



03/31/2017

Digital Substation

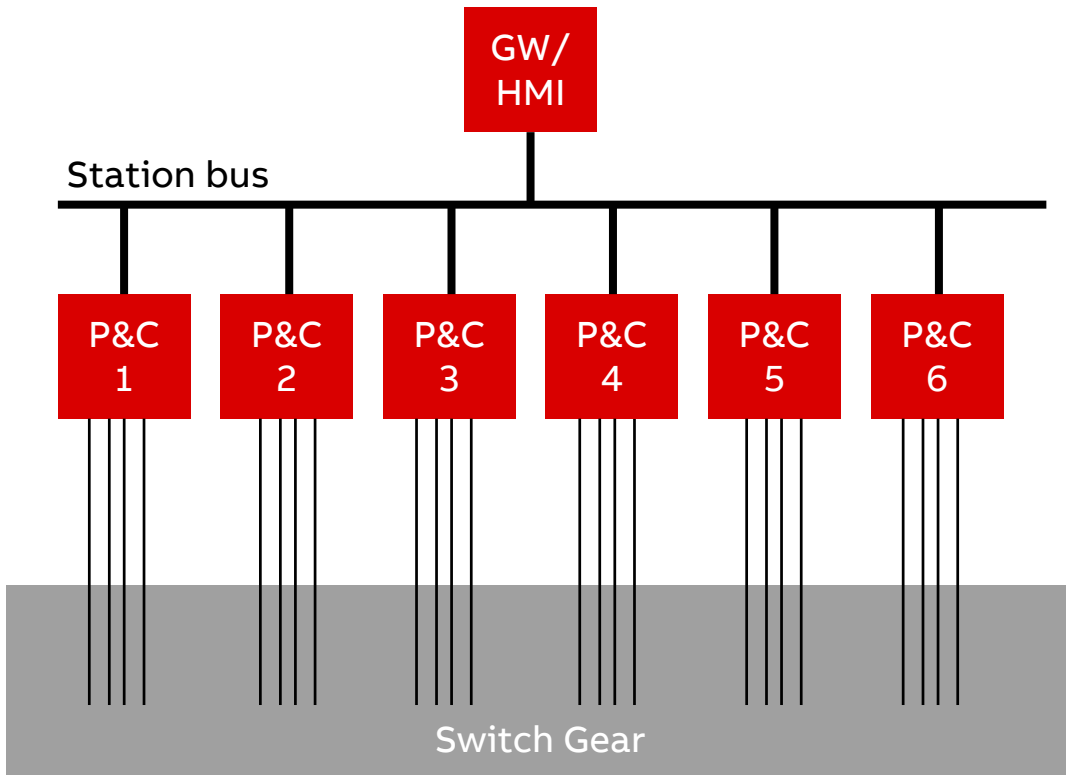
Turning IEC61850 features into benefits

Peter Rietmann, Program Manager Digital Substation NA

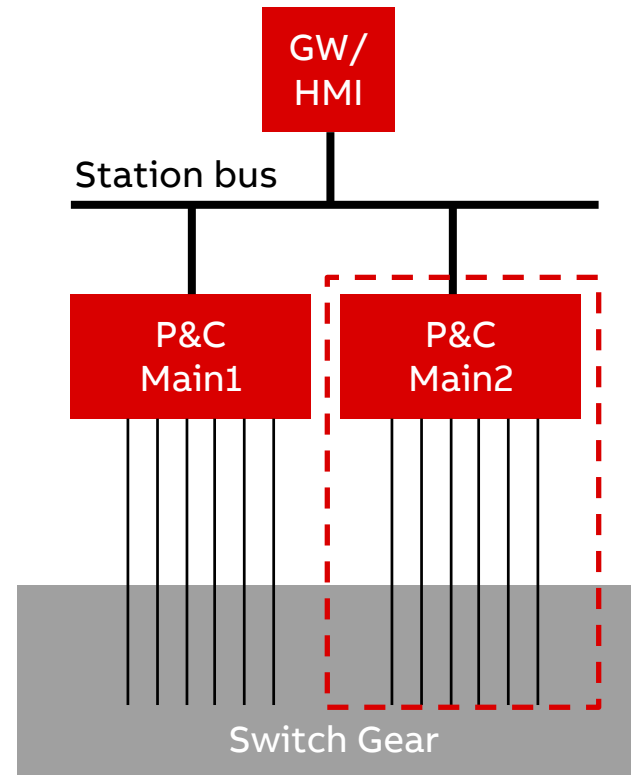
Increasing Reliability

Higher functional integration and process close digitalization

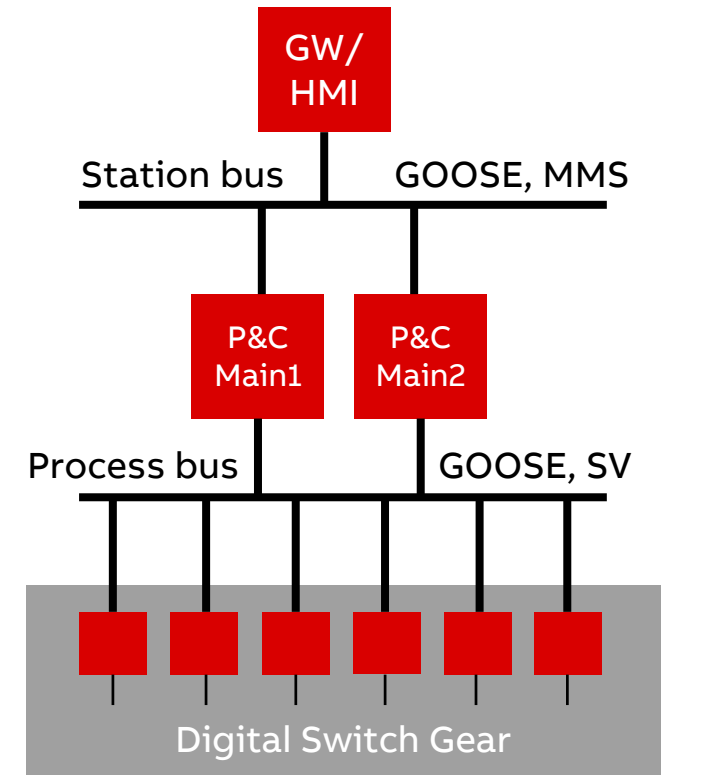
SA Distributed solution:



SA Central solution:



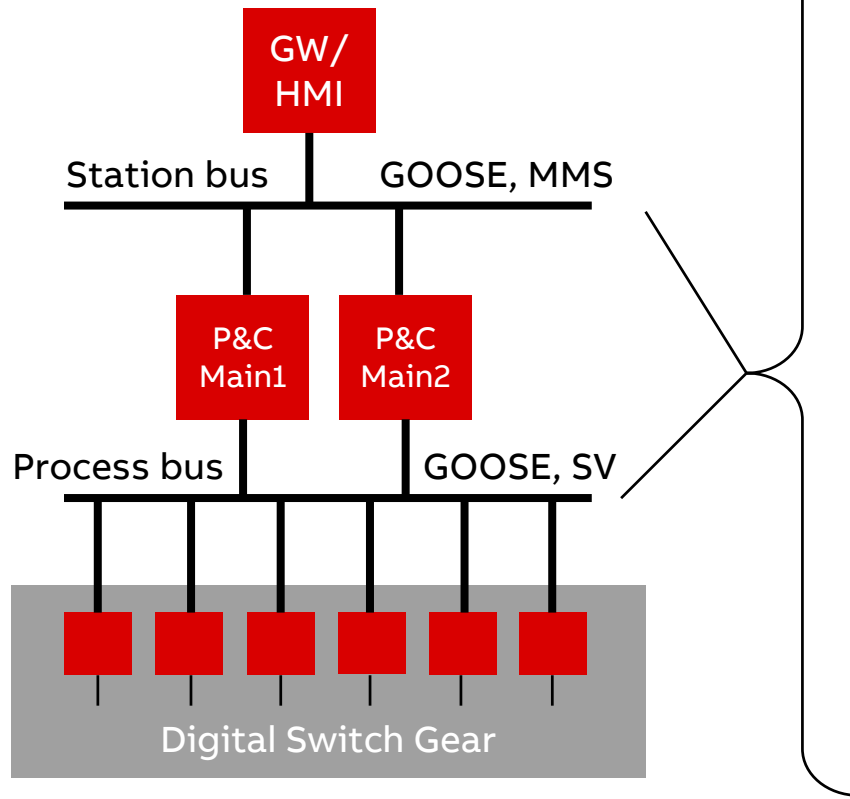
Digital substation solution:



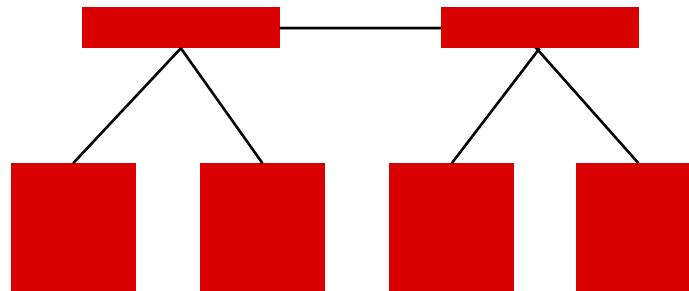
Increasing Reliability

Basic network topologies

Digital substation solution:



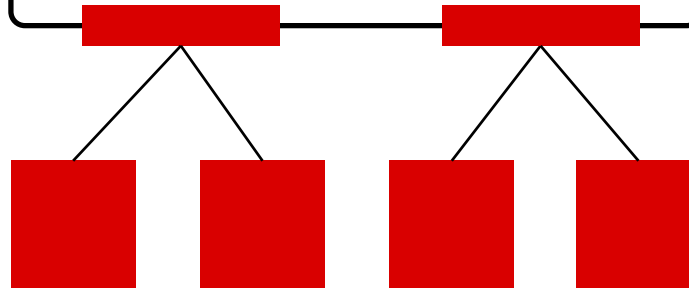
Single network, star or bus



Single network, star or bus

- Easy to configure
- No network redundancy

Single network, RSTP Self-healing



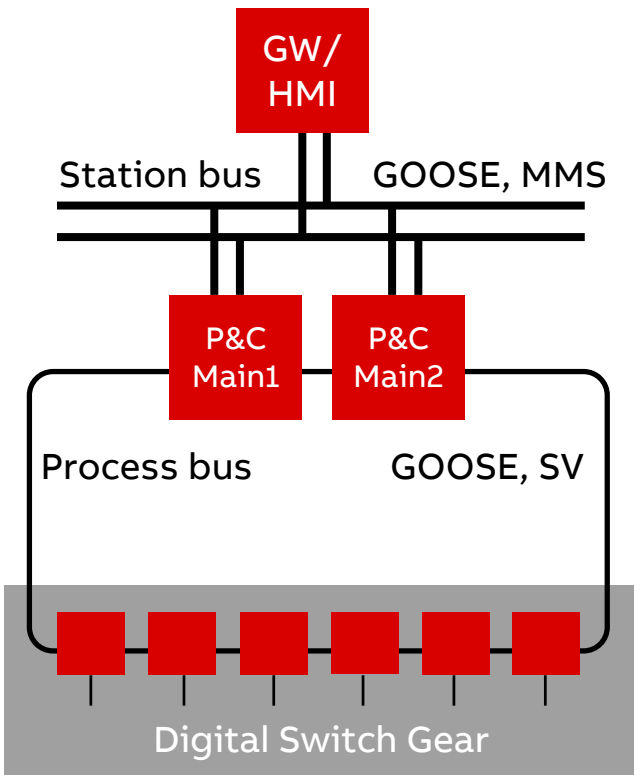
Single network, ring or multiple rings

- Complex to configure
- Reconfiguration delay time in case of network failure
- Not suitable for process bus

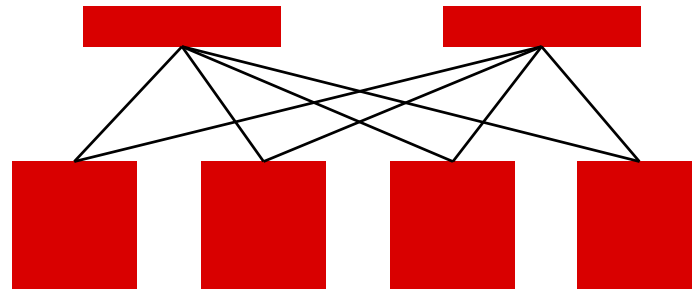
Increasing Reliability

Basic network topologies

Digital substation solution:



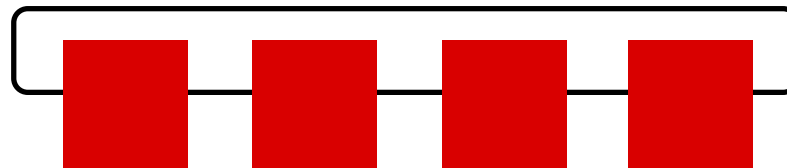
Link redundancy, PRP



Link redundancy, PRP

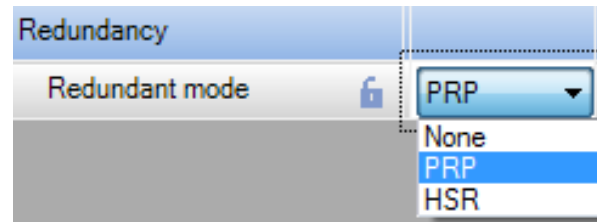
- Easy to configure
- Redundant networks
- End-to-end redundancy
- Bumpless no switch over time
- Suitable for station and process bus
- High performance, large networks

Link redundancy, HSR



Link redundancy, HSR

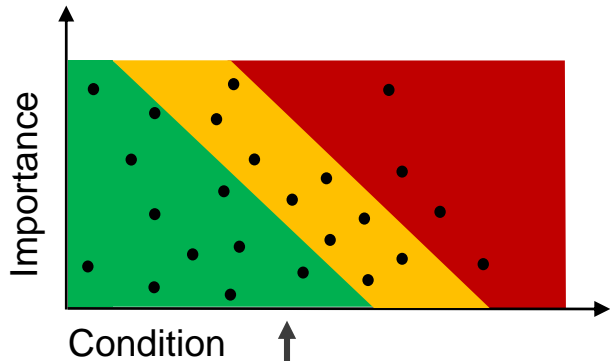
- Easy to configure
- Bumpless no switch over time
- Suitable for station and process bus
- Smaller networks



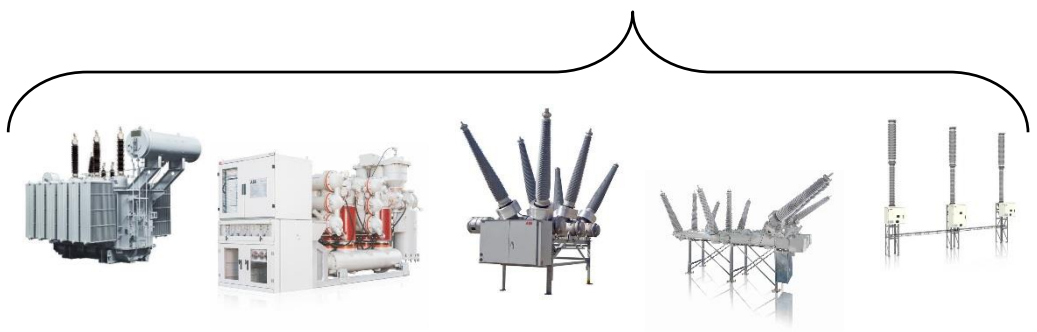
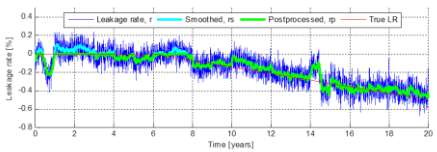
Digital Switchgear

Trend: Higher integration and more data

Fleet Management



Data analysis



Traditional primary equipment with hardwired interface

- Transmission: Stand-alone merging units enable digitalization
 - Modular approach to reduce copper cable process connections
 - Low functionality focus on simplicity
 - Bridging new and old technology e.g. combine NCITs and PT/CTs
- Distribution: Feeder relays incorporate merging unit function
 - Enable distributed or central P&C functions

Digital switchgears

- Transmission: Primary equipment comes with IEC61850 interface
 - Motor drive for CBs and disconnectors
 - CB monitoring, Transformer monitoring
 - Non conventional instrument transformers
- Distribution: Feeder relays with merging unit function and NCITs
 - Increased safety and reduced weight

SP Energy Networks

Future Intelligent Transmission NEtwork SubStation

Project: SPTEN02 FITNESS

- Demonstrate a multi-vendor fully interoperable digital substation solution
 - Deploying standardized and fully Integrated substation protection, monitoring and control system based on the IEC61850-9-2 standard.
- Reduce environmental impact of substations
- Enhance substation safety
- Enable increased flexibility and greater controllability in substations
- Timescale 4 years (Apr 2016 to Mar 2020)



The solutions enabled by FITNESS will facilitate reduction in substation costs, improve system access and reduce network constraints feeding through to significant benefits to GB customers

SP Energy Networks

Future Intelligent Transmission Network SubStation

The FITNESS substation design also enables savings in operational practice and procedures.

Traditionally,

- if a protection device fails, the primary plant may operate under depletion i.e. with non-redundant protection for no more than two hours. After two hours, the primary plant must then be taken out of service, resulting in an outage.
- In conventional practice, to avoid outage, protection device failure requires immediate and urgent response to return the system to normal service.

With the FITNESS substation design,

- hot-standby reserve protection can be used to take over functions of the failed device,
- thus avoiding the need for resorting to a system depletion or outage.
- The failed device can be replaced through remote access and configuration change, and does not require a change to wired connections to primary plant, meaning that the primary plant can remain in service throughout.

Digital substation

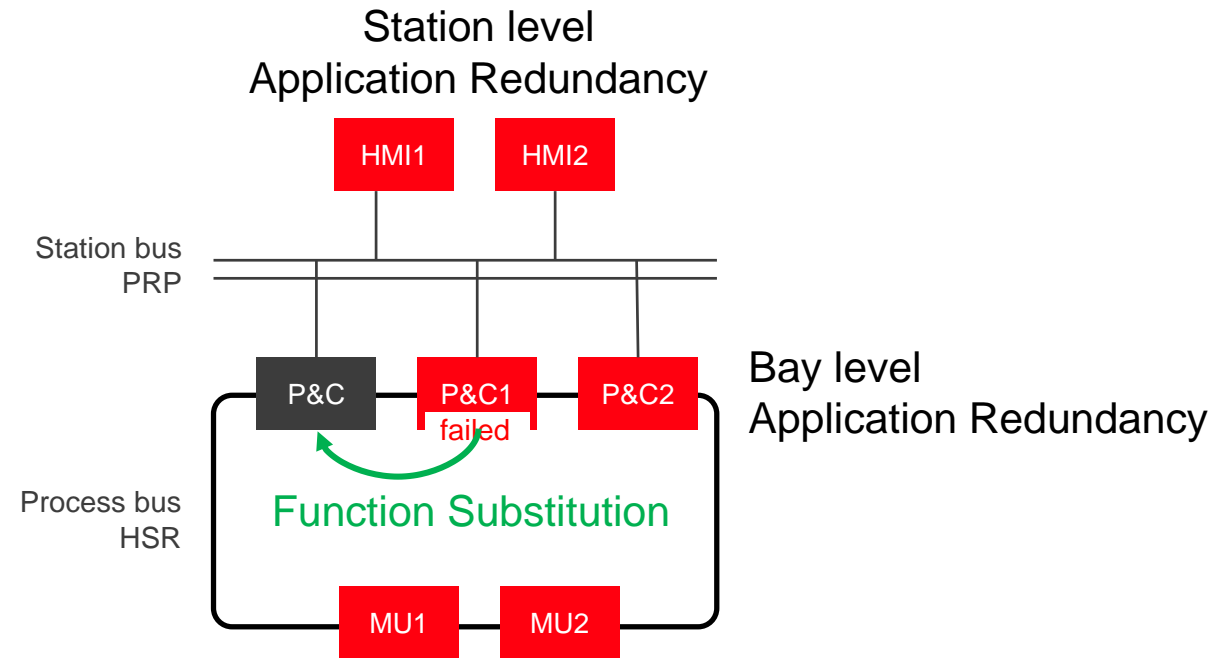
Increased system availability through flexibility

Approach:

- Use robust system components, apply redundancy where needed (flexible to application driven performance and availability requirements)

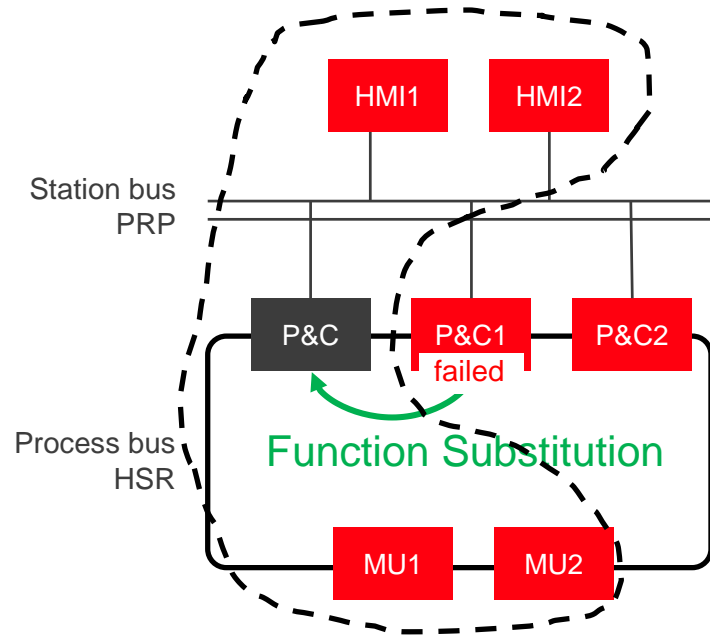
Available features:

- End-to-end redundant protection and control systems
- Seamless communication redundancy with HSR and PRP
- Functional redundancy (hot stand-by, hot-hot, substitute, simulate)



Digital substation

Increased system availability through flexibility



How to test it before taking into service?

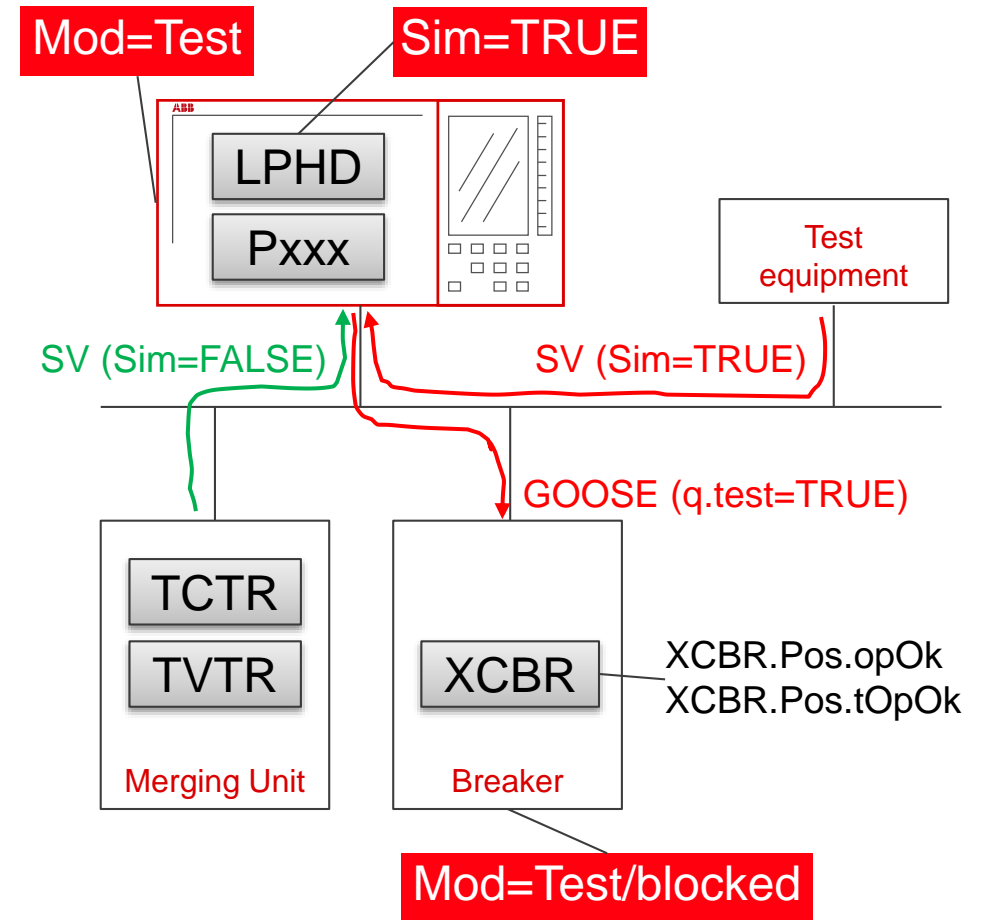
- Verify communication of substitution IED with MUs
- Verify communication of substitution IED with HMIs
- Confirm protection and control functions

Efficient testing without system down time

IEC61850 Ed2 – Test mode and simulation

Testing procedure

- Protection device receives simulated sampled values from a test device
- Protection IED will initiate a trip
- Trip is sent as GOOSE with q.test=TRUE to XCBR
- XCBR will receive GOOSE but not trip as it is in TEST-BLOCKED mode
- Output can be verified through OpOk and tOpOk attributes



Operational flexibility and re-configurability

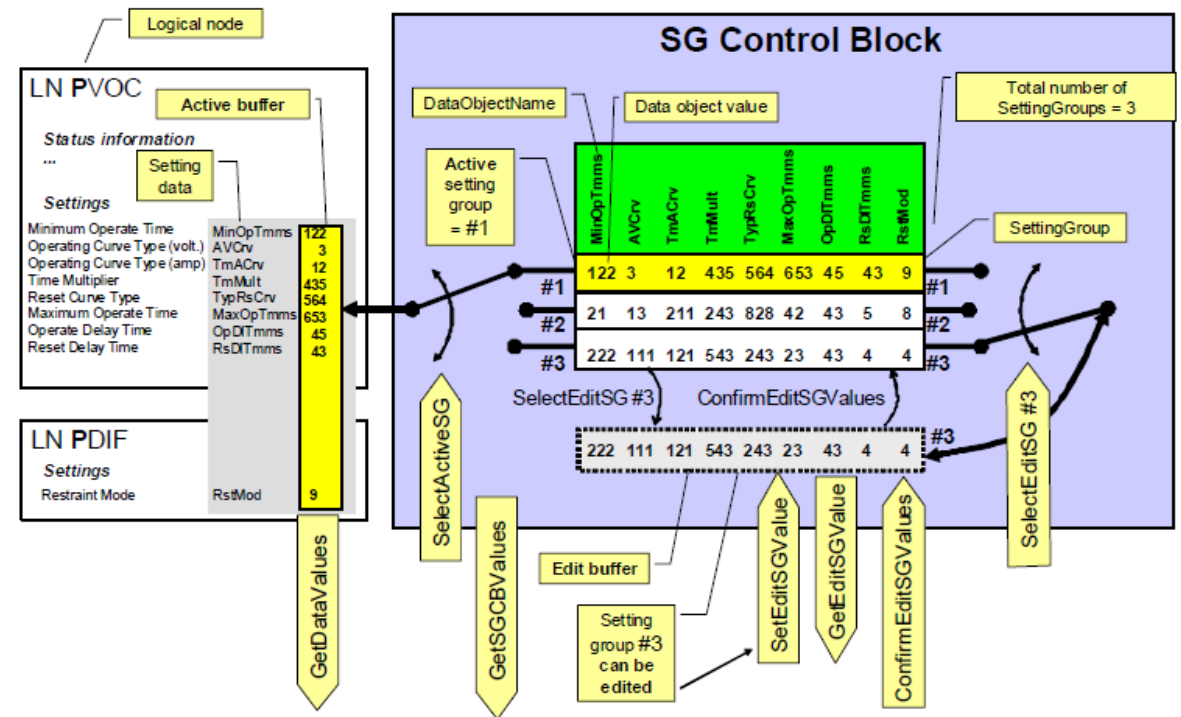
Adjusting settings to dynamic load limits

Challenge

- Demonstrate that protection group settings can be selected from wider system observations, thus enabling adaptive protection in case of low carbon generation and fault level changes
- Automating protection settings choice in response to system observation, e.g. for varying short circuit levels.
- Replacing nuclear power with wind: Impact on system stability

Solution

- Settings via IEC 61850 for line protection and voltage regulation. This enables IEC 61850 clients to remote parameterize the IEDs in a standardized way.
- E.g. High-speed distance protection
 - Change zone X&R reaches and load-encroachment blinder area settings remotely
 - Over-current protection: Change current pickup remotely



Summary

- More than 12 years IEC61850 experience demonstrate the maturity of the standard
- Initially installations based on station bus, now strong increasing projects with process bus
- Increased usage of interoperable IEC61850 features enables utilities to become more flexible and create more reliable solutions
- Sum of benefits makes digital substation compliant to IEC 61850 the unmatched solution for substations of the future grid



ABB