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Implementation of IEC 61850

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Implementation of IEC 61850

... working towards multi-vendor interoperability through the cost-effective adoption of Edition 2 of IEC 61850 and determining next steps for full standardization

- **Edition 2** – selected new features and how they improve IEC 61850
- **Interoperability** – what are the issues?
- **Next steps** – integration of Power Generation including DER and IEC 61850 beyond the substation

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IEC 61850 – where are we?

- First Edition published 2003 – 2005
- Thousands of substations around the world are built with IEC 61850
- Concept is used in other domains for power generation
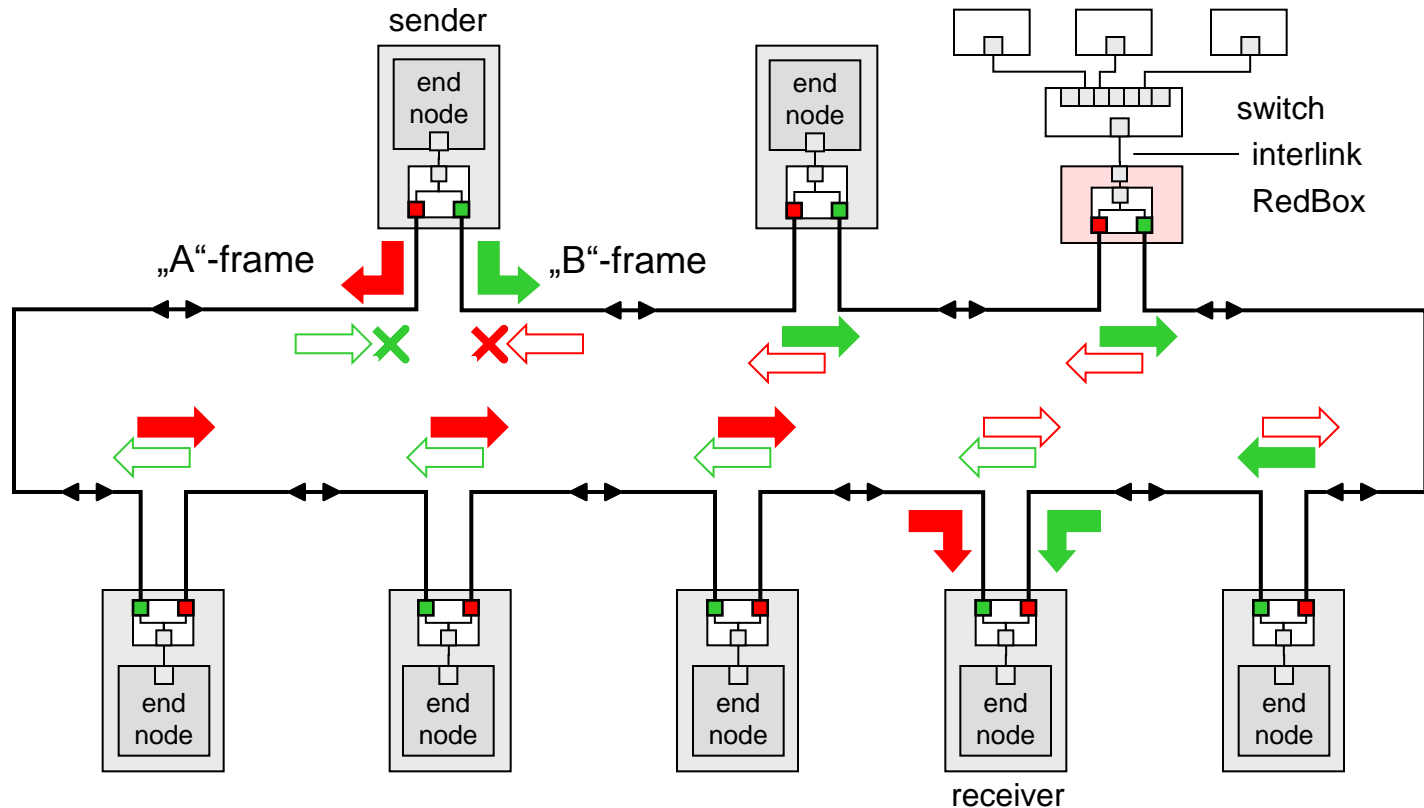- Scope has been extended beyond the substation

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Parallel Redundancy Protocol (PRP)

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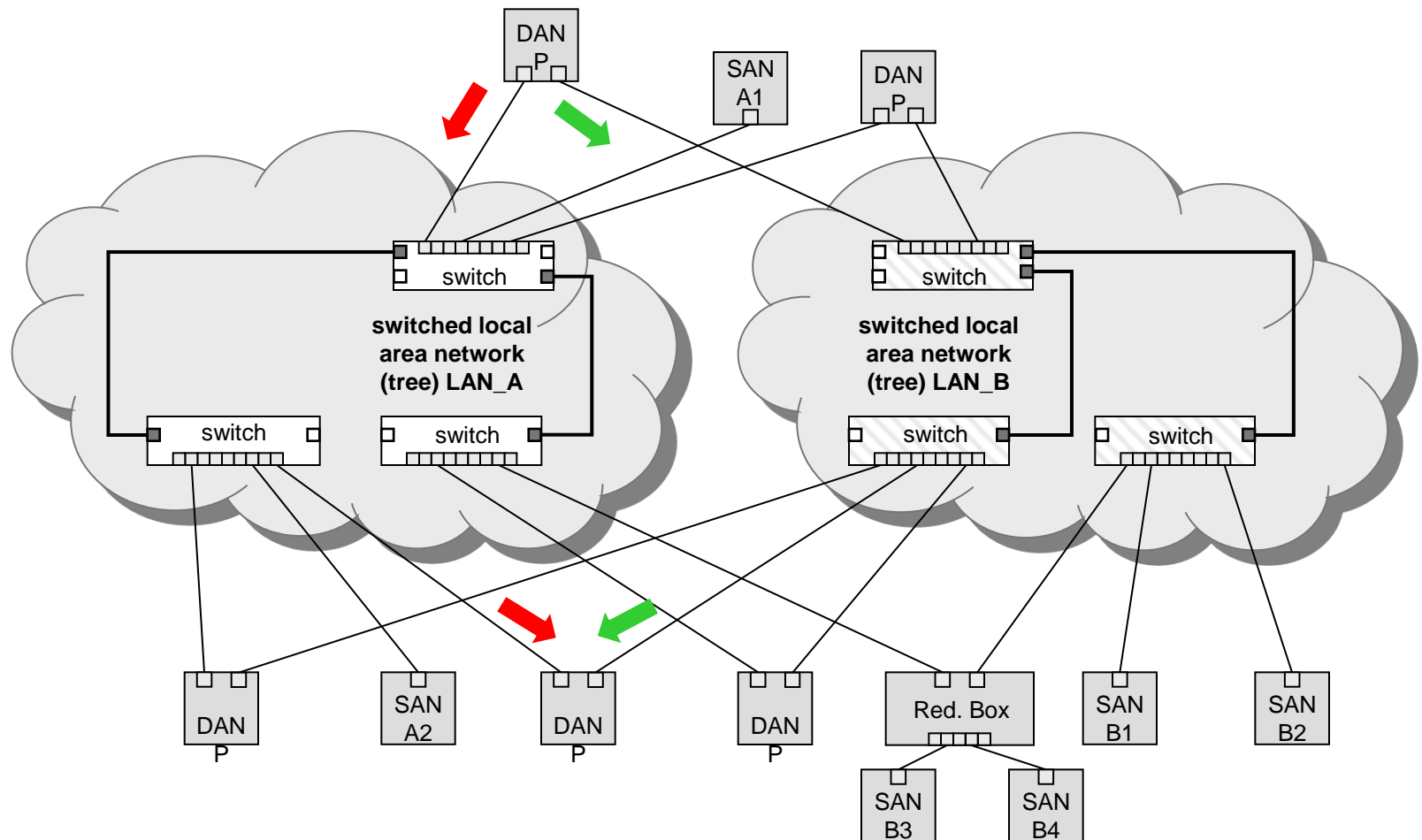
Introducing Redundant Ports in IEDs

High Availability Seamless Ring (HSR)

Monitoring GOOSE subscription

LGOS class			
DO	CDC	Explanation	
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.	
Data objects			
Status information			
NdsCom	SPS	Subscription needs commissioning	O
St	SPS	Status of the subscription (True = active, False=not active)	M
SimSt	SPS	Status showing that really Sim messages are received and accepted	O
LastStNum	INS	Last state number received	O
ConfRevNum	INS	Expected configuration revision number	O
Settings			
GoCBRef	ORG	Reference to the subscribed GOOSE control block	O

- ■ one instance per subscribed GOOSE

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Control Hierarchies

Tele control

Station control

Bay control

F

T

LocSta

T

F

Loc

CSWI

XCBR

T

F

Loc
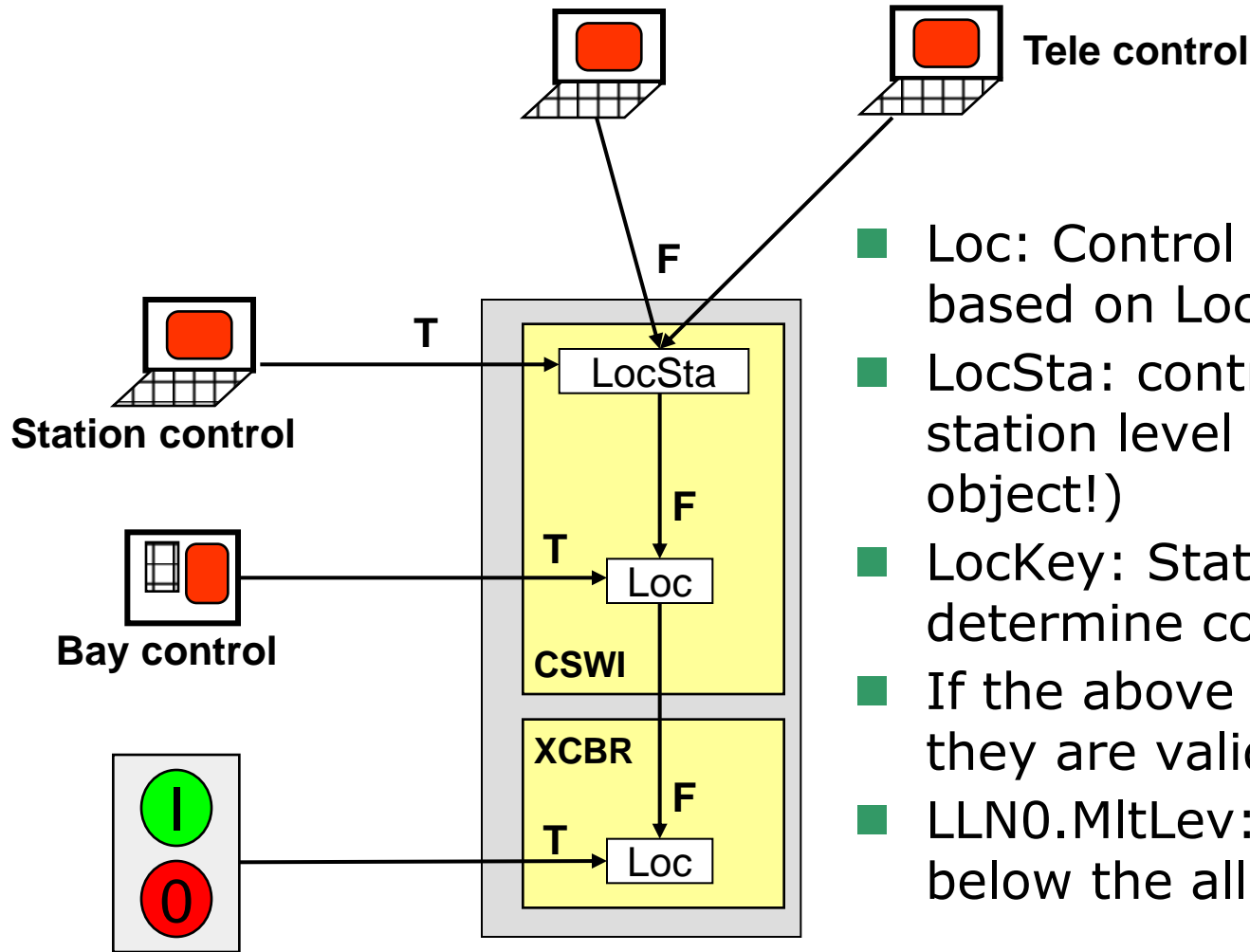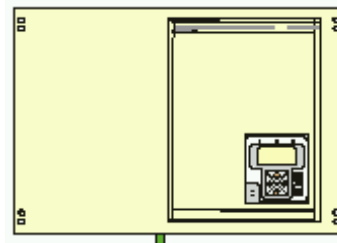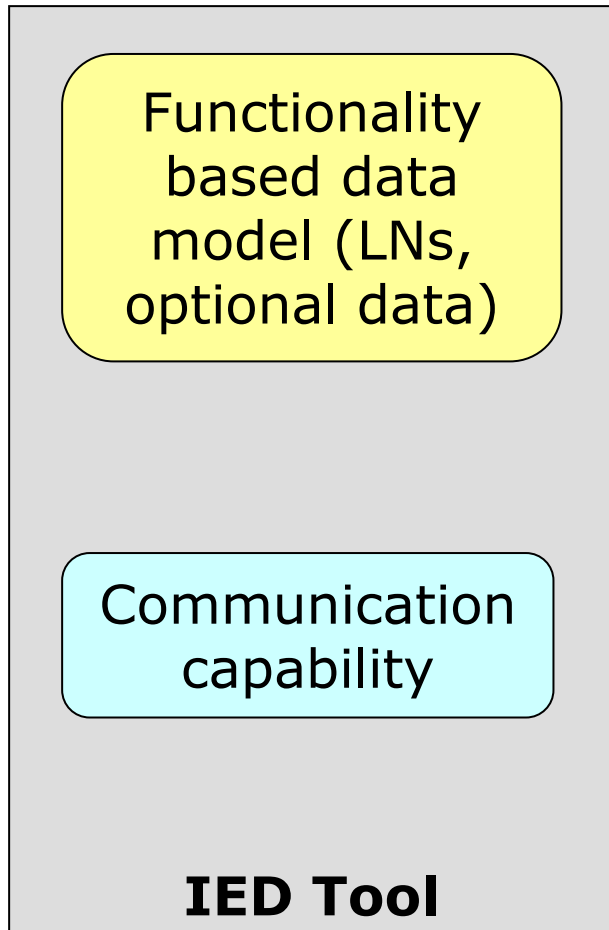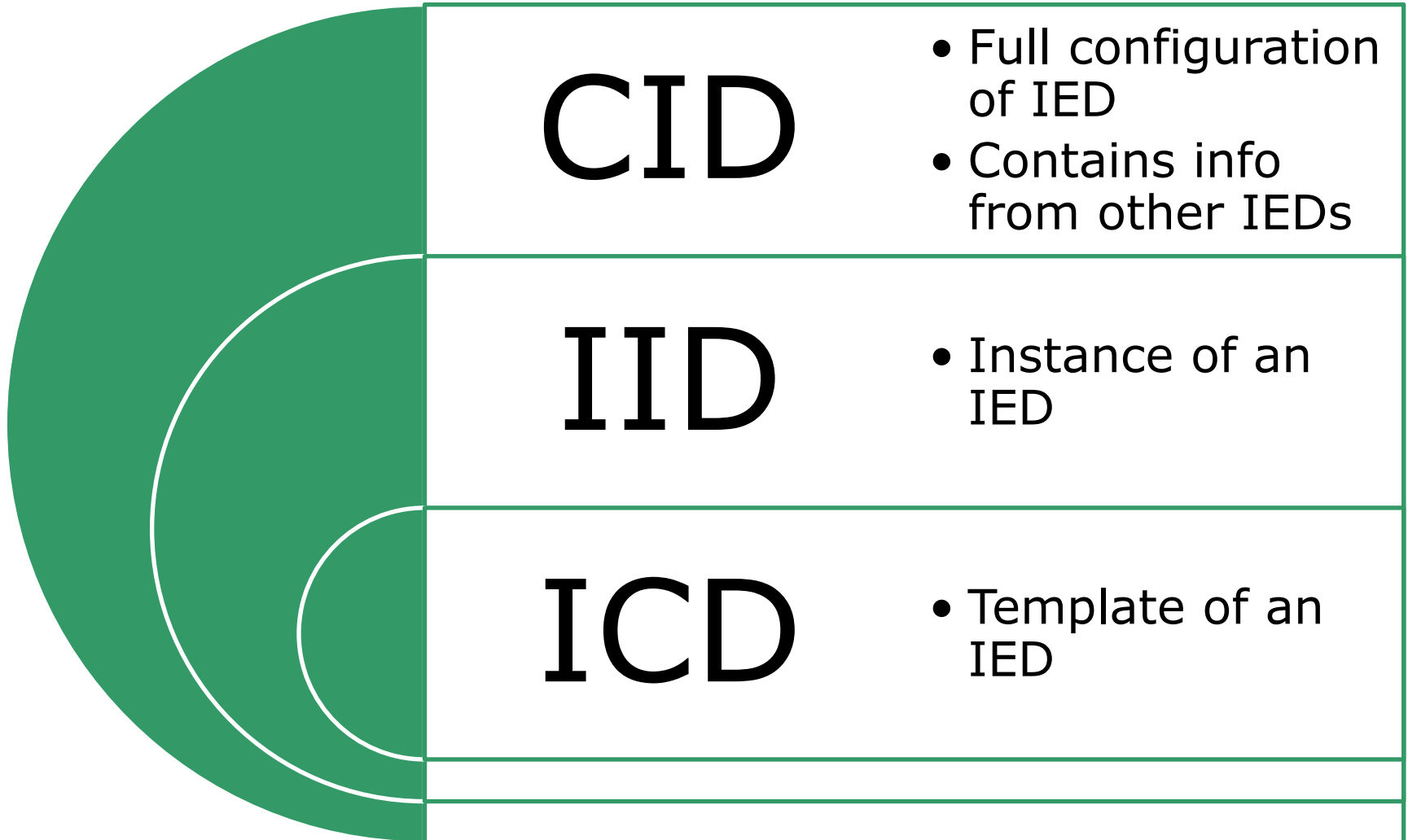
- Loc: Control behavior of LN; based on LocKey and MltLev
- LocSta: control behavior at station level (controllable object!)
- LocKey: Status of a key to determine control behavior
- If the above DO are at LLN0 they are valid for complete LD
- LLN0.MltLev: control on levels below the allowed is possible

System and IED tool responsibilities

IED properties

Functionality based data model (LNs, optional data)

Communication capability

IED Tool

Preconfigured functional parameters, CF attributes

Communication behavior (controls, data sets)

System Tool or Online

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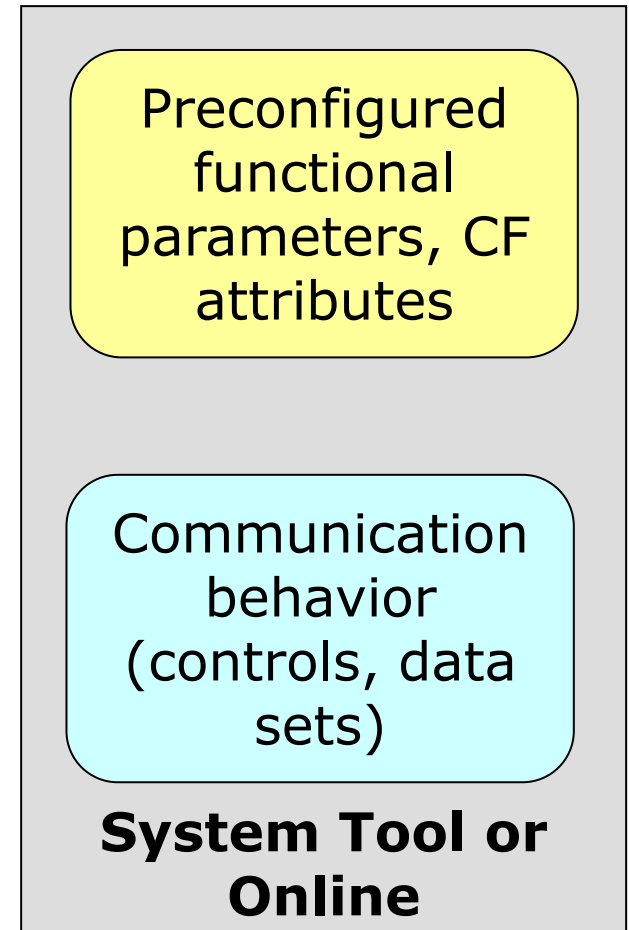
Clarification – icd, iid and cid

CID
- Full configuration of IED
- Contains info from other IEDs

IID
- Instance of an IED

ICD
- Template of an IED

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Testing support in IEC 61850

- **Diagnostics support**
  - Service tracking – monitor communication services
  - Monitor device behavior related to communication and system functions
- **Functional testing**
  - Equipment isolation
  - Simulation of GOOSE and Sampled Value messages
  - Simulation of signals (inputs)

Support for isolation and test

Separating test and normal information flow

- LN Mode **test** and test/blocked
- Control service parameter **Test**
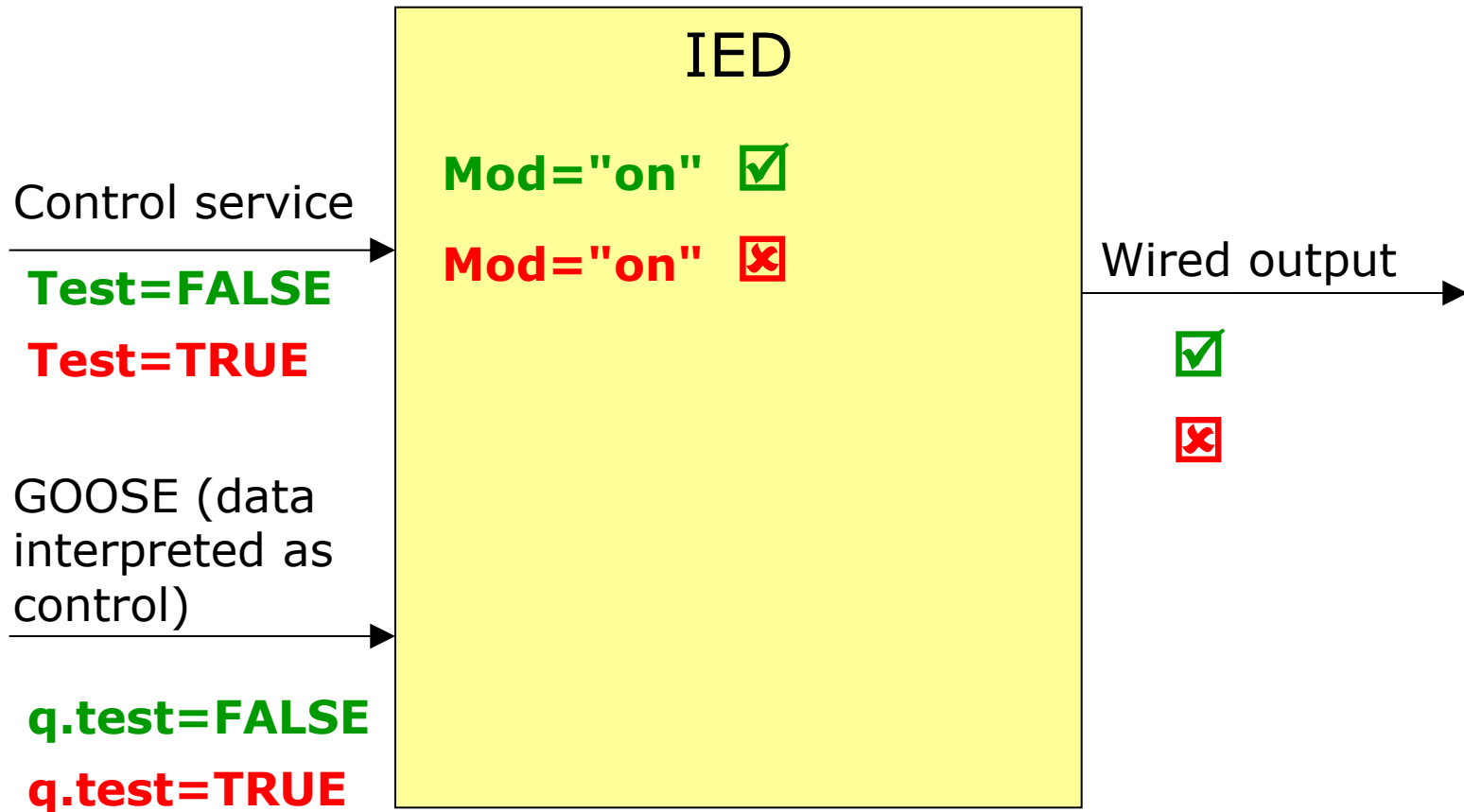- Quality attribute **q.test**

Separating simulated and normal messages

- Parameter **Simulation** in GOOSE and SV message
- DO **Sim** in LN LPHD

Support observation

- **Mirroring** of control service requests

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Testing an IED – Mod "on"

IED

Control service →

Mod="on" ☑

Mod="on" ☒

Test=FALSE

Test=TRUE

Wired output →

☑

☒

GOOSE (data interpreted as control) →

q.test=FALSE

q.test=TRUE

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Testing an IED – Mod "test"

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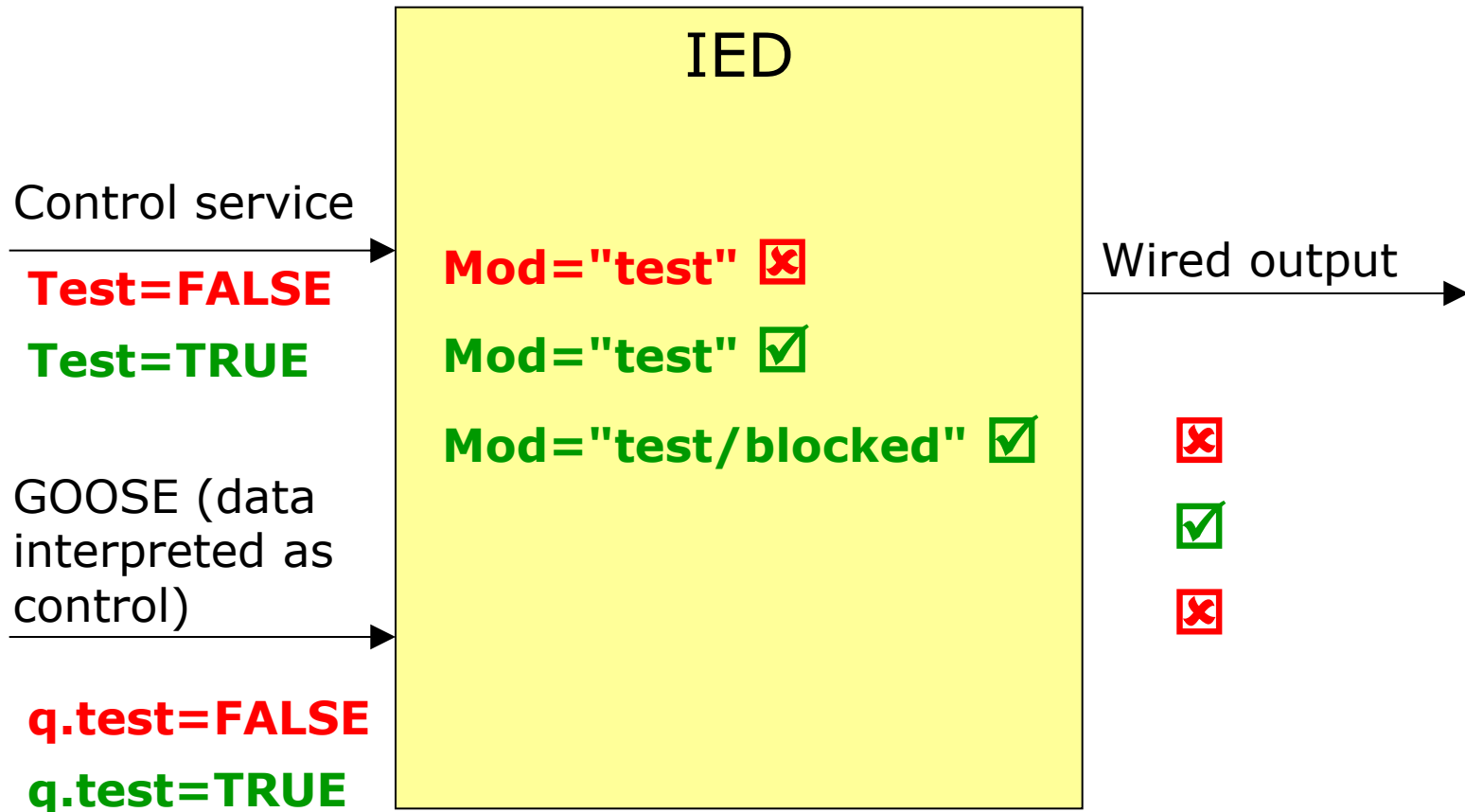
Mirroring control information

Control service

ctlVal

Wired output

opRcvd

opOk

tOpOk

IED

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Simulation of messages

GoID=GO1; Simulation=TRUE

GoID=GO1; Simulation=FALSE

IED

LPHD
Sim=**TRUE**
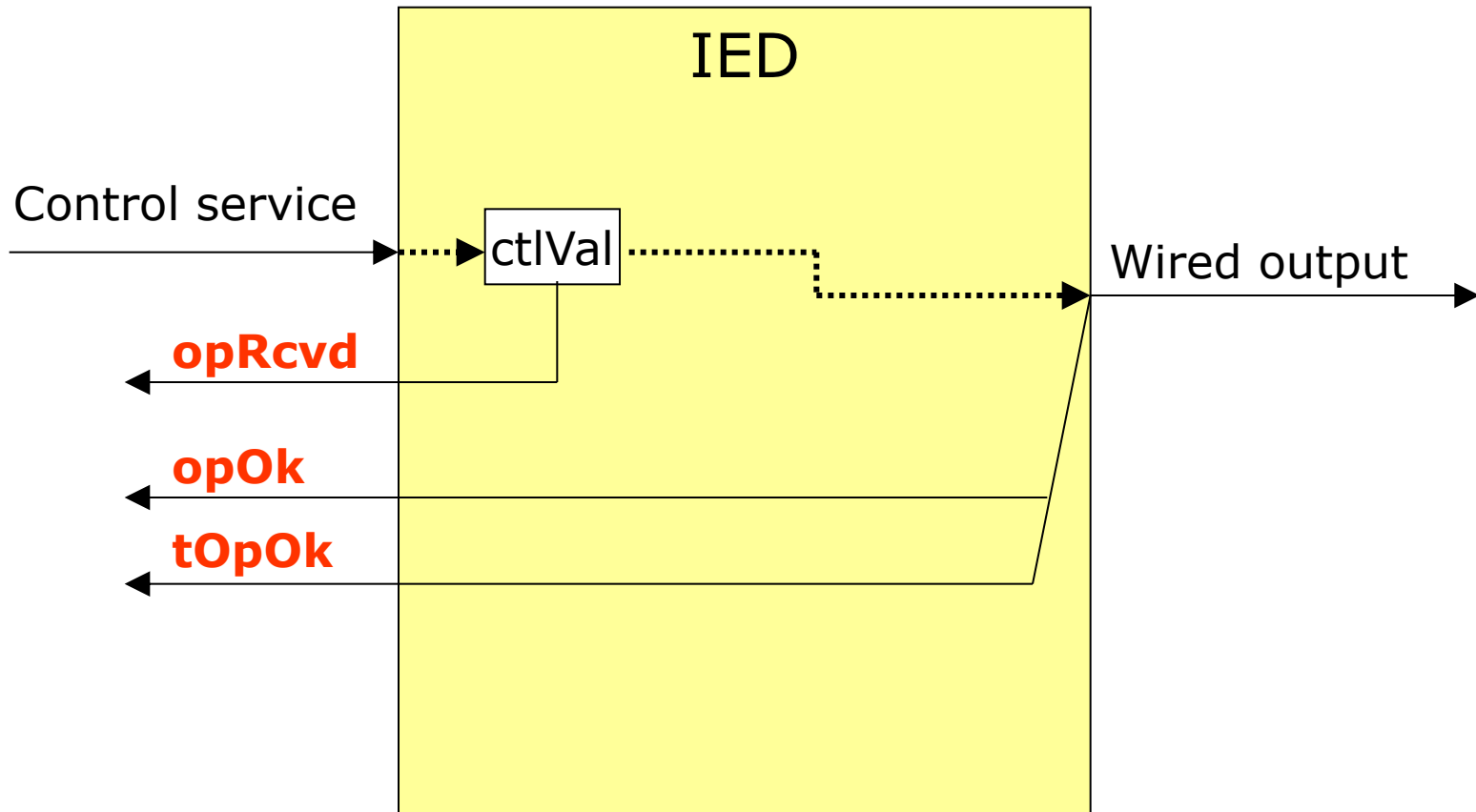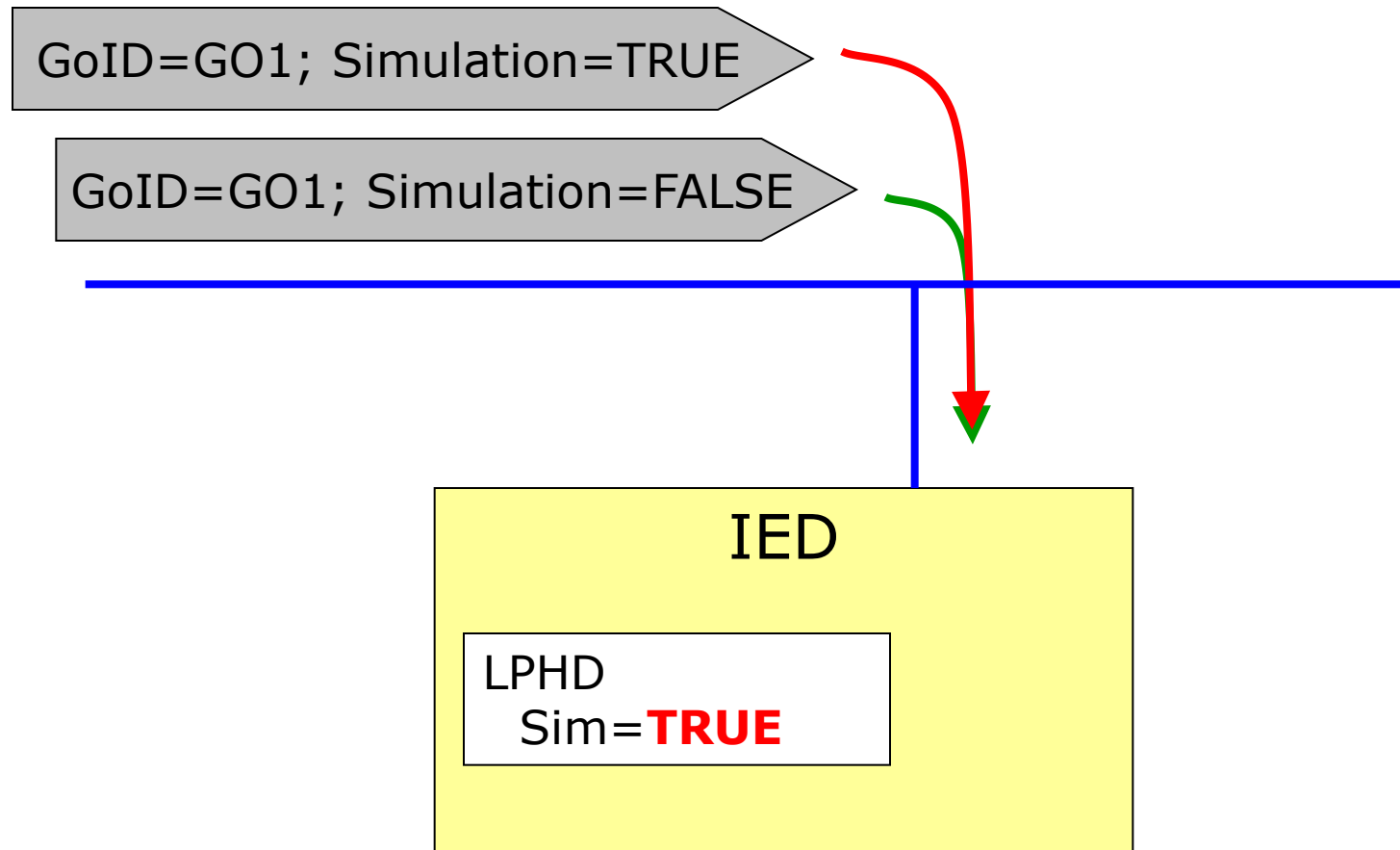
Isolation and test
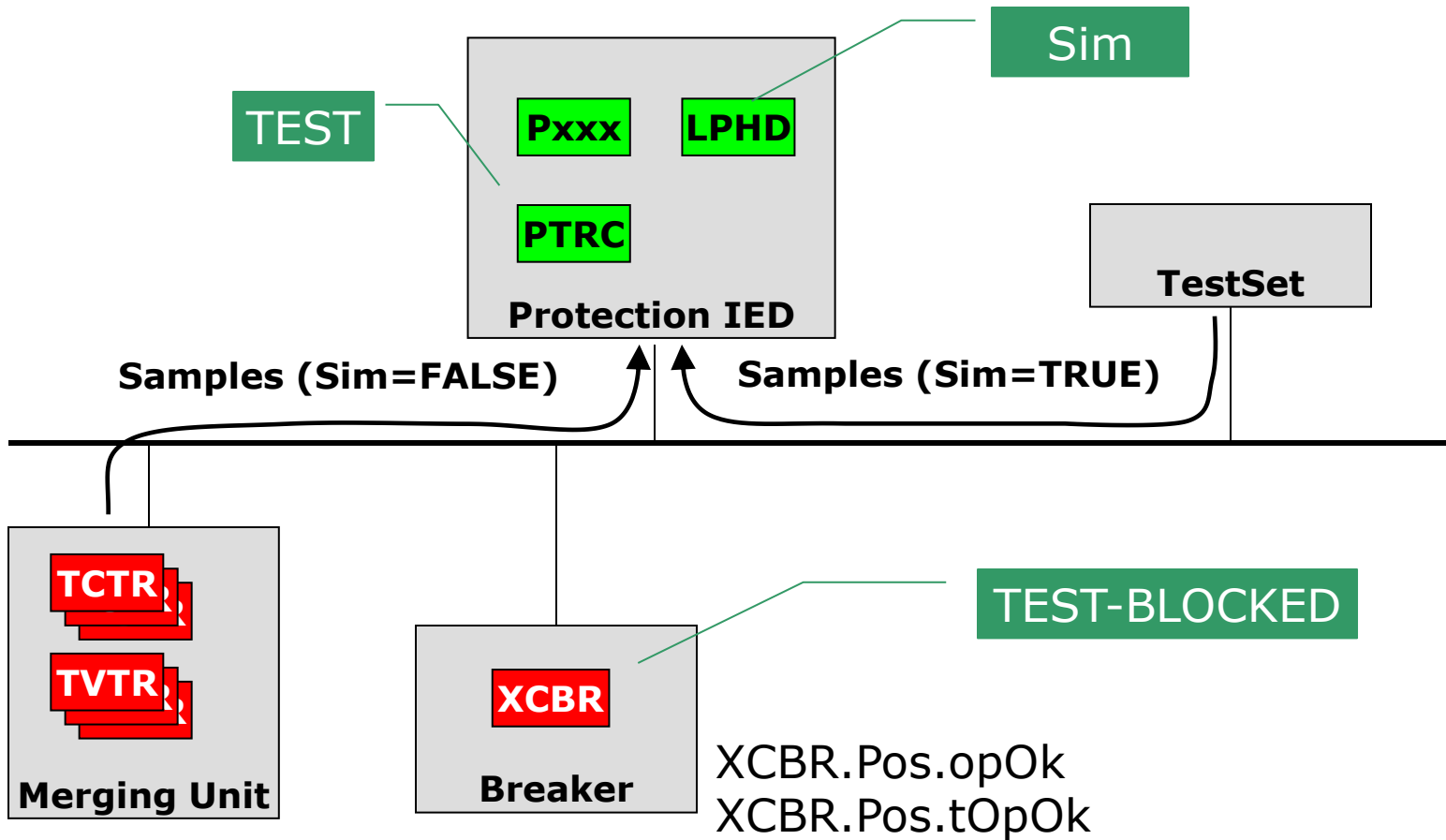
Interoperability – the grey areas

From IEC 61850-2

"ability of two or more **IEDs** from the same vendor, or different vendors, to **exchange information** and **use that information** for correct execution of specified functions"

Interoperability and IEC 61850

- **IEC 61850 has three core components**
  - Information exchange – ACSI and mappings on communication protocols
  - Application modeling – Logical nodes
  - Engineering – Configuration Language
- **Interoperability has the same levels**
  - Ability to **exchange information** is provided by ACSI – *this is achieved today*
  - Ability to **use the information** is supported by the application models – *improvements are possible*
  - Engineering interoperability today is *limited*

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Options provided by the standard
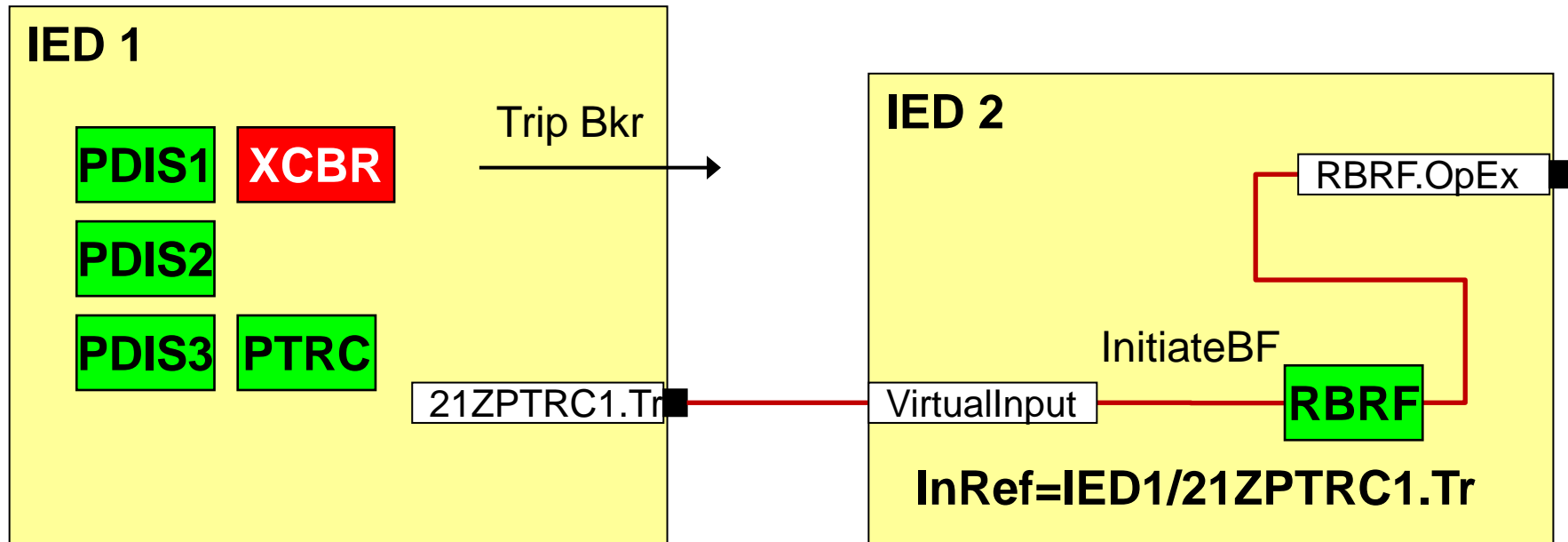
- Declaration of capabilities of an IED in SCL has been extended with Ed 2; PIXIT reduced
  - Example: limitations for dataset definition (e.g. only selection of individual data attributes) not allowed anymore
- Development of profiles is in discussion
  - Basic application profiles
  - User profiles (e.g. ENTSO-E)
- Profiles limit the options by defining a required subset

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Engineering flexibility of devices

- **IED properties can be**
  - Fix: defined by IED implementation
  - Conf: defined through configuration file (SCL); initialized at startup
  - Dyn: dynamically changed through client / server services or on frontpanel

```xml
- <Services>
    <GetDirectory />
    <GetDataObjectDefinition />
    <DataObjectDirectory />
    <GetDataSetValue />
    <ReadWrite />
    <ConfReportControl max="4"/>
    <GetCBValues />
    <ReportSettings rptID="Dyn" datSet="Fix" optFields="Dyn" bufTime="Dyn" trgOps="Dyn"
        intgPd="Dyn" cbName="Fix" />
  </Services>
```

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Signal flow in IEC 61850 - InRef

IED 1

PDIS1   XCBR

PDIS2

PDIS3   PTRC

Trip Bkr

21ZPTRC1.Tr

IED 2

RBRF.OpEx

InitiateBF

VirtualInput   RBRF

InRef=IED1/21ZPTRC1.Tr

- **GOOSE – wires become virtualized**
- **Signal flow**
  - engineered in SCL (**ExtRef**)
  - described in online data model (**InRef** / Ed2)

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Options provided by the standard

- **Signal flow engineering in SCL**
  - Various elements in SCL support engineering of GOOSE subscriptions - however, they are all optional
- **Example: ExtRef**
  - How can an IED declare, to which LNs how many inputs are allowed?
  - Which LNs do accept inputs (ExtRef)?
- **Development of a guideline for recommendations for data flow configuration by the UCA IEC 61850 users group is under discussion**

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Tool interoperability

- Interoperability testing of tools was a major focus at the IOP 2013
- File exchange between tools is typically possible
- But due to various options, a system tool needs to know many details of a particular IED tool
  - Example: is an ExtRef specifying a data attribute or a data object?
  - Example: What shall the communication parameters of unused, but preconfigured GOOSE messages be?

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Next steps – Integrating DER

Documents from WG17 about DER

- IEC 61850-7-420 – Communications Systems for Distributed Energy Resources (DER)
- IEC 61850-90-6: Using IEC 61850 for distribution automation
- IEC 61850-90-7: IEC 61850 object models for inverter based applications
- IEC 61850-90-8: IEC 61850 object models for electrical vehicles
- IEC 61850-90-9: IEC 61850 object models for electrical energy storage systems
- IEC 61850-90-10: Modeling of schedules in IEC 61850

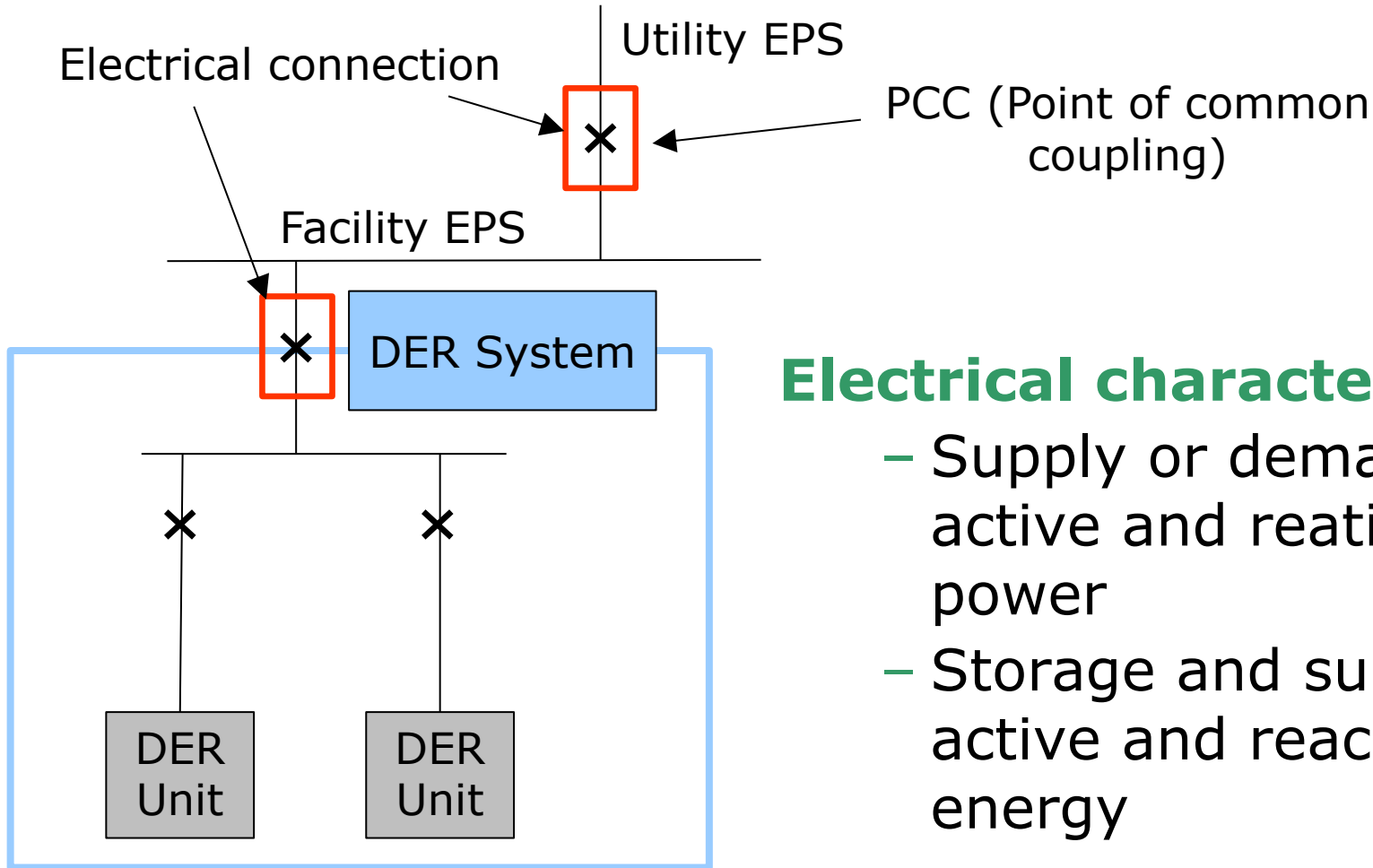it4power

Technical Report IEC 61850-90-15

Scope

- Describe the concepts to integrate DER systems into the grid using IEC 61850
  - Concept of a hierarchical DER system which comprises a **DER management system**, **DER systems** and various types of **DER units**
  - Functional requirements of DER grid integration
  - Setting up an information model of the DER system based on IEC 61850

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DER Grid Integration - Definition

DER Grid Integration means that for reasons of **security of supply** and **security of the power system**, DER system should provide on request **ancillary services** that are in conventional power systems provided by bulk power generation systems.
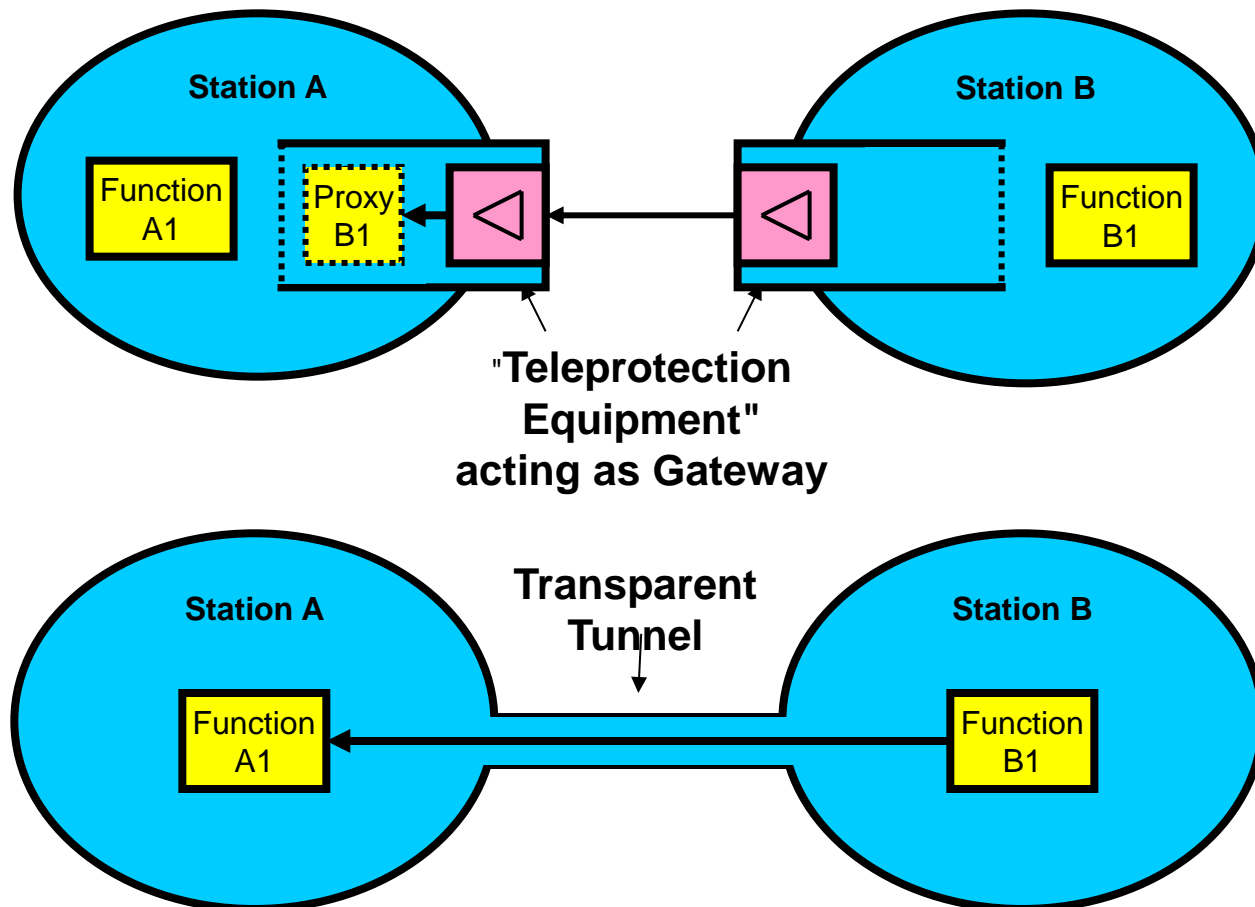
Integration of DER

Electrical connection

Utility EPS

PCC (Point of common coupling)

Facility EPS

DER System

DER Unit

DER Unit

Electrical characteristics

– Supply or demand of active and reative power
– Storage and supply of active and reactive energy

End to end communication

- Communication between substations – IEC 61850-90-1

Station A / Station B with Function A1, Proxy B1, Function B1 — "Teleprotection Equipment" acting as Gateway

Station A / Station B — Transparent Tunnel connecting Function A1 and Function B1

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Interaction between stakeholders