Relion. Thinking beyond the box.

Designed to seamlessly consolidate functions, Relion relays are smarter, more flexible and more adaptable. Easy to integrate and with an extensive function library, the Relion family of protection and control delivers advanced functionality and improved performance.
ABB Protective Relay School Webinar Series

Disclaimer

ABB is pleased to provide you with technical information regarding protective relays. The material included is not intended to be a complete presentation of all potential problems and solutions related to this topic. The content is generic and may not be applicable for circumstances or equipment at any specific facility. By participating in ABB's web-based Protective Relay School, you agree that ABB is providing this information to you on an informational basis only and makes no warranties, representations or guarantees as to the efficacy or commercial utility of the information for any specific application or purpose, and ABB is not responsible for any action taken in reliance on the information contained herein. ABB consultants and service representatives are available to study specific operations and make recommendations on improving safety, efficiency and profitability. Contact an ABB sales representative for further information.
Howard is a 1987 Graduate of Clemson University, where he received his Bachelors of Science in Electrical Engineering. He has over 28 years experience in protection, control and automation in utility transmission and distribution systems.

He spent his first 12 years of his career as a Substation Relay, Protection and Control Engineer for Santee Cooper. Howard was involved in Engineering, Operations, maintenance and Design of Transmission, Distribution, and Generation substations while there. Howard has worked the next 15 years as both an Engineering Manager for Substation Automation Systems and Product Manager for Transmission and Distribution Automation Products.

Howard has experience in delivery of systems using both DNP and IEC61850. He has been active in CUEPRA, IEEE, UCA, and DNP users groups.. Howard is presently a member of SGIP.

Howard joined ABB in 2011. He is currently the Program Manager for ABB’s Distribution Automation Smart Grid Center of Excellence. Howard is responsible for helping close the product gaps through R&D and product development in ABB’s DA Smart Grid Portfolio, as well as, leading the NAM Distribution Automation Verification Center(DAVC).
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Contents

1. Introduction
2. IEC 61850 in ABB products and solutions
3. Overview of the IEC61850 Standard
   A. Understanding the Model
   B. Client\Server Application
   C. GOOSE Messaging
   D. Substation Configuration Language
4. IEC61850 Ed.2
5. Redundancy
   A. HSR
   B. PRP
ABB IED products offer native IEC 61850 features with high performance functionality

Since 2005, ABB has been delivering products with IEC 61850 as a standard

ABB has products and solutions to accommodate from small to very large Substation Automation IEC 61850 systems

- Relion® IEDs
- Remote I/O RIO600
- MicroSCADA, RTU560, COM600, 800xA

ABB IEC 61850 tools:

- One common IED tool, PCM600
- IET600, system configuration tool
- ITT600, testing tool
IEC 61850 in DA Products
ABB Native IEC 61850 Solution

- The ABB products constitute a genuine IEC 61850 solution for reliable power distribution in utility and industrial power systems

- The native IEC 61850 support offers:
  - High communication performance
  - Continuous supervision of the integrity of the protection and communication system
  - Integration to 3rd party systems with standard application modeling

- ABB’s Connectivity Package concept enables:
  - Streamlining of the IEC 61850 system engineering and IED configuration
  - Enables easy integration with RTU560, COM600 and MicroSCADA Pro
  - Helps automating the engineering part, e.g. event lists and single line diagram
  - Shortens the system engineering time

Supported ABB Solutions
- MicroSCADA Pro SYS600
- RTU560
- Grid Automation controller COM600
- System 800xA
Substation Automation Products
Proven reliability across our technology

+250,000
Relion® Series IEDs
Installed Worldwide

+10,000
MicroSCADA Pro Licenses
Delivered Worldwide

+100,000
Remote Terminal Units (RTU)
Installed Worldwide

+8 million
COMBIFLEX/COMBITEST
modules
Installed Worldwide
Substation automation

ABB's brief history with IEC61850

1994-2003
- Active IEC work with up to 13 permanent delegates in all key working groups
- Extensive interoperability test amongst key suppliers
- Finalization and release of IEC61850
- 1st project delivered by ABB, EGL 380kV in Switzerland
- 1st IEC61850-8-1 multi-vendor project worldwide

2004
- 1st UCA certification for the ABB System Verification Center
- 1st IEC61850-8-1 multi-vendor project worldwide

2005
- UCA certification for the ABB System Verification Center
- 1st ABB pilot IEC61850-9-2 process bus installation

2008
- 1st UCA certification for IEC61850-9-2 Merging Unit worldwide

2010
- 1st UCA GOOSE performance certificate

2012
- Globally > 3000 ABB SA Systems Based on IEC 61850 delivered
IEC 61850

- The goal of the IEC 61850 series is to provide interoperability between the IEDs from different suppliers or, more precisely, between functions to be performed by systems for power utility automation but residing in equipment (physical devices) from different suppliers.

- Interoperable functions may be those functions that represent interfaces to the process (for example, circuit breakers) or substation automation functions such as protection functions.
A breakthrough for substation automation

**Basics:**
- Fast ethernet (100 MBps to 1 GBps)
- Station bus 61850 8-1
- Process bus 61850 9-2
- Data model
- Substation configuration language

**Much more than a protocol:**
- Modularization and structuring of data
- On-line meaningful information
- Free allocation of functions in IEDs
- Complete description of configuration
- Structured engineering & services
- Testing, validation, and certification
IEC61850 Overview
Structure of Standard

- Basic Principles
- Glossary
- General Requirements
- System and project management
- Communication requirements

Primary Parts

- Substation Automation System Configuration
- Basic Communication Structure
- Mapping to MMS and Ethernet
- Sampled Measured Values and mapping to Ethernet
- Conformance testing
IEC 61850 – What is it?
IEC 61850 is the international standard for substation automation systems. It defines the communication between devices in the substation and the related system requirements.

Architecture

Station level
- Station bus (8-1)

Bay level
- Control
- Protection

Process level
- Process Interface

GOOSE

SMV

Operator workplace

Engineering/Monitoring

Gateway

CLIENT/SERVER

Control
Protection
Protection & Control
Control
Protection

Cu wires
IEC 61850 Communication Profiles

- **Sampled Values (Multicast)**
  - SV (Type 4)
- **Generic Object Oriented Substation Event**
  - GOOSE (Type 1, 1A)
- **Time Sync**
  - TimeSync (SNTP) (Type 6)
- **Core ACSI Services**
  - MMS Protocol Suite (Type 2, 3, 5)
  - UDP/IP
  - TCP/IP T-Profile

---

**ISO/IEC 8802-3 Ethertype**

- SMV
- GOOSE
- IP (O)
- HSR (O)
- 802.1Q
- 802.1Q
- 802.1Q (O)
- 802.1Q (O)

(Type x) is the Message type and performance class defined in IEC 61850-5

Figure 1 – Overview of functionality and profiles
IEC61850 Data model

The core of 61850 is the standard representation of functions and equipment, its attributes, and its location within a system.
# IEC61850 Data model

## Logical Node

### Table 1 – LN groups

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

- **MMXU**: Three-phase measurement
- **MMDC**: DC-related measurement
- **MMTR**: Three-phase metering
- **MHA1**: Three-phase harmonics and inter-harmonics
- **PDIR**: Directional element
- **PHAR**: Harmonic restraint
- **PSCH**: Protection scheme
- **PTEF**: Transient earth fault
- **PZSU**: Zero speed or underspeed
- **PDIS**: Distance protection
- **PVPH**: Volts per Hz relay
- **PTUV**: Undervoltage
- **PDOP**: Directional over power
- **XCBR**: Circuit Breaker
- **XSWI**: Circuit Switch

...more
IEC 61850 Overview
Functional Modeling, LN Relations

Physical Device Bay Controller

- GIGO: General Input / Output
- XCBR: Circuit Breaker
- Current Transformer
- TCTR: Distance Protection
- TVTR: Voltage Transformer
- PDIS: Disturbance Recorder
- RDRE: Disturbance Recorder
- MMXU: Measurement Unit
- ATCC: Tap Changer Controller

Connections:
- Limit overflow
- Sum of switched current
- Distance
- Reactance
- Instantaneous (record)
- RMS demand
- Circulating current

Examples for some current related data
IED Reports information to Master via Polling Methods

Measurements
- Ia (Amps)
- Va (Volts)
- P (Watts)

Status
- 52a, 52b (Pos), 50PU, 51Trip
## Substation Data

### DNP Protocol

<table>
<thead>
<tr>
<th>Function / Equipment</th>
<th>Protocol Specific Addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Position of Breaker1</strong></td>
<td></td>
</tr>
<tr>
<td>52A = Device 5,</td>
<td>DNP – Obj. 1, index 0</td>
</tr>
<tr>
<td>52B = Device 5, DNP–Obj. 1,</td>
<td>DNP – Obj. 1, index 1</td>
</tr>
<tr>
<td><strong>Breaker1 Current</strong></td>
<td></td>
</tr>
<tr>
<td>PhA = Device 5, DNP–Obj. 30</td>
<td>DNP – Obj. 30, index 0</td>
</tr>
<tr>
<td>PhB = Device 5, DNP–Obj. 30</td>
<td>DNP – Obj. 30, index 1</td>
</tr>
<tr>
<td>PhC = Device 5, DNP–Obj. 30</td>
<td>DNP – Obj. 30, index 2</td>
</tr>
<tr>
<td><strong>Breaker 1 51P and 50P targets</strong></td>
<td></td>
</tr>
<tr>
<td>51P = Device 5,</td>
<td>DNP – Obj. 1, index 35</td>
</tr>
<tr>
<td>50P = Device 5,</td>
<td>DNP – Obj. 1, index 36</td>
</tr>
</tbody>
</table>

![Diagram showing substation and breaker connections](image-url)
**IEC61850 Standard**

**Use of a Standard Data Model**

**Function / Equipment**

**Position of Breaker1**
- 52A = Device 5,
- 52B = Device 5,

**Breaker1 Current**
- PhA = Device 5,
- PhB = Device 5,
- PhC = Device 5,

**Breaker 1 51P and 50P targets**
- 51P = Device 5,
- 50P = Device 5,

**Logical Node**

**Breaker = XCBR**
- Position = XCBR.Pos.stVal

**Measurements = MMXU**
- Current PhA = MMXU.A.phsA
- Current PhB = MMXU.A.phsB
- Current PhC = MMXU.A.phsC

**51P Target**
- 51P = PTOC.Op.general
- 50P = PIOC.Op.general
IEC61850 Data model
Logical Node (LN)

- A named grouping of data and associated services that is logically related to some power system function
- Consists of one or more attributes each of a type defined by a Common Data Class (CDC)

IEC61850 Object Model

IEC61850 Object Names Use Power System Context
IEC 61850
Expanding the Data Model - Example
IEC 61850 Client/Server

Client

Server

Report information from IED to master

Data

Named and Grouped

Data Sets

Organizes the Data into Groups

Report Control Blocks

Allows reporting data for changes in: data, quality, etc.

ICD

ICD

10/8/2015 | Slide 24

Measurements
- Ia (Amps)
- Va (Volts)
- P (Watts)

Status
- 52a, 52b(Pos), 50PU, 51Trip
Data placed into data sets which are then associated with Report Control Blocks (RCBs)

1. Connect to server
2. Enable the RCB
3. Receive the data

3 steps for the client
What is a GOOSE message?

- Generic Object Oriented Substation Event
- Fast and reliable distribution of information
  - Status (breaker position, trip, pickup, alarms, etc.)
  - Analog (counter values, etc.)
- Performance
  - Fast messages Type 1A (Class P2/P3) received within 3ms.
  - This includes transmission time into the other IEDs (similar to an output to input connection between 2 relays)
What is a GOOSE message?

- GOOSE messages are based on change event
- GOOSE messages include diagnostic functions (a “heart beat” to all devices subscribed is sent periodically)
- GOOSE messages are managed by GCBs (GOOSE control block) inside IEDs
- GOOSE messages send “Data Sets” upon changes of state

Data set  GCB  Network
Multicast goose messaging

Publish and Subscribe

© ABB Group
Protection and control applications
What can we do with GOOSE?

Inside the substation

- Breaker failure protection
- Station arc flash protection
- Blocking based bus protection
- Loss or source – high speed transfer
- Load shedding
  - Analog GOOSE inputs
  - Binary GOOSE outputs

- Inter-bay signals using IEC 61850 and GOOSE
- SNTP time synchronization utilising station communication
Horizontal GOOSE communication

Benefits

- Automatically supervised connections
  - Connection failures are always detected
  - Data quality sent to peer IEDs along with event to enable data validation
- More I/O without hardware changes or additions
- Performance
  - The standard includes a concept for signal testing
- Expandability
  - IED retrofit installations with just small wiring changes
  - New functionality can be introduced
- Flexibility
  - Possibility to easily add functionality afterwards
  - IEDs can share unused I/O
- Reduces wiring between IEDs
SCL and modeling in 61850

- 61850 defines a common language where all compliant manufacturers can exchange information regarding the “functions” (Logical Nodes) and related data available inside their equipment.

- Substation Configuration Language

- Offers 4 file formats (Ed. 1)(SCL)
  - SSD: Substation Specification Description
  - ICD: IED Capabilities Description
  - CID: Configured IED Description
  - SCD: Substation Configuration Description
SCL and modeling in 61850

- Documenting complete projects in SCD file
  - IEDs and their connection to the application
  - Functions and their connection to the application
  - Communication network
  - Connections between IEDs
  - Reporting mechanism
System tool approach

- Thanks to common file format engineering of the SAS system can be performed under a single tool.
- This provides a single point of interaction with the configuration files of all devices regardless of manufacturer.
- End result (SCD file) must be part of the final system documentation just like DC and AC elementary are.
IEC 61850 Edition 2
Why Edition 2 is required

- Remedying various shortcomings identified during first installations
- Enhance the applications range / new applications
  - Automation of wind power systems, Hydro power systems
  - Distributed energy resources, Combined heating and power systems
  - Photovoltaic plants
- Beyond the switch yard
  - Communication between substations
  - Communication between substations and network control centers
- Remaining challenges from Edition 1
- Complete process bus between primary and secondary equipment
  (analog samples and switch positions and commands)
IEC 61850 Edition 2
The standard continues...

IEC 61850 Edition 1
From proprietary protocols towards a
global communication standard
for substation automation

Data model for water
and wind application

IEC 61850 Edition 2
A broad, encompassing standard for
communication networks and systems
beyond substation automation

Many new Extensions in
work for additional (smart
grid) applications
IEC 61850 Edition 2
Solidify existing parts, extension for new applications

Control Center

- Improve interoperability
  - Error corrections
  - Compatibility of Edition 1 and Edition 2
  - IED and system tools conformance statement

- Increase system availability
  - Bumpless link redundancy for end devices
  - No single point of failure

- Communication beyond substation
  - Substation to substation
  - Substation to control center (not released yet)

- More flexible engineering process
  - Top down, Bottom up, modifications
  - Multiple projects
  - Substation to substation

Substation 1
Substation 2
IEC 61850 Edition 2
Scope mapped to system architecture

Legend:
- Published (Ed1)
- Published (new)
- Ongoing

New Title: Communication networks and systems for power utility automation

- Hydro Power Plant
  - IEC 61850-7-410
- Wind Power Plant
  - IEC 61850
  - IEC 61400-25
- DER, PV, ...
  - IEC 61850-90-7
  - IEC 61850-7-420
- Battery storage
  - IEC 61850-90-9
- Electr. vehicles
  - IEC 61850-90-8
- Distribution Automation
  - IEC 61850-90-6
- Network Engineering Guideline
  - IEC 61850-1-10
  - IEC 61850-90-4
- Substation
  - Control Center
  - Maintenance Center
  - IEC 61850-90-3
  - Mapping to IEC 101/104
  - Using IEC 61850
## IEC 61850 Edition 2
### Overview of new main features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
<th>Impact</th>
<th>m/o</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correction of errors and many small details</td>
<td>Ensure interoperability</td>
<td>Mainly on tools</td>
<td>M</td>
</tr>
<tr>
<td>Data model extension</td>
<td>Modeling for hydro, wind, DER and power quality</td>
<td>IEDs (servers and clients)</td>
<td>O</td>
</tr>
<tr>
<td>Longer LD names / prefixes</td>
<td>Object names extended from 64 to 128 characters</td>
<td>IEDs, Tools (IED and system)</td>
<td>M</td>
</tr>
<tr>
<td>SCL extension</td>
<td>Allow bottom-up system design and multiple projects</td>
<td>Tools (IED and system)</td>
<td>O</td>
</tr>
<tr>
<td>SCL implementation conformance statement SICS</td>
<td>Clarity on tool capability</td>
<td>Tools (IED and system)</td>
<td>M</td>
</tr>
<tr>
<td>Parameter and configuration Data revision and value change</td>
<td>Better version handling and reporting</td>
<td>IEDs (servers)</td>
<td>O</td>
</tr>
<tr>
<td>Defined named enumerations distinct from countable integers</td>
<td>Easier understandable, no interpretation needed</td>
<td>Clients, Tools (IED and system)</td>
<td>M</td>
</tr>
<tr>
<td>Link redundancy</td>
<td>Higher availability and interoperable solutions</td>
<td>IEDs (servers and clients)</td>
<td>O</td>
</tr>
<tr>
<td>Mechanisms for testing, simulation, maintenance</td>
<td>Support for efficient and automatic ‘in system’ testing</td>
<td>IEDs</td>
<td>O</td>
</tr>
</tbody>
</table>
### IEC 61850 Edition 2 – New features

**Data model extension**

<table>
<thead>
<tr>
<th>Group Indicator</th>
<th>Logical Nodes Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Automatic control</td>
</tr>
<tr>
<td>C</td>
<td>Control</td>
</tr>
<tr>
<td>D</td>
<td>Distributed Energy Resources (DER)</td>
</tr>
<tr>
<td>F</td>
<td>Functional Blocks</td>
</tr>
<tr>
<td>G</td>
<td>Generic</td>
</tr>
<tr>
<td>H</td>
<td>Hydro</td>
</tr>
<tr>
<td>I</td>
<td>Interfacing and archiving</td>
</tr>
<tr>
<td>K</td>
<td>Mechanical and non-electrical primary equipment</td>
</tr>
<tr>
<td>L</td>
<td>System LN</td>
</tr>
<tr>
<td>M</td>
<td>Metering and measurement</td>
</tr>
<tr>
<td>P</td>
<td>Protection</td>
</tr>
<tr>
<td>Q</td>
<td>PQ events detection related</td>
</tr>
<tr>
<td>R</td>
<td>Protection related</td>
</tr>
<tr>
<td>S</td>
<td>Sensor and monitoring</td>
</tr>
<tr>
<td>T</td>
<td>Instrument transformers</td>
</tr>
<tr>
<td>X</td>
<td>Switchgear</td>
</tr>
<tr>
<td>Y</td>
<td>Power transformers</td>
</tr>
<tr>
<td>Z</td>
<td>Further power system equipment</td>
</tr>
</tbody>
</table>

- **Logical nodes**
  - Edition 1: Approx. 90
  - Edition 2: More than 150

- **New LN groups**
  - **F Group**: FCNT: Counter, FPID: PID regulator, FSPT: Set-point control function, …
  - **K Group**: KFAN: Fan, KFIL: Filter, KPMP: Pump, …
  - **Q Group**: QVVR: Voltage Variation, QFVR: Frequency Variation, QVTR Voltage Transient, …

- **Other new LN**:
  - LTRK: Service tracking, …
IEC 61850 Edition 2 – New features
Mechanisms for testing, simulation, maintenance

- New data objects and concepts for testing
  - Testing of function parts in the running system
  - Allows a standardized application of the test and test-blocked mode

- Enables more efficient testing and maintenance
IEC 61850 Edition 2 – New features
Link Redundancy

- Redundancy within the network
  - **RSTP**, IEEE 802.1D
  - **(n-1)** criteria
  - With recovery time upon failure

- Redundancy in the end nodes
  - **PRP**, IEC 62439-3
    Parallel Redundancy Protocol
  - **HSR**, IEC 62439-3
    High-available Seamless Redundancy
  - **(n-1)** criteria
  - **Zero** recovery time upon failure

PRP/HSR is a patent of ABB Corporate Research. ABB has assured the IED to provide licenses throughout the world free of charge under reasonable and non-discriminatory terms.
## Recovery delay demands as shown in IEC 61850-5

<table>
<thead>
<tr>
<th>Communicating partners</th>
<th>Service</th>
<th>Application recovery tolerated delay</th>
<th>Required Communication Recovery Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCADA to IED, client-server</td>
<td>IEC 61850-8-1</td>
<td>800 ms</td>
<td>400 ms</td>
</tr>
<tr>
<td>IED to IED interlocking</td>
<td>IEC 61850-8-1</td>
<td>12 ms (with Tmin set to 4 ms)</td>
<td>4 ms</td>
</tr>
<tr>
<td>IED to IED, reverse blocking</td>
<td>IEC 61850-8-1</td>
<td>12 ms (with Tmin set to 4 ms)</td>
<td>4 ms</td>
</tr>
<tr>
<td>Protection trip excluding Bus Bar protection</td>
<td>IEC 61850-8-1</td>
<td>8 ms</td>
<td>4 ms</td>
</tr>
<tr>
<td>Busbar protection</td>
<td>IEC 61850-9-2 on station bus</td>
<td>&lt; 1 ms</td>
<td>Bumpless</td>
</tr>
<tr>
<td>Sampled Values</td>
<td>IEC 61850-9-2 on process bus</td>
<td>Less than two consecutive samples</td>
<td>Bumpless</td>
</tr>
</tbody>
</table>

To fulfill these requirements, IEC 61850-8-1 and -9-2 uses redundancy solutions standardized for Industrial Ethernet by IEC 62439-3.
HSR
Normal operation

Operation description:

1. Message from IED is sent via both links ("A" and "B") to the SCADA via HSR ring.
**HSR**

**Operation under failure condition**

Operation description:

1. Failure recognized in HSR ring ("A" link)
2. Message is received by SCADA via healthy part of ring ("B" link)

---

**Devices not supporting HSR**

---

**IEC61850 HSR**

---

**SYS600C**

---

**REF615A**

---

**RER620A**

---

**REC650A**

---

**REL670A**

---

**REF615A**

---
Normal operation

Operation description:

1. Message is received in SYS600C via both parallel links (LAN “A” and LAN “B”)

- SYS600C
- SCADA
- Ethernet Switch
- IEC 61850 PRP
- Ethernet Switch
- LAN A
- LAN B
- REF615A
- RER620A
- REC650A
- REL670A
- REF615A
PRP
Operation under failure condition

Operation description:
1. Failure recognized in PRP network (LAN “A”)
2. Message is received in SYS600C via healthy link (LAN “B”)
Link redundancy for end devices
- PRP: Parallel Redundancy Protocol
- HSR: Highly reliable Seamless Ring
- Red Box to connect single port IEDs

Customer Benefits
- Higher system availability, No single point of failure
- **Zero** recovery time upon failure
- Guaranteed interoperability

**ABBs offering (today):**
- SA Solutions and products with PRP
- Large # of delivered systems, experience
Thank you for your participation

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