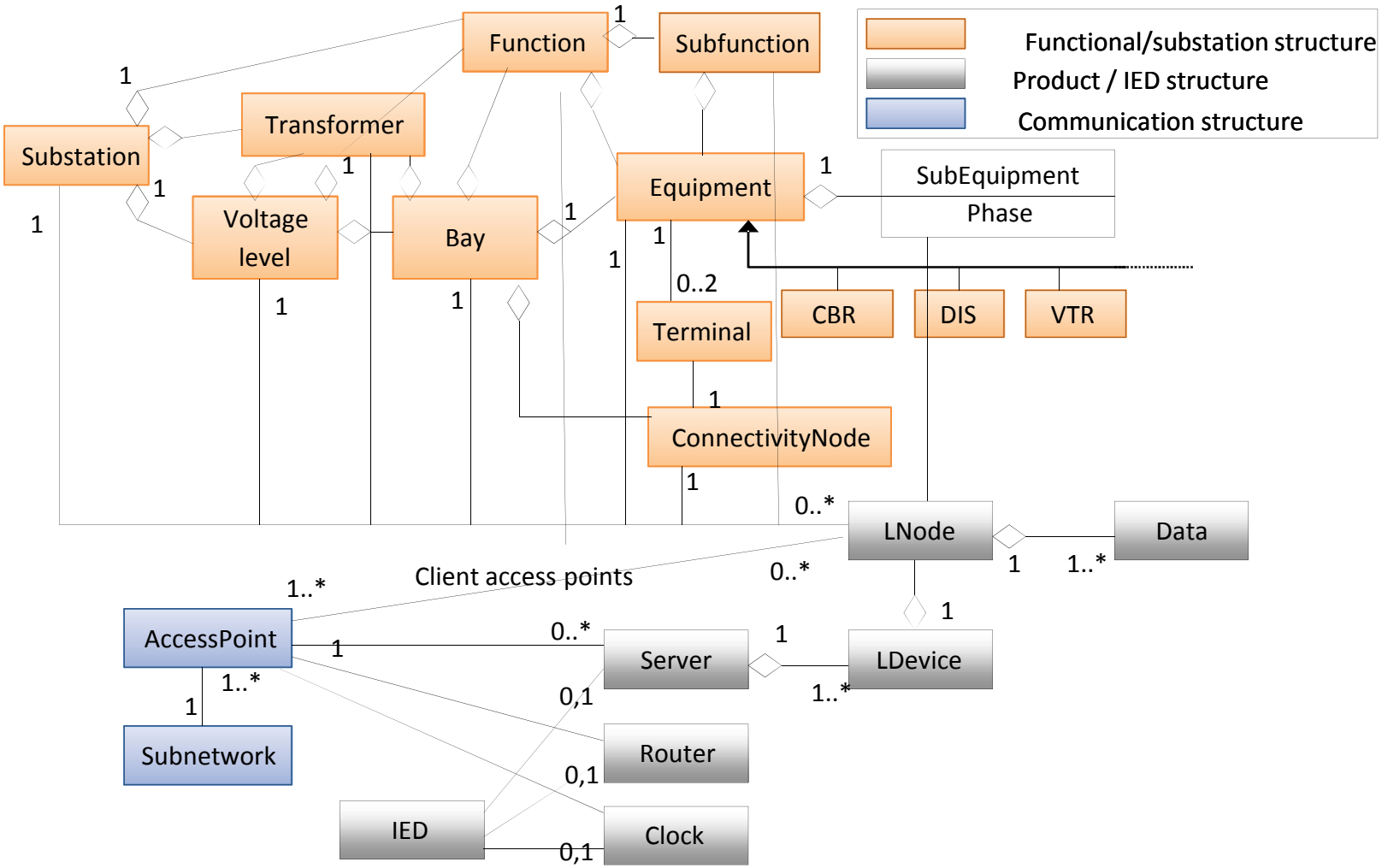
1. Arhitektura
2. Arhitektura IEC 61850 sustava
3. Informacijsko modeliranje
4. Komunikacijski servisi
5. Implementacijski zahtjevi
6. **Konfiguracija**

IEC 61850 – Inženjering sustava

- Planiranje postrojenja
- Studija stabilnosti
- Proračuni TS i KS
- Jednopolna shema
- Naručivanje opreme
- Provjera izvodljivosti
- Konfiguracija
- FAT
- SAT
- Analiza rada sustava



IEC 61850-6 – Model sustava



IEC 61850-6 – SCL

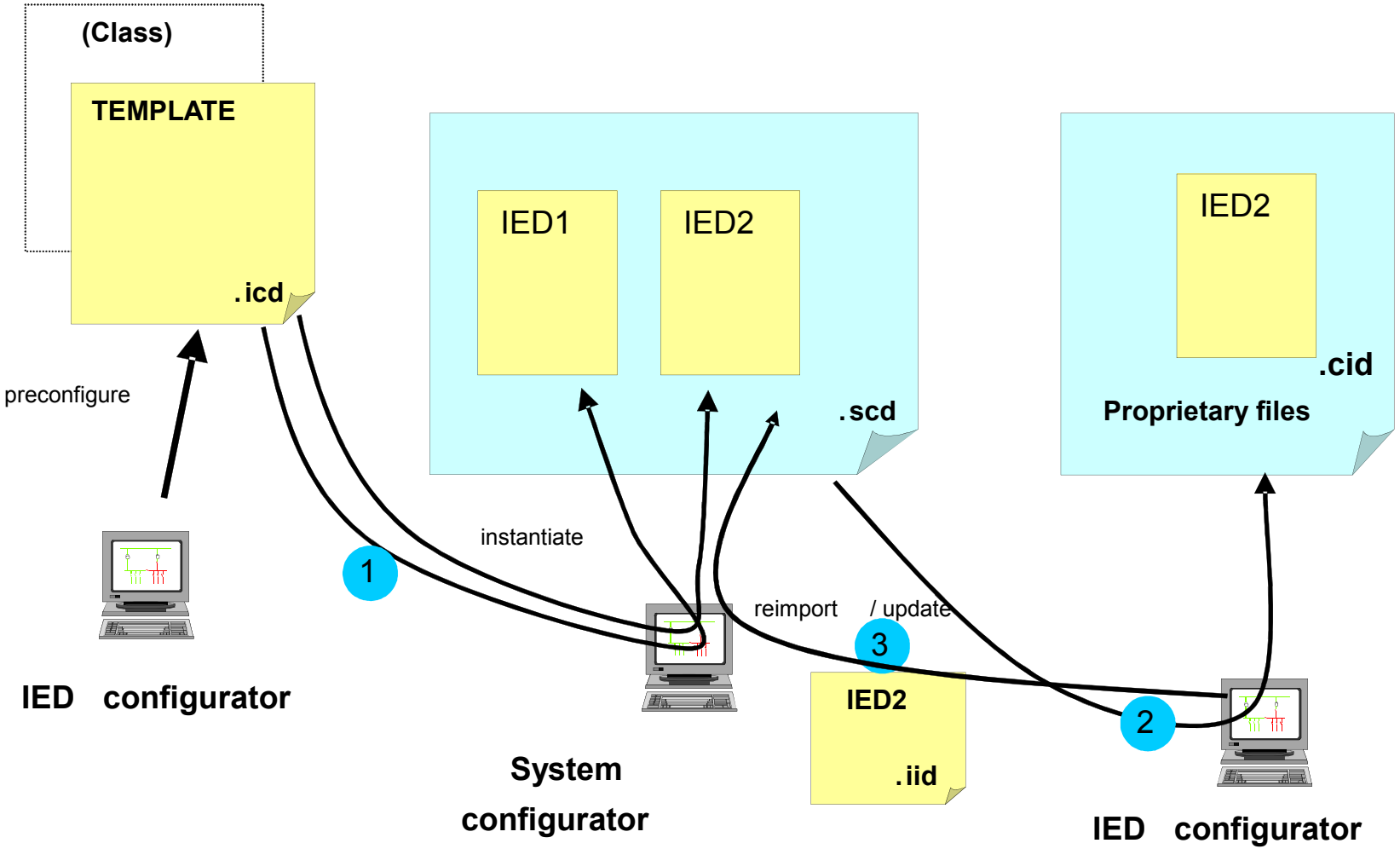
- XML (eXtensible Markup Language) -> Notacija
- IED (Intelligent Electronic Device) -> Relej, upravljački uređaj
- SCL (System Configuration description Language) -> Jezik
  - SSD (System Specification Description) -> Sučelja opreme
  - ICD (IED Capability Description) -> Mogućnosti uređaja
  - IID (Instantiated IED Description) -> Trenutna konfiguracija
  - CID (Configured IED Description) -> Konačna konfiguracija
  - SCD (System Configuration Description) -> Konačna konfiguracija
  - SED (System Exchange Description) -> Sučelja za proširenja

IEC 61850-6 – Odnos među SCL dokumentima

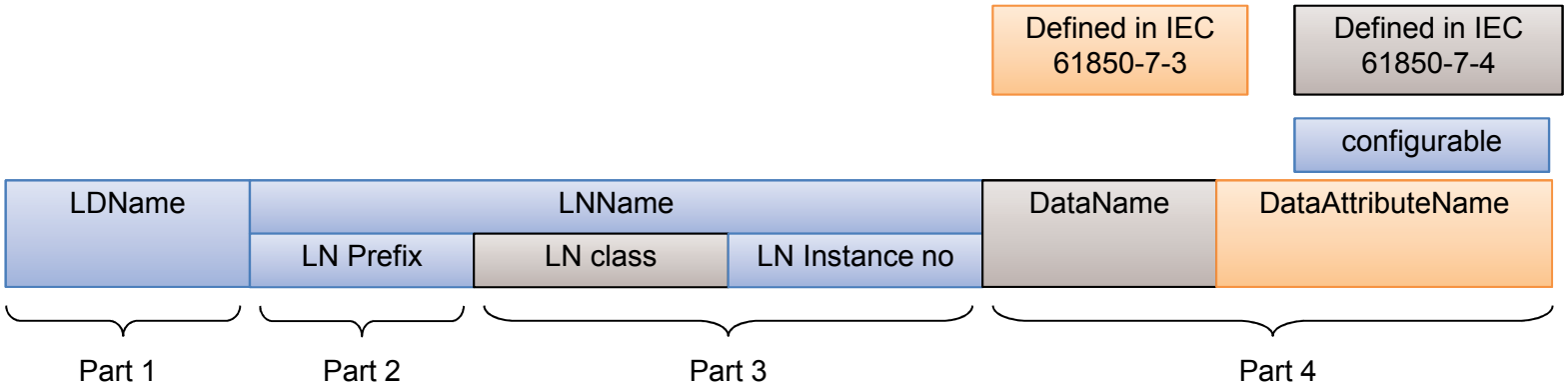
	Phase	Bay	PAC Devices	Plant Application / Substation	What it means
A	Standard scheme – template	G	G	G	Totally generic **SSD**
B	Standard scheme – defined	S	G	G	All HW interfaces fixed **SSD**
C	Standard scheme – applied	S	S	G	IEDs fixed **ICD**, **IID**
D	Standard scheme: Instantiated Instantiated with small variations	S	S	S	Everything fixed, also settings (standard scheme applied in reality) **SCD**, **CID**

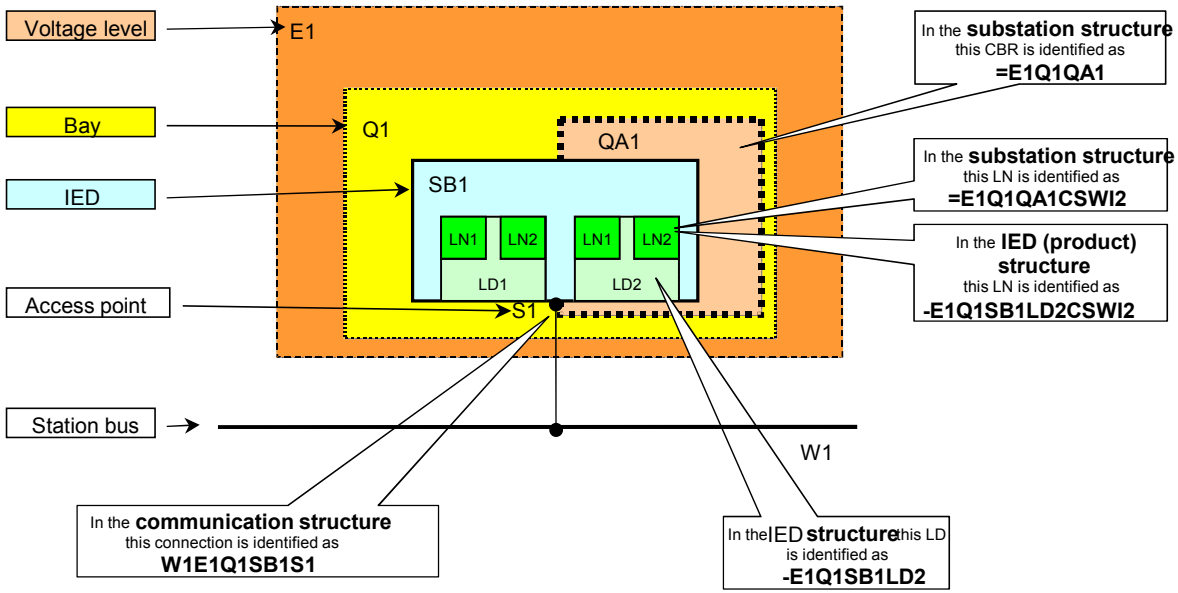
S = specific; G = generic; B and C can be one step.

IEC 61850-6 – Uređivanje datoteka

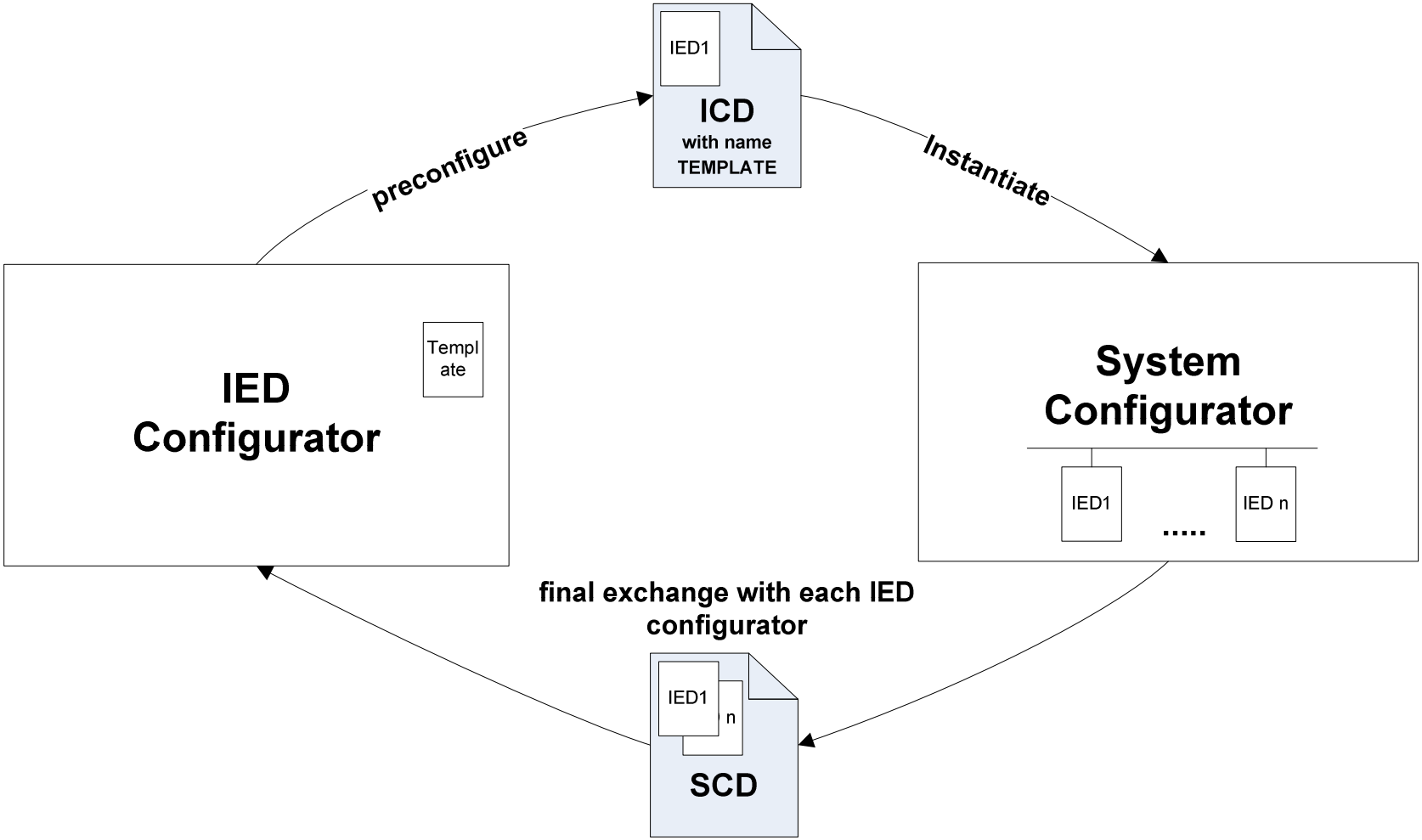


IEC 61850-6 – Identifikacija signala

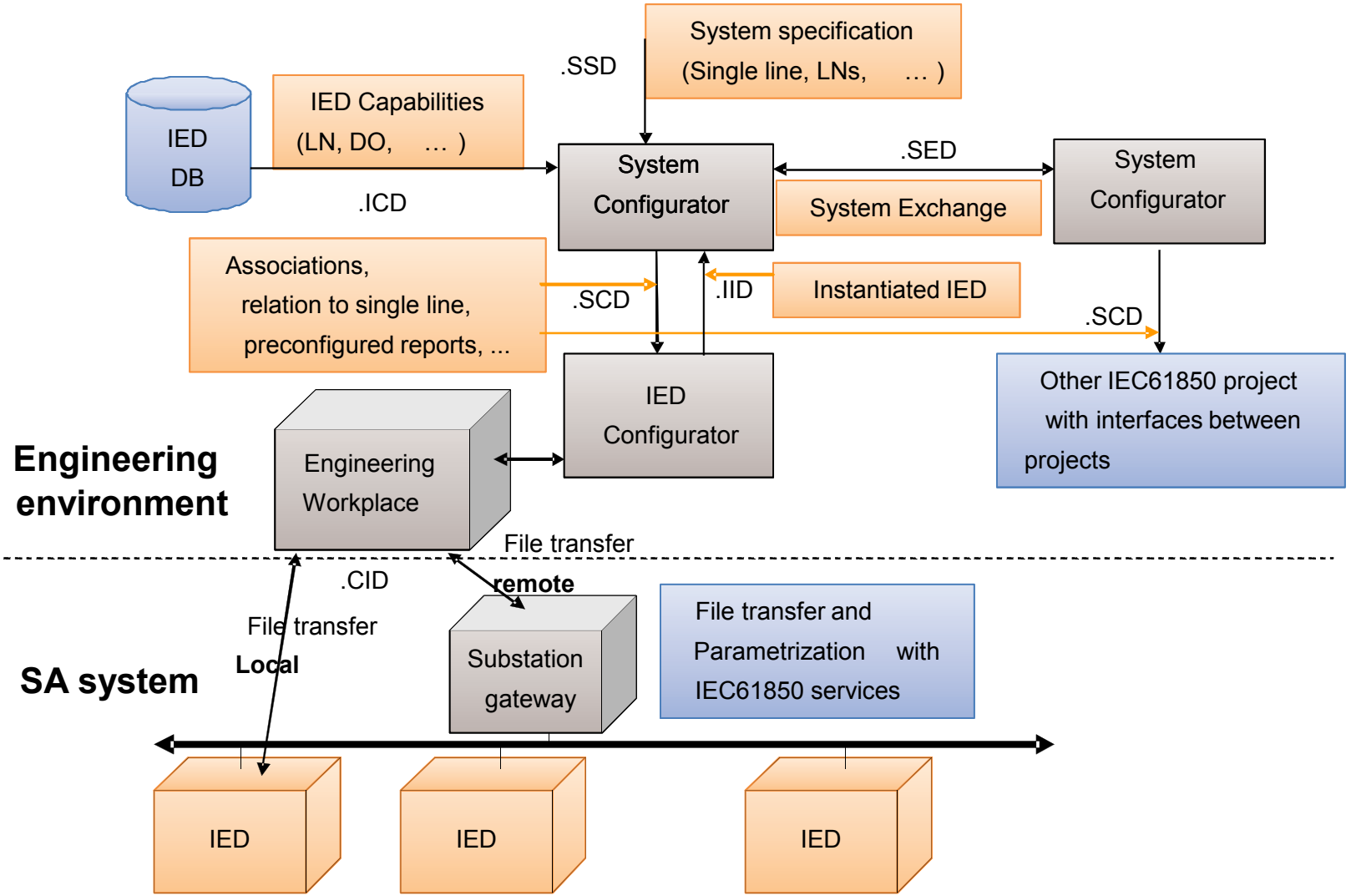




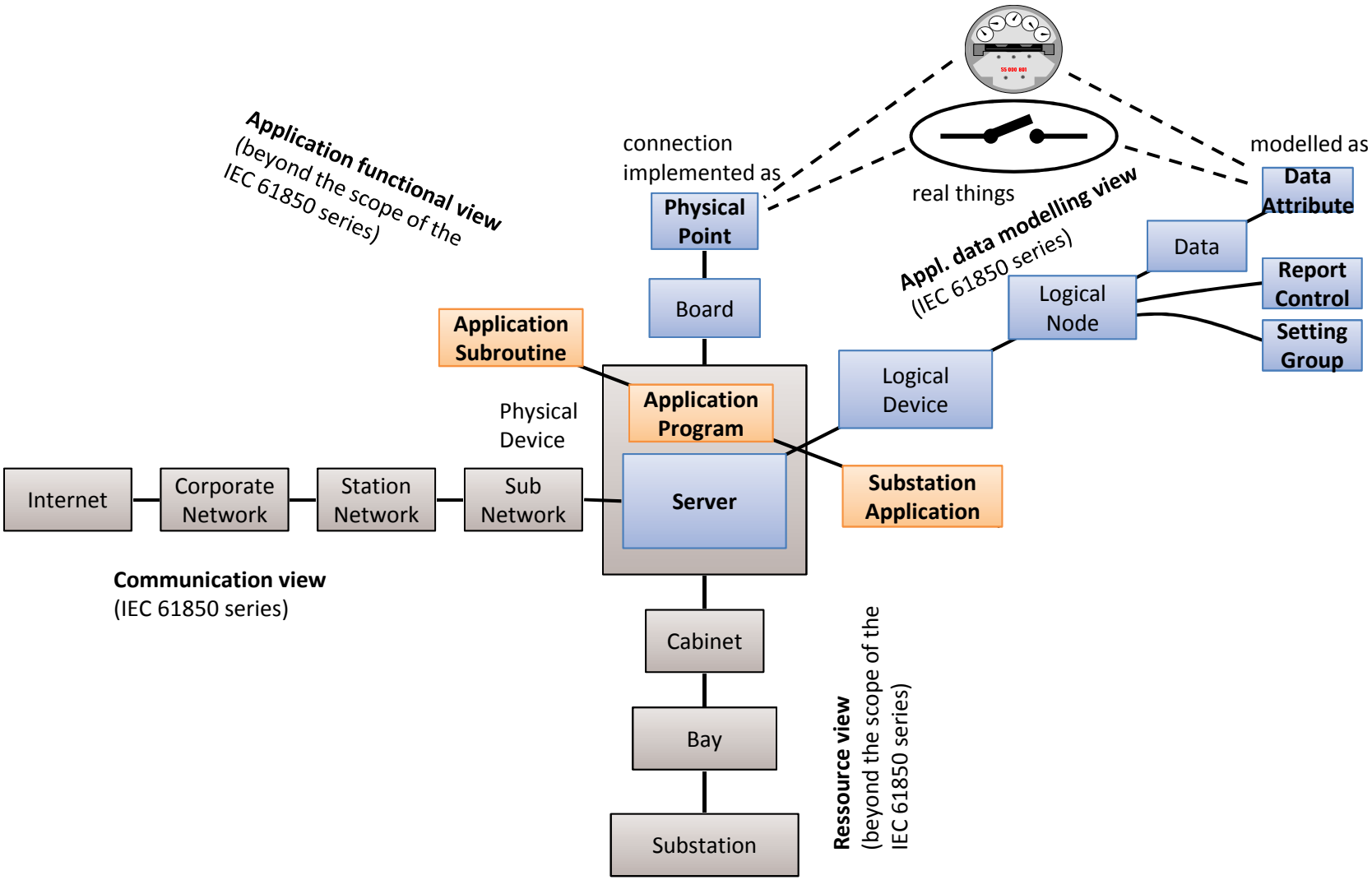
IEC 61850-6 – Konfiguracijski ciklus



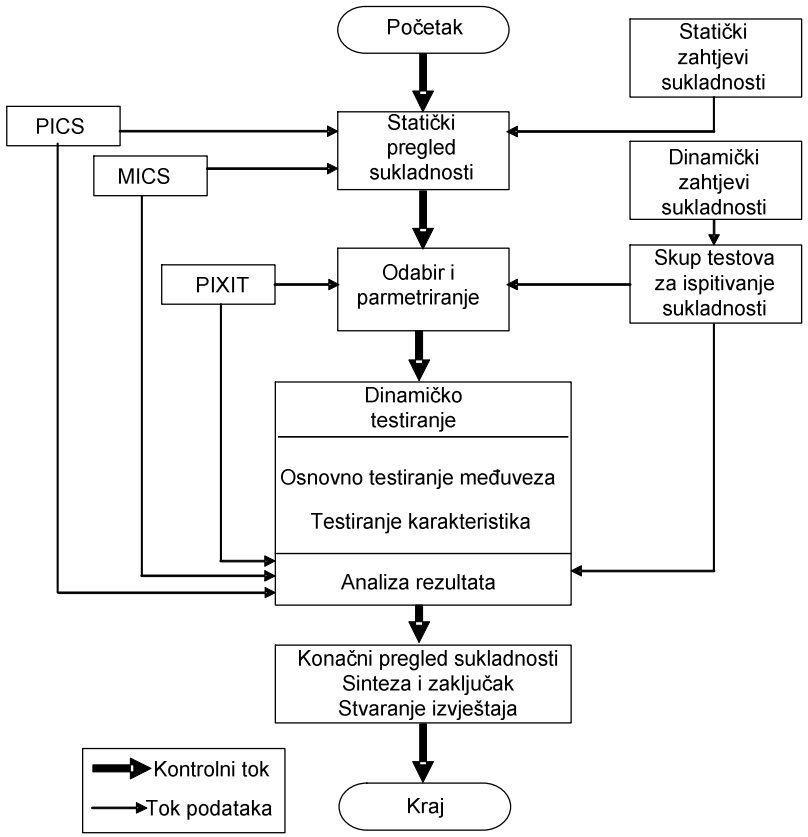
IEC 61850 – Rad sa SCL datotekama

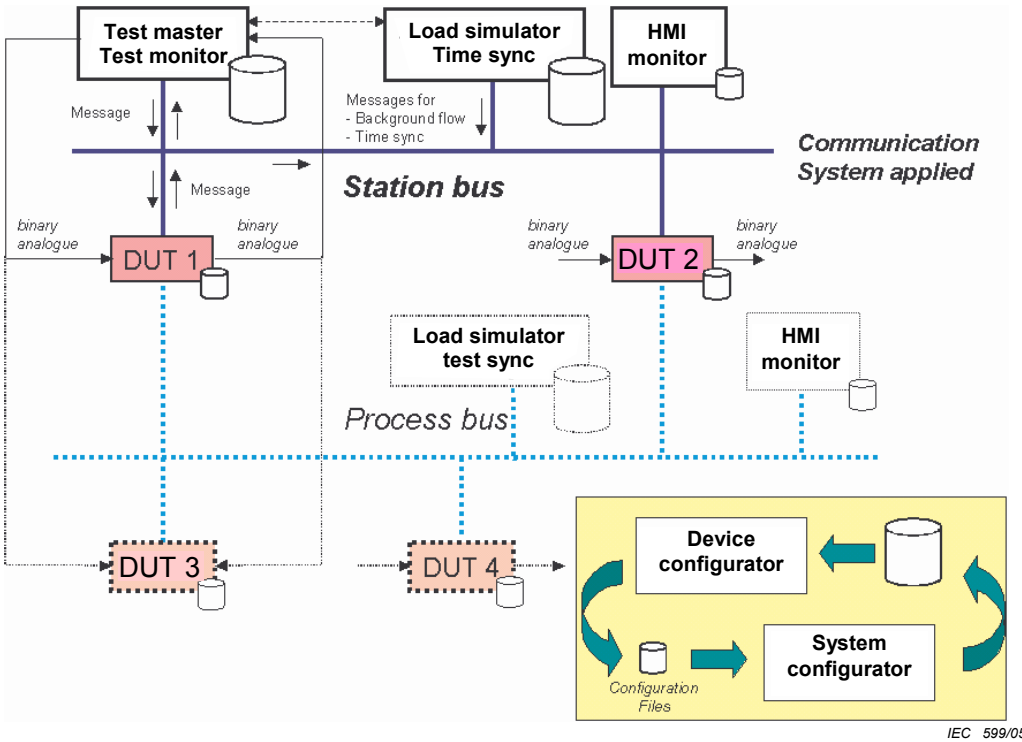


IEC 61850 – Perspektive sustava



IEC 61850-10 – Provjera sukladnosti





IEC 61850-10 – Opis testiranja

depicted in Annex A.

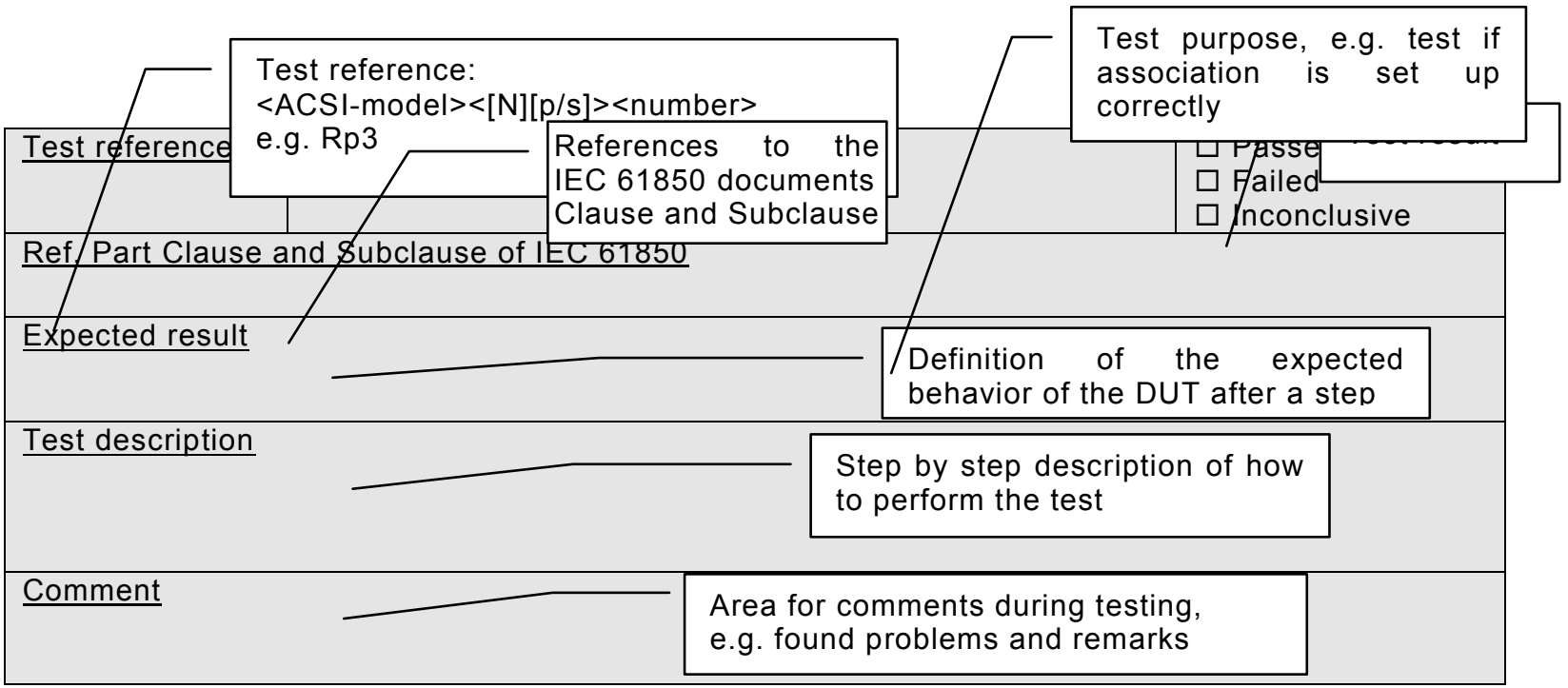


Figure 3 – Test procedure format

IEC 600/05

IEC 61850-10 – Certifikati

- UCAIUG (US)
- KEMA (NL)
- TUEV-SUED (DE)
- Server/klijent
- PICS/MICS/PIXIT
- Komunikacija-funkcija
- IEC 61850-100-1 (draft)

IEC 61850 Certificate Level A[1]

Page 1/2

No. 74100372-MOC/INC 11-1382

Issued to:
Schweitzer Engineering Laboratories, Inc
2350 NE Hopkins Court
Pullman, WA 99163-5603
USA

For the product:
SEL-710 Motor Protection Relay
Version R406

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: "IEC61850 PICS SEL-710, version 20110606", "IEC61850 MICS SEL-710, version 20110606", "IEC61850 TICS SEL-710, version 20110606" and product's extra information for testing: "IEC61850 PIXIT SEL-710, version 20110606".

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 v2.2b):

1 Basic Exchange (15/24)	9b GOOSE Subscribe (10/10)
2 Data Sets (3/6)	12a Direct Control (7/11)
5 Unbuffered Reporting (13/18)	12c Enhanced Direct Control (7/13)
6 Buffered Reporting (16/20)	12d Enhanced SBO Control (12/19)
9a GOOSE Publish (5/12)	13 Time Synchronization (3/5)

This Certificate includes a summary of the test results as carried out at KEMA in the Netherlands with UniCAsim 61850 version 3.21.02 with test suite 3.21.02 and UniCA 61850 analyzer 4.22.03. The test is based on the UCA International Users Group Device Test Procedures version 2.2b. This document has been issued for information purposes only, and the original paper copy of the KEMA report: No. 74100372-MOC/INC 11-1381 will prevail.

The test has been carried out on one single specimen of the product as referred above and submitted to KEMA by SEL. 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, 14 June 2011

M. Adriaensen
Regional Director Management & Operations Consulting

R. Schimmel
Certification manager

1 Level A - Independent Test lab with certified ISO 9000 or ISO 17025 Quality System

Copyright © KEMA Nederland B.V., Arnhem, the Netherlands. All rights reserved. Please note that any electronic version of this KEMA certificate is provided to KEMA's customer for convenience purposes only. It is prohibited to update or change it in any manner whatsoever, including but not limited to dividing it into parts. In case of a conflict between the electronic version and the original version, the original paper version issued by KEMA will prevail.

KEMA Nederland B.V.
Utrechtseweg 310, 6812 AR Arnhem P.O.Box 9035, 6800 ET Arnhem The Netherlands
T +31 26 356 20 25 F +31 26 351 36 83 sales@kema.com www.kema.com