This webinar brought to you by the Relion® product family
Advanced protection and control IEDs from ABB

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

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Presenter

- Business Development Manager for Substation Automation and HV Protection
- 25 years electric utility experience working in substation engineering, automation and metering

Mike Longrie
Communication
The new kind of communications

Home / Office Network
Plug and Play Technology –
Phones, Printers, computers, mobile phones, network devices, Laptops, and many more devices

Digital Substation deploys similar Ethernet networking technology to Substations
All the devices are connected in the substation
Local area network that includes devices from multiple vendors.
Market movement

Trends
- Focus on reliability, availability, power network stability
- Increased pressure from regulators on reliability and security
- Need for data analytics
- Changing workforce

Factors constraining market adoption
- Utility resource constraint leads to inability to evaluate and approve new technology
- Protection engineers are conservative and reluctant to change
- Historically limited interoperability has required vendor specific designs and a substation learning curve
Applications
Digital substation

Station Level
- Station automation
- Monitoring
- Fault evaluation
- Event and alarm viewing and acknowledgement
- Remote communication for telecontrol and supervision

Bay Level
- Protection
- Control
- Monitoring
- Interlocking
- Data acquisition

Process Level
- GIS or AIS switchgear
- Instrument transformers
- Power transformers
- Surge arresters
- Non-conventional transformers

IEC 61850-9-2 Non-conventional instrument transformer

IEC 61850-8-1 or DNP 3.0 over TCP/IP
What is so special about the digital substation?
Footprint, copper wires, safety, reliability and cost

- Continued self-supervision
- Self-healing bus
- Optical bus
- Interlocking logic
- Control center
- Station HMI
- Hardwired with parallel copper wires

[Diagram of digital substation components]
Basics - A breakthrough for Substation Automation

Goal of the Standard

- **Interoperability**
  - Exchange information between IED’s (Intelligent Electronic Device) from several manufacturers – three types of communications, MMS, GOOSE, Process level
  - IEDs use this information for their own function

- **Free Configuration**
  - Free allocation of functions to devices
  - Support any philosophy of customer – centralized or decentralized systems

- **Long Term Stability**
  - Future proof
  - Follow progress in mainstream communication technology
  - Follow evolving system requirements needed by customers
Basics - What is 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 (information)  GCB  Network
Basics - Process Bus
What is Process Bus

IEC 61850 station bus

Station level

IEC 61850 process bus

Bay level

IEC 61850 process bus

Process level

conventional connections to CT/VT and drives

Process bus to merging units for current and voltage sensors

Process bus to merging units for current, voltage and binary signals
Leveraging utility experience to provide transformative digital solutions that deliver significant improvements over traditional approaches

Enhanced safety....
Reduce risk of fire and safety hazards for your personnel

Functional consolidation....
Next generation multi-function capabilities significantly reduce footprint

Improved reliability and efficiency through simplicity....
Reduced complexity improves reliability and efficiency

Proofs - The Digital Substation Solutions for utilities‘ critical needs

Lower total cost of ownership
WARNING!!! The secondary circuit of CTs should never be opened or left open when current is flowing in the primary. If the secondary circuit is open, the primary current will drive the core to saturation, inducing abnormally high and possibly lethal PEAK voltages.
Proofs - Enhanced safety
Reducing open CT risks in the control house

- Reduce risk of injury when conventional instrument transformers, voltage and current signals are connected to a digital interface at the primary equipment safely away from field personnel
- Safely replace relays without taking the substation out of service

Increased safety and reduced risk of personnel injury in the control house
Proofs - Enhanced safety
Reducing the risks in the control house

Digital substation reduces wiring complexity and resulting risks for operations & maintenance personnel

Before

After

No cable tray

Single conduit to carry fibers
Proofs - The Digital Substation
Solutions for utilities' critical needs

Leveraging utility experience to provide transformative digital solutions that deliver significant improvements over traditional approaches

Enhanced safety....
- Reduce risk of fire and safety hazards for your personnel

Functional consolidation....
- Next generation multi-function capabilities significantly reduce footprint

Improved reliability and efficiency through simplicity....
- Reduced complexity improves reliability and efficiency

Lower total cost of ownership
Proofs – Analogy of functional consolidation
The evolution of technology

- Technology drives consolidation of functions in all industries
- Reduces amount of inventory
- Improves the work process
- Requires new skill sets
Proofs – Free allocation of function/logical nodes
Enables functional consolidation

Function Library          Hardware Platform          PAC Application

PDIS 21  PDIF 87B  PIOC 50  PEFM 51/67N  PVPH 24  RSYNC 25  RREC 79  MMTR  MMUX
PDIF HZ  PDIF 87L  PIOC 50N  POCM 51/67  PTOF 81  PTUF 81  RBRF 50BF  PUVM 27
PDIF REF  PDIF 87T  POCM 51/67  PSCH

Communication

REG670
RET 670
REB 670
REL 670
RED 670
REB 670
RET 670
RET 670

ABB
Proofs – Example of Functional consolidation
Reduced footprint, hardware and infrastructure

Reduction in panels from 3 to 1

Conventional

Digital

14 protection & control devices
(Electro-Mechanical system could add 3 devices per function)

2 protection & control devices
including busbar protection/backup

Advanced solution
From 3 panels to 1 panel
Proofs – Example of functional consolidation
Reduced footprint, hardware and infrastructure

Comparison of digital vs. traditional solution for static VAr compensator (SVC) project example

- 4 ABB Relion relays vs. 14 traditional relays
- 50% reduction in number of panels – 4 to 2

Main protection - traditional relays

Main protection - digital substation
Proofs - The Digital Substation
Solutions for utilities’ critical needs

Leveraging utility experience to provide transformative digital solutions that deliver significant improvements over traditional approaches

- Enhanced safety....
  Reduce risk of fire and safety hazards for your personnel

- Functional consolidation....
  Next generation multi-function capabilities significantly reduce footprint

- Improved reliability and efficiency through simplicity....
  Reduced complexity improves reliability and efficiency

Lower total cost of ownership
Proofs - Simplicity improves reliability
Reduces complexity and number of points of failure

Example – Hybrid digital substation implementation

<table>
<thead>
<tr>
<th>Traditional Copper Wires</th>
<th>Digital Communications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conventional cabling</strong></td>
<td><strong>Partly Digital Communications</strong></td>
</tr>
<tr>
<td>No of cables: 768</td>
<td>No. cables: 256</td>
</tr>
<tr>
<td>Conductors: 4500</td>
<td>No. conductors: 1500</td>
</tr>
<tr>
<td>Terminations: 9000</td>
<td>No. terminations: 3000</td>
</tr>
</tbody>
</table>

**Test/Debug** – Labor intensive
**Maintenance** – Drawings up to date?
**Reliability** – Many connections

**Test/Debug** – Easier to test/debug using digital tools
**Maintenance** – Digital record of connections and much simpler wiring improves maintenance
**Reliability** – Less connections and units to fail improves reliability (receive digital notification of an issue)

67% reduction wires
Conventional design

Control IED  Protection IED  Protection IED

Switchgear  CTs/VTs

Circuit diagrams
Connection tables
Cable lists
Proofs - Simplicity improves reliability
Reduces complexity and number of points of failure

Example – Complete digital substation implementation

Traditional Copper Wires

- **Conventional cabling**
  - No of cables: 768
  - Conductors: 4500
  - Terminations: 9000

- **Test/Debug** – Labor intensive
- **Maintenance** – Drawings up to date?
- **Reliability** – Many connections

Digital Communications

- **Full Communications**
  - No. of Fiber optic cables: 4
  - Continuous self supervision

- **Test/Debug** – Easier to test/debug using digital tools
- **Maintenance** – Digital record of connections and much simpler wiring improves maintenance
- **Reliability** – No conventional cables and self supervision

Elimination of wires
Proofs - Simplicity improves efficiency
Tools simplify substation analysis and testing

Visualization of logic within the substation

Simple Testing of Relay Sources

Faster troubleshooting of substation logic

Easy review of voltage and current source connections for relaying (polarity of inputs)
Parallel Redundancy Protocol (PRP)

**Operation Mode**
- 2 Ports active
  - Messages are sent / received simultaneously on both ports
  - Switch over time 0ms

**Advantages**
- No recovery time
- No messages are lost
- Network redundancy (Network A and B)
- IEDs are not active part of the network
- Standard according IEC 61850-8-1/9-2 Edition 2
How it works
PRP Operation in normal condition
Demonstration
PRP Operation with “faulty” condition
Proofs – Digital Substation Benefits
Assessment of cost impact

- Overall reduced time to engineer, install and commission substations
- Up to 50% reduction in real estate requirements
- >70% reduction in copper wiring – installation, maintenance, and debug
- Reduced operational costs using tools to improve installation and troubleshooting needs
Proofs – Digital Substation Benefits
Assessment of operations impact

- Improved safety for personnel
- Improved documentation
- Improved reliability
- Improved maintenance and diagnostics
- Increased flexibility for future expansion
- Reduced outage time for retrofits
- Safeguards investment with a future-ready solution that provides migration to the digital substation
  - DNP 3.0 today, 670 delivered with IEC 61850 for tomorrow usage
Summary - Why the Digital Substation is so special!

- Reduce amount of cables by using fiber instead of copper
- Optimize drive and interface boxes with direct process bus connection
- Lower requirements on CTs/VTs by reducing burden from cabling and minimizing No of circuits
- Simplify P&C panels and increase safety by full isolation from process
- Include NCITs in P&C system and by that further increase safety & availability
- Reduce maintenance through increased supervised area
The Digital Substation - part of the future Smart Grid
Communication, interoperability & cyber security!

ABB has designed the building blocks to meet these requirements for the
Digital Substation – ready for the future Smart Grid
Advanced protection, control and automation
Migrating to the Digital Substation

- Communication is the game changer and interoperability throughout systems of systems is the main challenge
- Change from old box-and-wire blue print to a system approach with functional specification allowing more efficient solutions with lower total cost
- Bring together Control & Protection with standardized Communication to ensure future proof interoperability and supports Cyber Security compliance
- Implement Reliability Centric Design of the complete system with self supervision and redundancy to guarantee availability and maintainability
- Plan, structure and empower involved work force in engineering, operation and maintenance
- Pilot with Proof of Concept and FAT/SAT to ensure total system performance
- Build a technology sandbox (test bed) to demonstrate the Digital Substation capabilities to your organization
Enabling advanced protection, control and automation
Extending to Asset health and Wide Area solutions

Wireless communications
- Provide a redundant communication path for critical asset health applications
- Mesh network allow communication reconfiguration
- Reliable, high capacity, low latency, secure and adaptable

Asset Health systems
- Control of the recovery allows for efficient decision making
- Transmission applications focused on grid resiliency in development
- Systems allow for managing congestion, balancing the load and maintaining reserve capacity

Proactive control systems
- Collect and analyze real-time data throughout the power grid
- Early warning system for blackouts
- Safety and stability margins analyzed
- Aids operators in making correct live decisions
- Dynamic monitoring system
Digital substation product portfolio

Substation interface and HMI (Station level)
- RTU560 & MicroSCADA SYS600C

Protection and Control (Bay level)
- Relion family control and protection IEDs
  - 670 series & 650 series
  - REB500 for distributed busbar applications
  - IEC 61850 system engineering: IET600
  - IEC 61850 testing: ITT600 SA Explorer

Interface to Switchgear (Process level – NCIT)
- ABB NCITs for GIS, CP-MU merging unit for ELK-CP14 and ELK-CP3 (current and voltage)
- ABB LTB with integrated Fiber Optic Current Sensor FOCS-MU (current only)

Process level – stand-alone merging units
- SAM600 modular process bus IO system
Thank you for your participation

Shortly, you will receive a link to an archive of this presentation. To view a schedule of remaining webinars in this series, or for more information on ABB’s protection and control solutions, visit:

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