DIGITAL SUBSTATION: EXPERIENCES WITH A SUBSTATION AUTOMATION AND PROTECTION SYSTEM BASED ON IEC61850 9-2 PROCESS BUS

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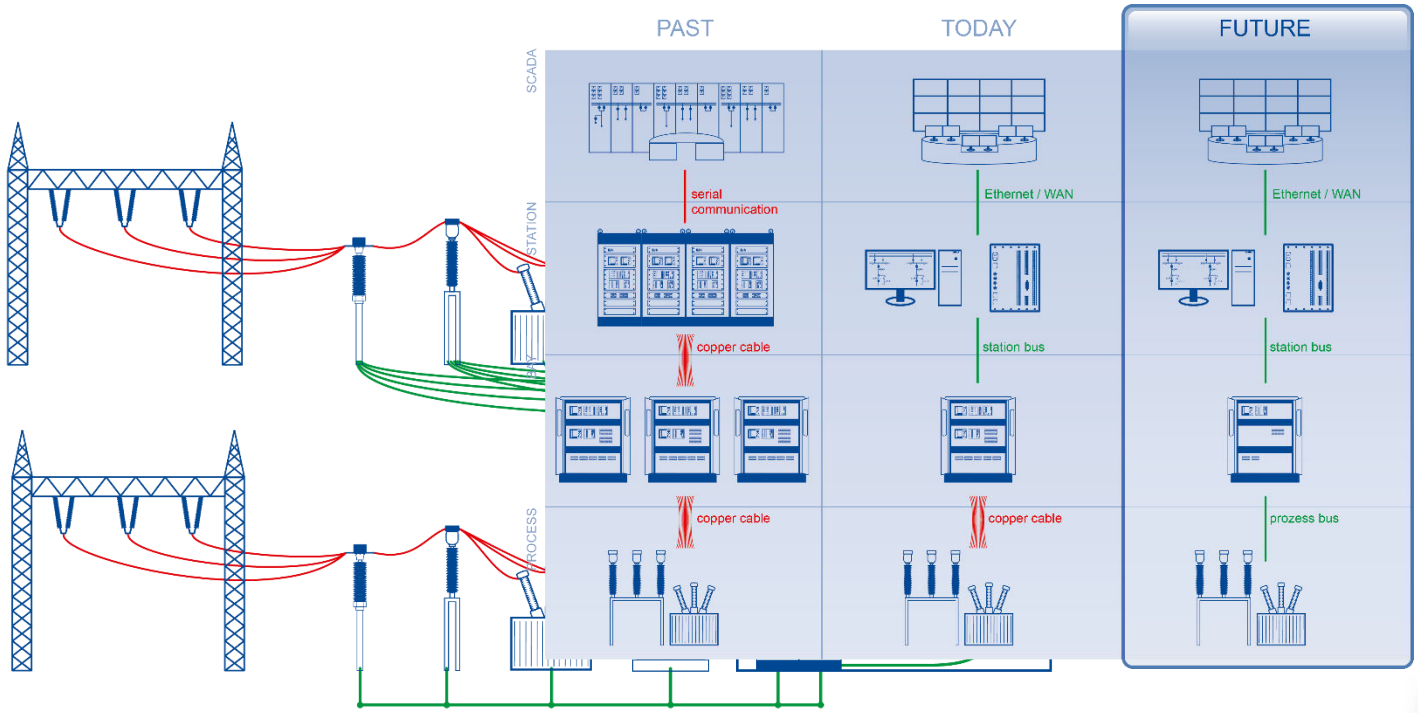
sprecher automation

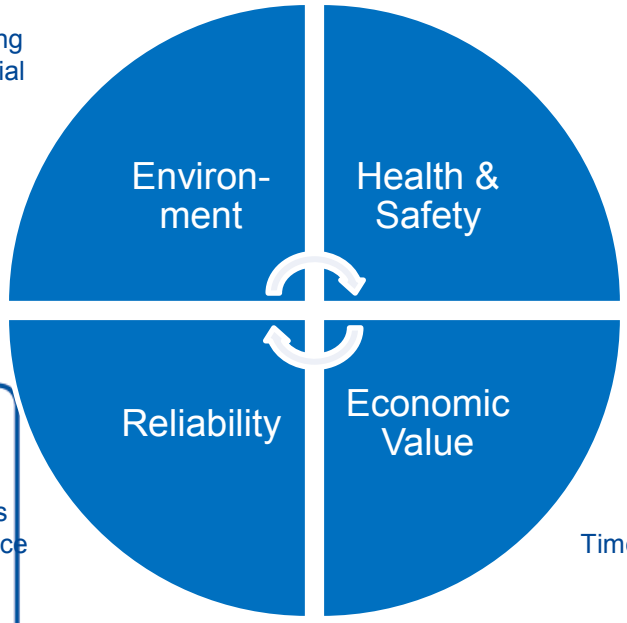
OVERVIEW PROCESS BUSS - GENERAL

- Remove hard-wiring on field-level
- NCIT (non-conventional instrument transformers) feed data to process bus
- Merging Units: Integrate Conventional Equipment



OVERVIEW PROCESS BUS - GENERAL

Copper Cabling
Overall Material
Expenditure



Reduced Time On Site
Reduced Hazards

Data Analytics
EMC Resilience

Fiber vs. Copper Cost
Time for Engineering & Testing
Land Take, Cabinets Size

CUSTOMER EXPECTATIONS

EXPENSES

Less Copper Wiring

Less Space required for Secondary Systems

TIME

Fast Commissioning due to Digitalisation

SAFETY

No Galvanic Connections (only Fibre-Optic)

No Risk of Overvoltage when Transformer Circuits are open (NCIT)

OVERVIEW DSAS PILOT

- Statnett: Digital Substation Pilot Project in a live 300kV Substation
  - Tender: Early 2016
  - Project: 10/2016 (Specification) – 10/2017 (Installation and Commissioning)
- Stakeholders: Statnett (Operator) +
  Jacobsen Elektro & Sprecher Automation (Vendor + Integrator)
- Goal:
  - Gather practical experiences with DS technologies
  - Evaluate Interoperability
  - Gain knowledge on how to create future DS using process bus advantages

OVERVIEW DSAS PILOT

Station Bus with Gateway and HMI

Distance Protection for Lines 1&2 + Bay Control Units.
Line1: SAMU + CIT,
Line2: MU+NCIT

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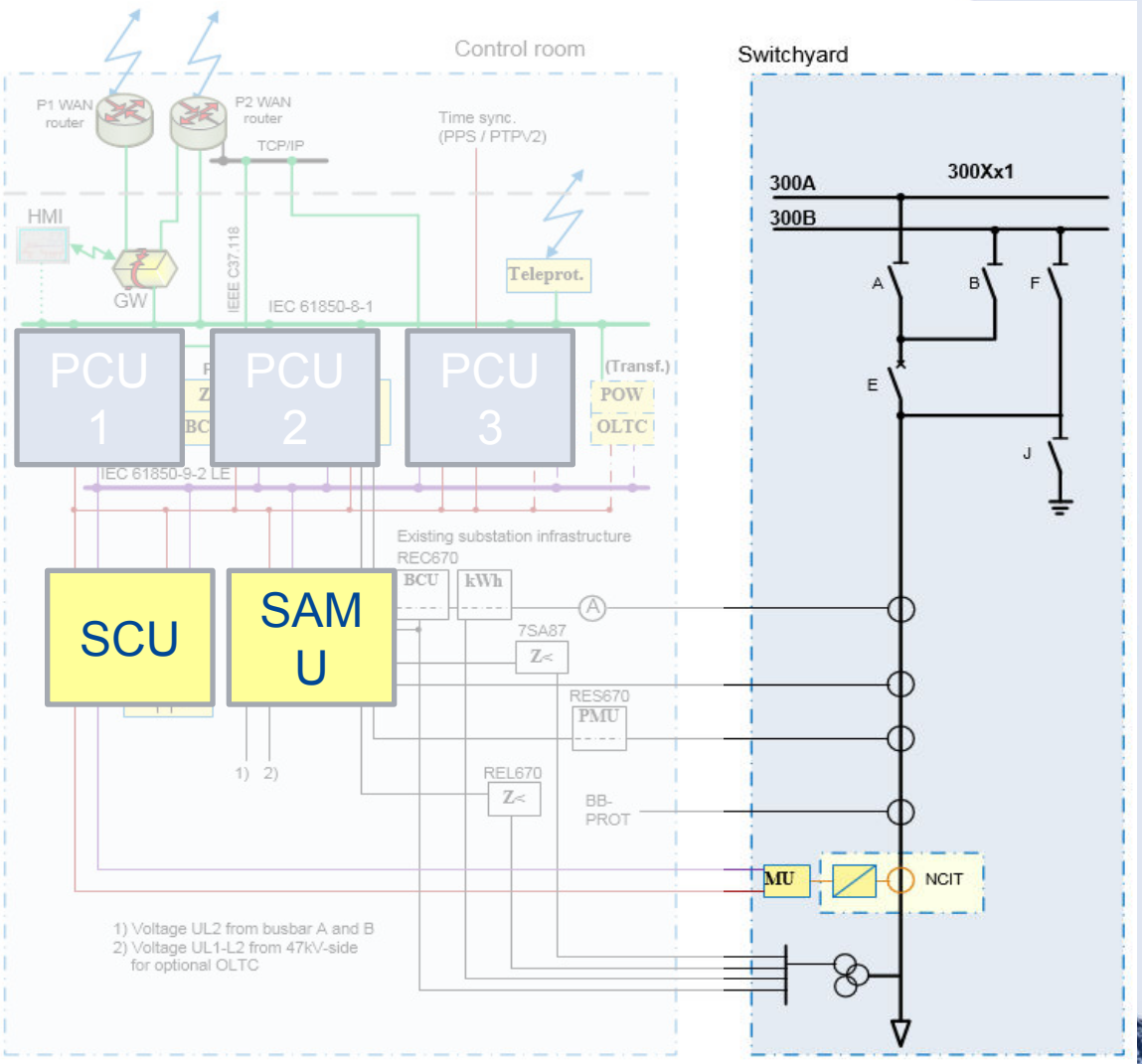
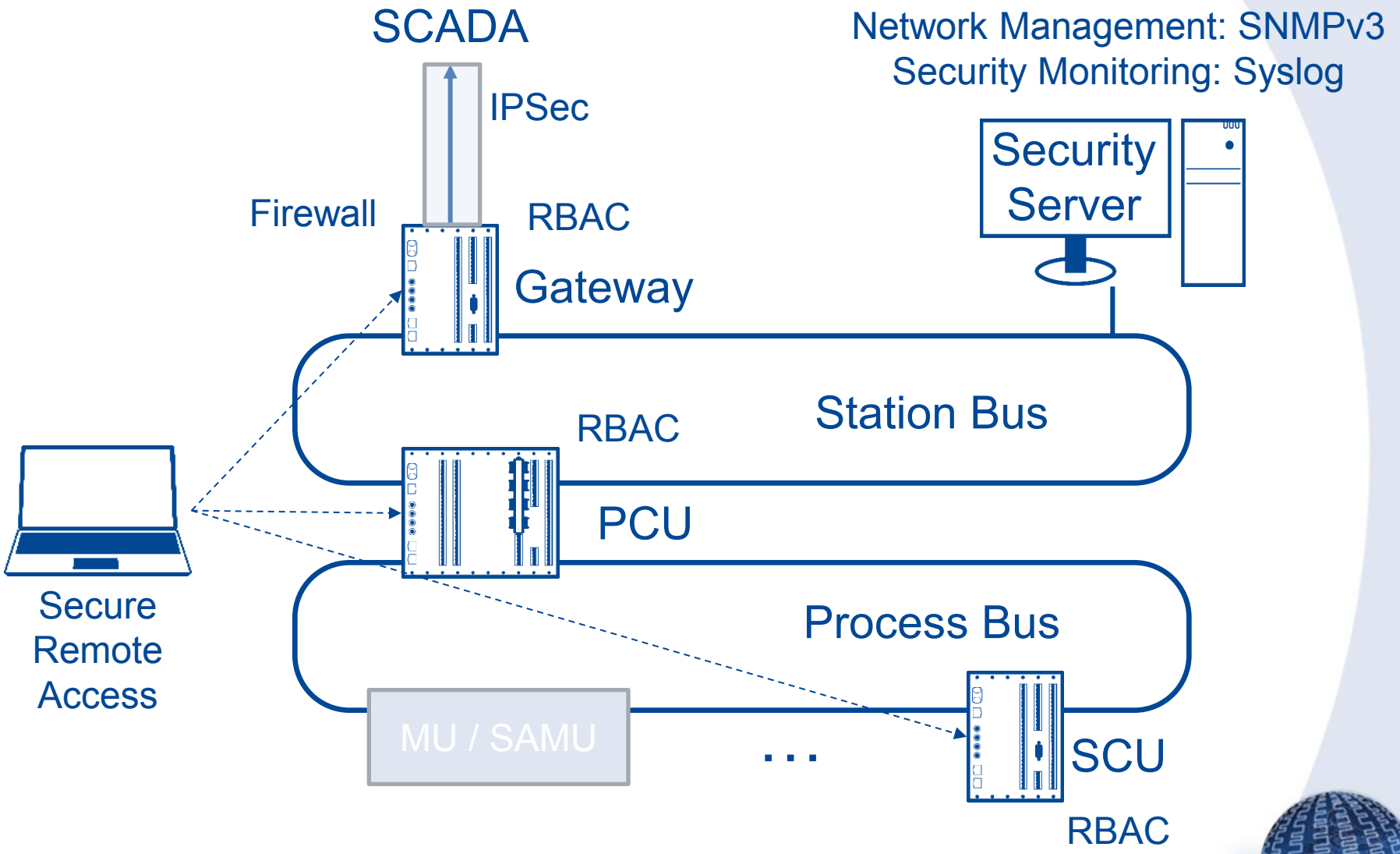
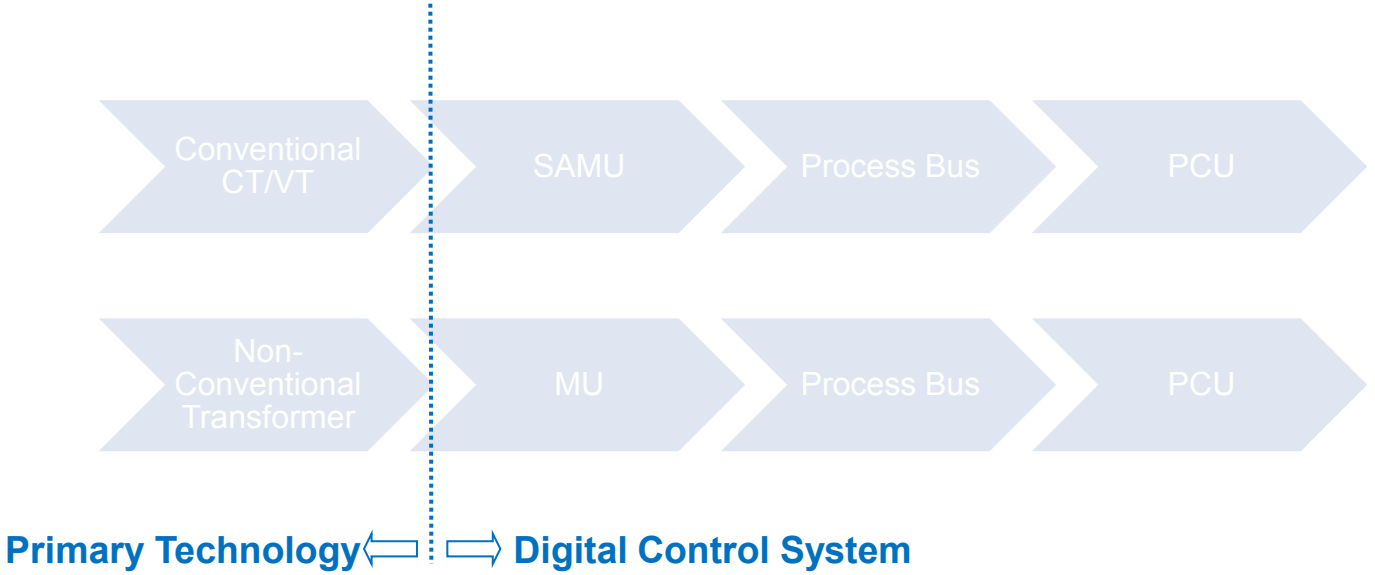


CYBERSECURITY CONCEPT



DSAS PILOT FUNCTIONAL SETUP

- Multiple Measurement / Command Chains
  - For validating NCIT vs. CT/VT
  - For creating redundancy



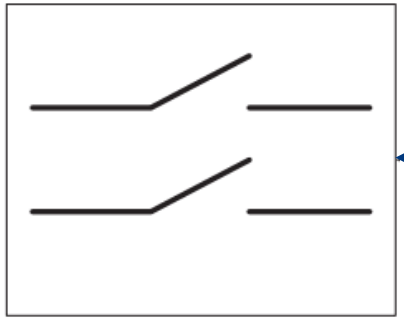
DSAS FUNCTIONAL SETUP

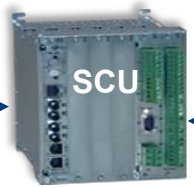
MU / SAMU

Samples Values
IEC 61850-9-2 LE

Process Bus

Station Bus

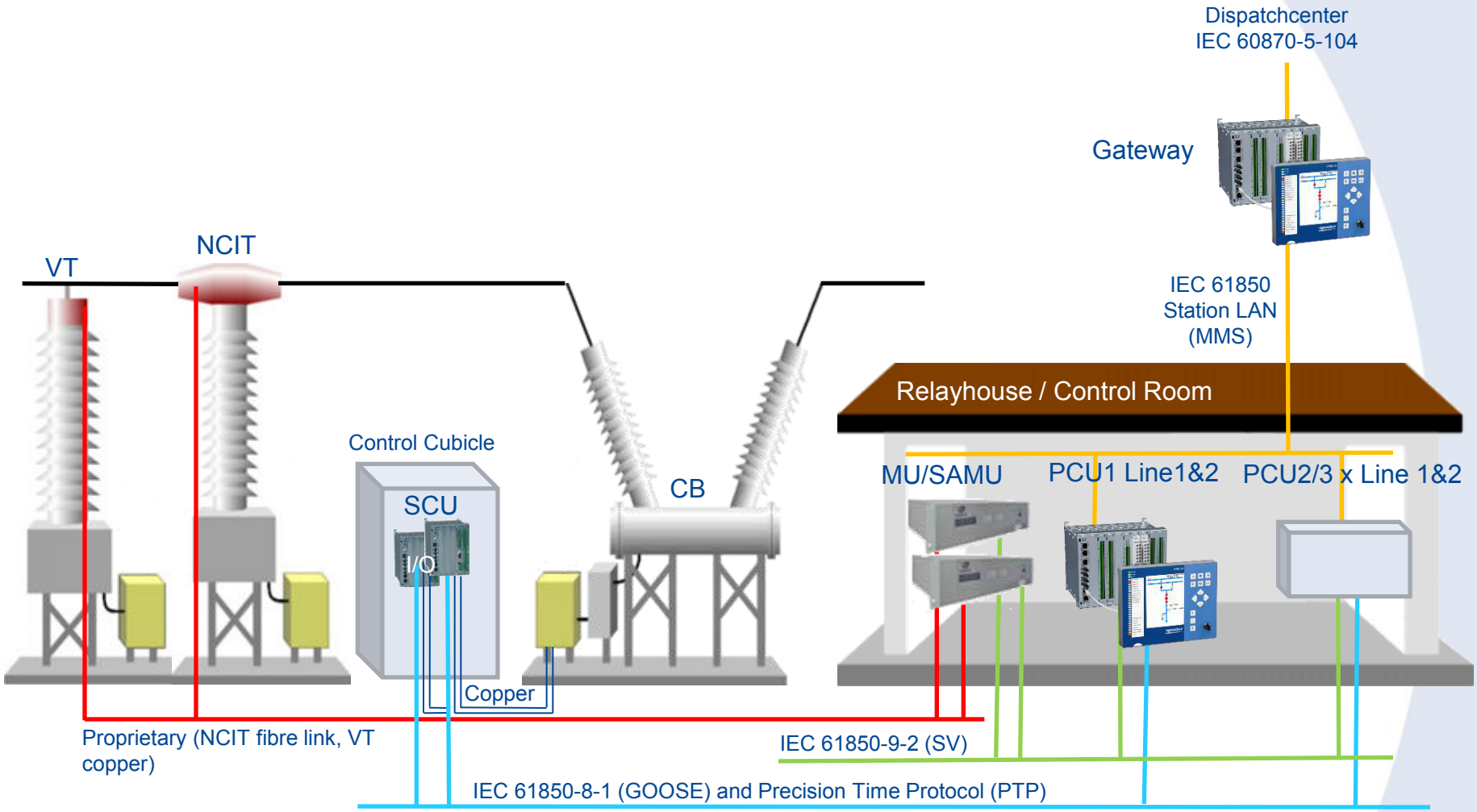




IEC 61850 GOOSE

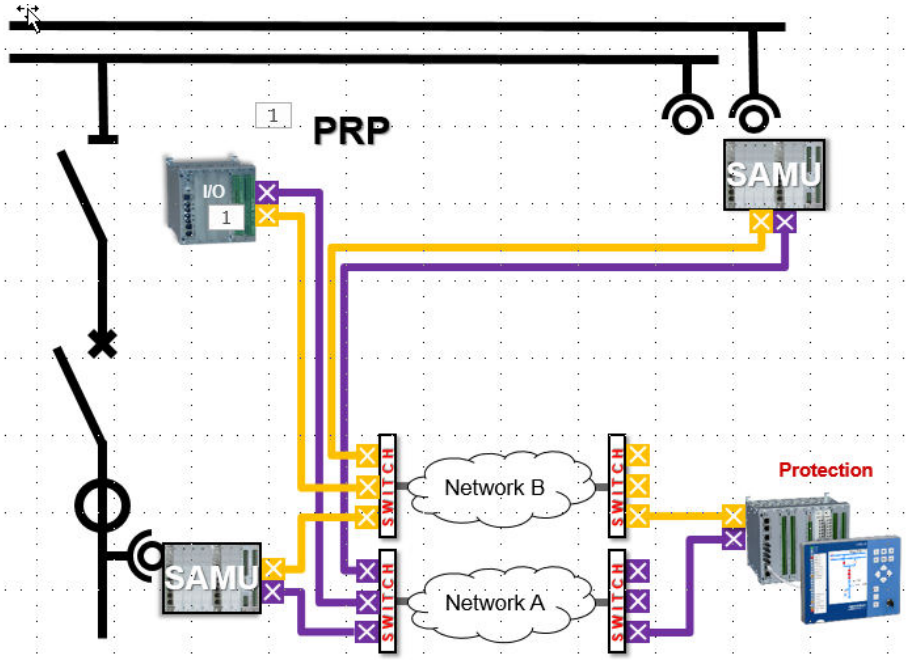
Primary Technology ⇦ ⇨ Digital Control System

DSAS PILOT COMMUNICATION



TECHNICAL CHALLENGES: AVAILABILITY

- Functional Redundancy: Parallel Command Chains (shown before)
- Network Redundancy: How to protect against network failures?
  - PRP for seamless redundancy



TECHNICAL CHALLENGES

- Time Synchronization: Sub-Microsecond
  - Merging units need to be synchronized
  - Additional synchronization between merging and protection units
  - PTP Power Profile (IEC 61850-9-3)
  - PTP needs to be compatible for all devices

- Bandwidth
  - GB-Ethernet needed! (4kHz sampling rate)
  - Testing doubles the bandwith consumption

CONCLUSION

- DSAS Pilot in live 300kV substation
  - Evaluate multiple combinations of CIT/NCIT technology with various vendors
  - Experience achievable advantages through DS / process bus
  - Realize pilot within one year

- Technical Challenges
  - Time Synchronization: PTP
  - Availability
    - Network redundancy with PRP
    - Redundant command chains
  - Bandwidth
    - Gigabit-Ethernet needed
    - Using VLANs for Process Bus / GOOSE
  - Vendor Lock-In MU/NCIT
  - Cybersecurity
  - Testing

Thank you
for your attention!