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Theoretical, laboratory and real life comparison of conventional and IEC61850 process bus based protection systems

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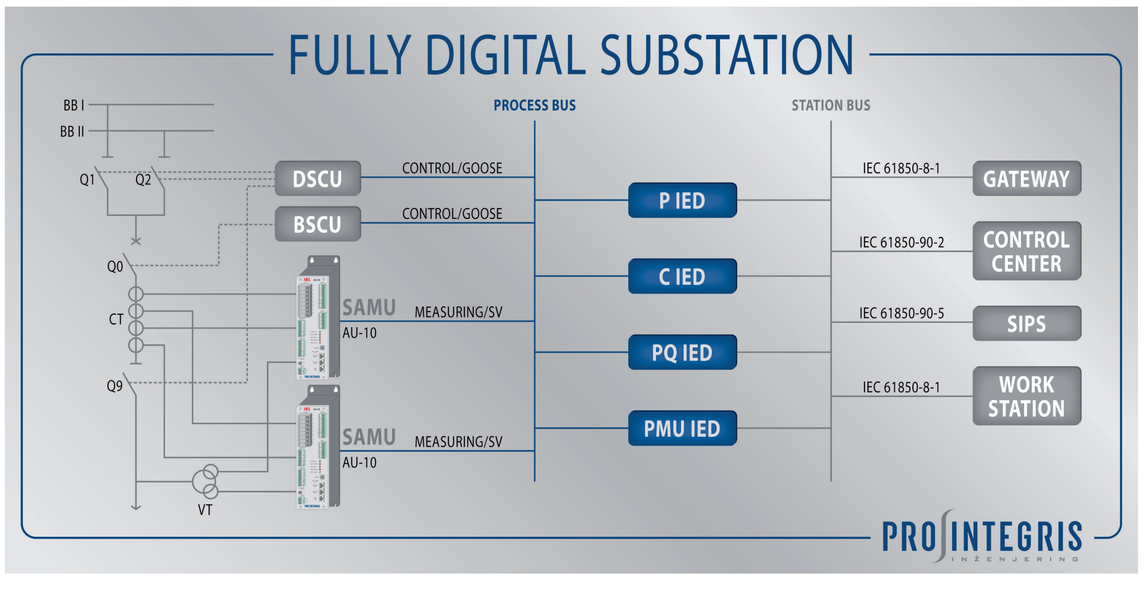
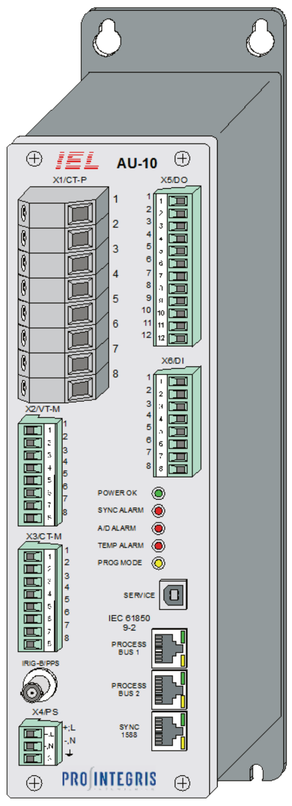
Process based secondary system



- All primary information are virtualized, as close to their source as possible, based on IEC61850 standard (Logical Nodes)
- Introduction of **Merging Unit (MU)** for measurements and **I/O process units** for switching equipment and other signals from switchyard
- New communication network called **Process Buss** for exchange of digital measurements - **Sample Values**, indications and command - **GOOSE**
- All IEDs become users of data on Process Bus

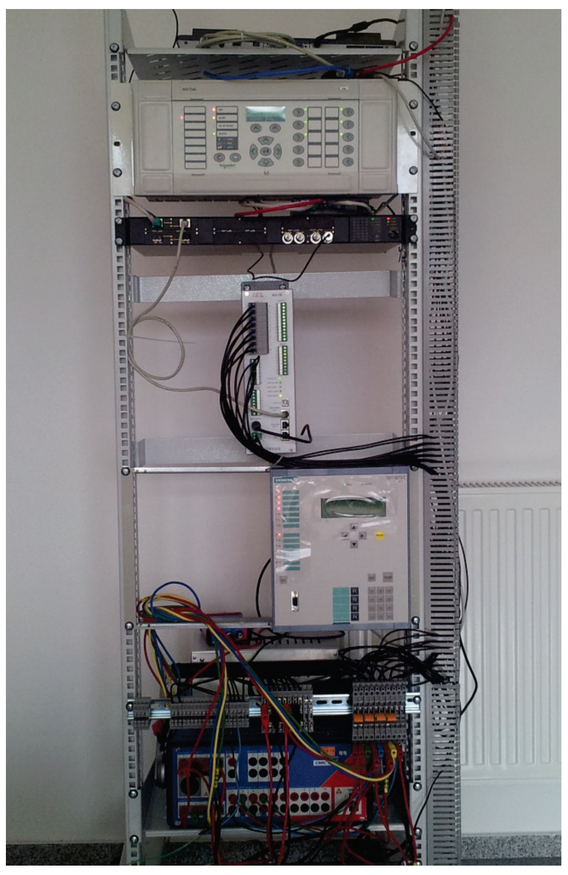
Merging Unit



- Acquire, digitalize and publish measured values on Process bus based on IEC61850-9-2 and UCA 9-2 LE
- Removal of secondary measurement wiring its technical limitations and hazards.
- Time fixed sample and publishing rates for protection (80 samples/period) and measurement (256/period) purposes
- Requires precise time synchronization (PPS) to avoid false oscillations
- Published SV contains primary real time values with time reference within second.
- Multicast stream independent of subscribers without repeating or buffering
- Roughly 30 and 70 Mb/min of network traffic

Laboratory testing

- Parallel injection of test sequences in process based system (MU & relay with SV) and relay with analog inputs
- Verification of time response (Pickup and Trip time) and measurement precision (Threshold values)
- Results were within acceptable protection tolerances with no clear advantage of one system
- Actuation of relays on testing device was on average 4ms faster by GOOSE then by wire

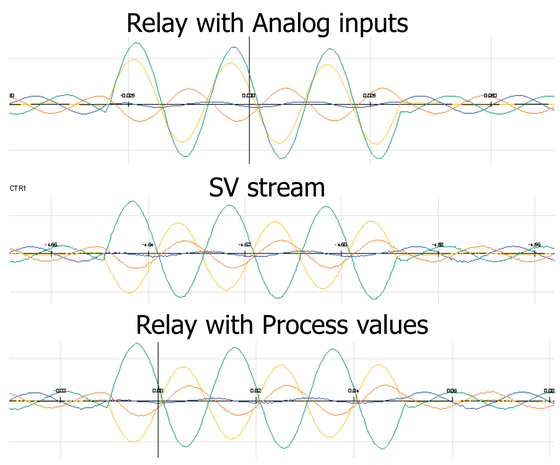


Pilot project

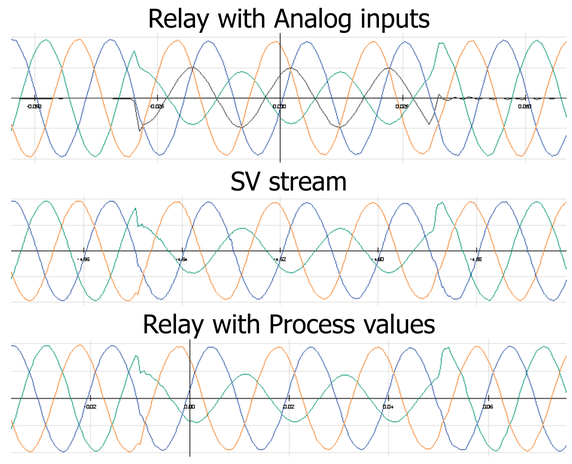
- Process based system was installed in parallel operation with existing protection system but it did not operate on breaker
- It was in operation for over a year with no loss of SV and no blocking of protection functions
- All disturbances registered on existing system were registered by process system

- Analysis of measured values showed good amplitude and wave response including DC offset

Comparison of current measurement



Comparison of voltage measurement



Migration to fully digital substation

- Use of process units and MU significantly reduce wiring
- Standardize SV create platform for use of NCIT with better measurement characteristics and enhanced safety and reliability
- As Process Bus becomes backbone of secondary system communication network needs to be designed to fulfill PAC functionality, handle and direct big network traffic and provide high level of availability and redundancy
- IEDs are independent of physical location of CTs and VTs
- Allocation (per device or bay) and realization (distributed or centralized) of functions become flexible with possibility of dynamic subscription to data on process bus
- Opportunity for adaptable functions that operate based on switchyard and/or system real time topology
- Constant monitoring of all data and communication on network gives overview of system state and opportunity for planned maintenance
- Digital system can be more easily simulated and tested in office/laboratory/factory prior to commissioning
- Required better knowledge of ICT and IEC61850 and/or development of more advanced engineering and testing tools
- It should bring down costs and time of building and maintaining substations