Chemtrols

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The Smart Substation using IEC 61850 Edition 2

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Important Smart Grid Characteristics

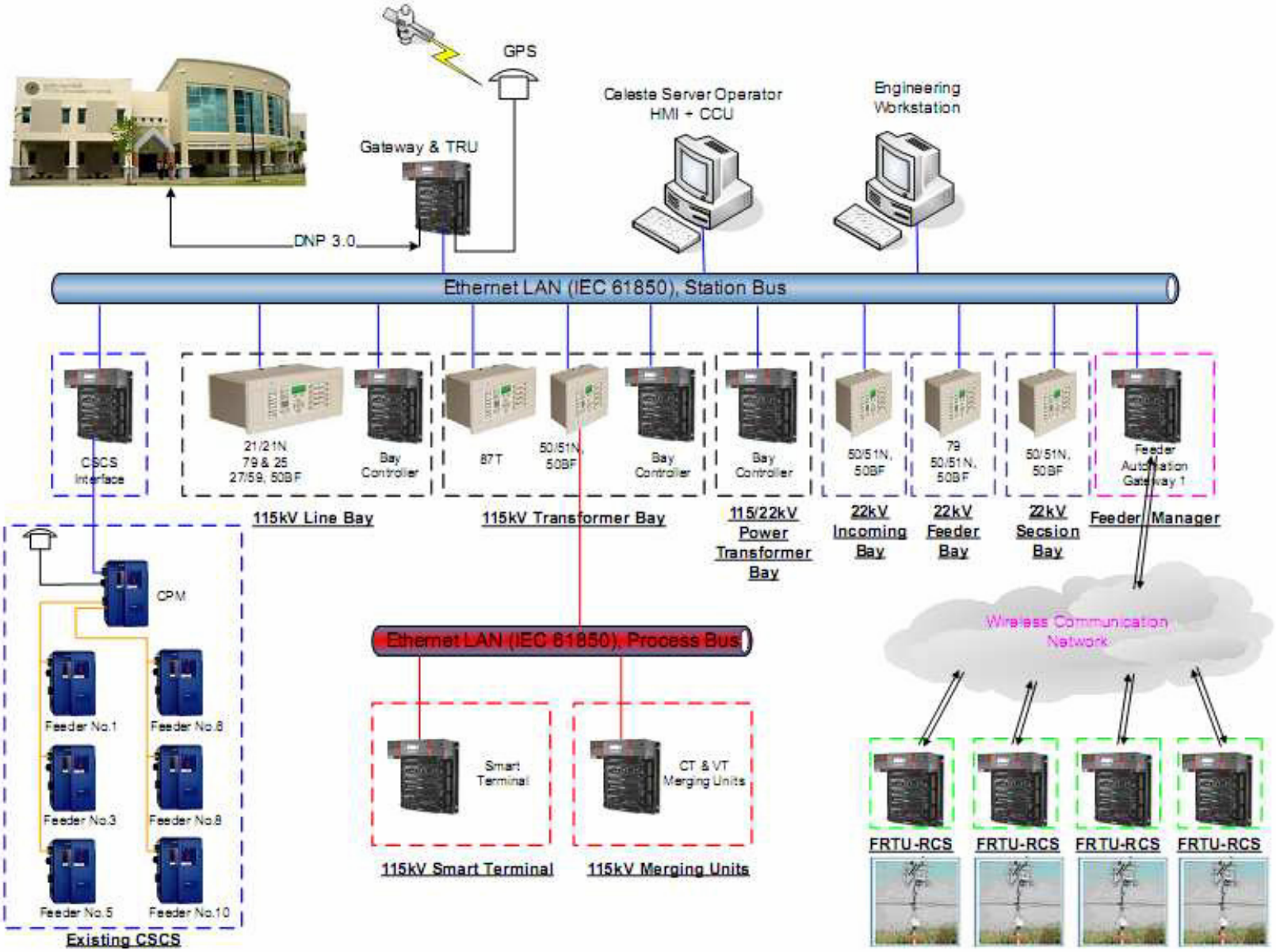
- Self Healing.
  - Automatic Mitigation of Power Outages, Service Disruptions and Power Quality Problems
- Accommodate Generation Options
  - Distributed Energy Reserves (DER), Photo-Voltaic, Wind, Fuel Cells
- Optimize Assets.
  - Harmonized Distribution & Transmission Power Flows. Select Lowest Cost Generation, improve Asset Utilization.
- Improve Security against Manmade or Natural Disruptions

Control and Automation Technologies such as Smart Substation must move hand in glove with Electrical Network Infrastructure changes

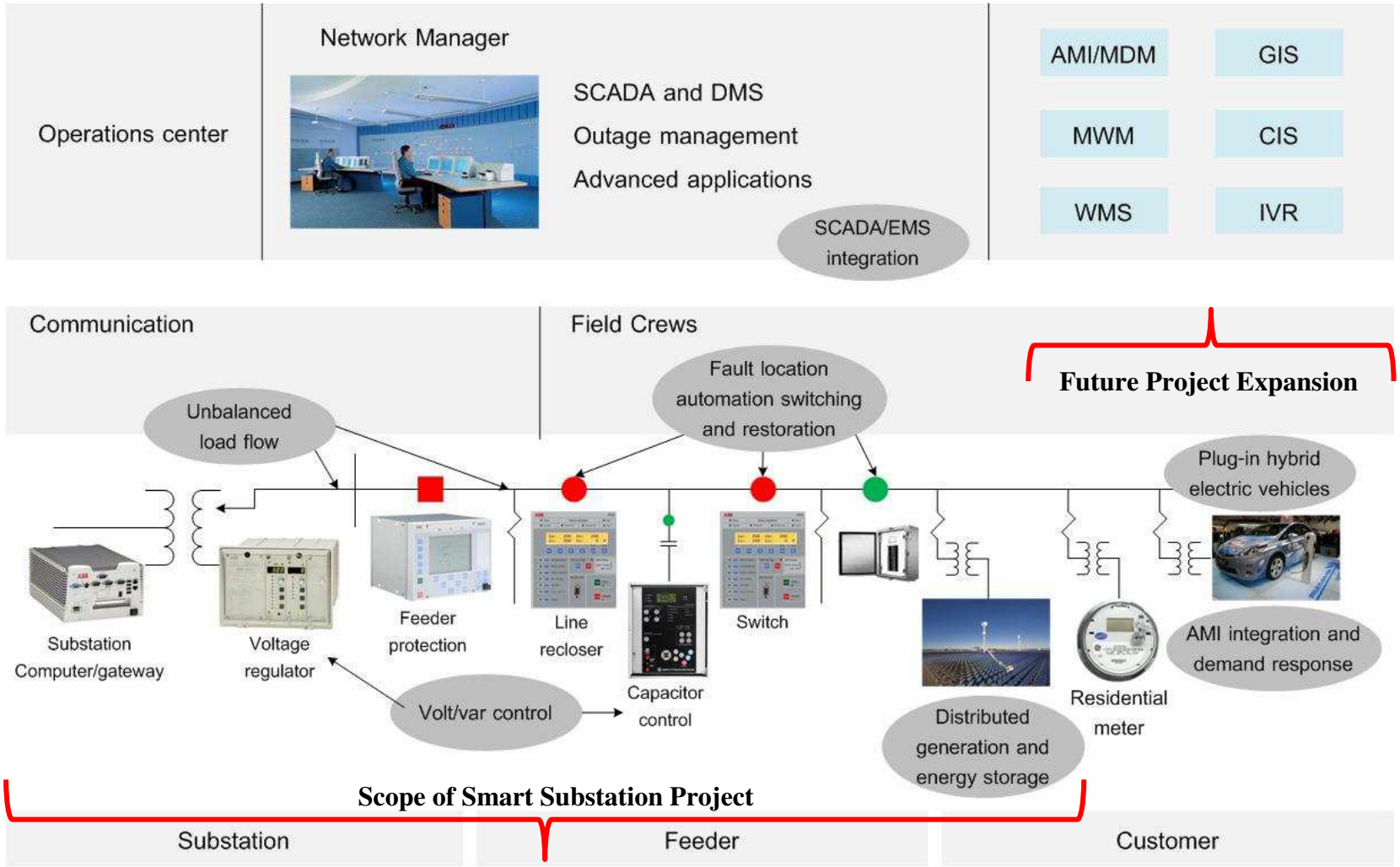
Smart Substation Mission

- Protect Legacy Investment of the existing Computerized Substation Control System (CSCS) whilst upgrading selected sections of the system with IEC 61850 Substation Automation System (SAS)
- Adopt advantages of Edition 2 of IEC 61850
- Incorporate KEMA certified IEC 61850 Substation Computer and HMI
- Incorporate Merging Unit and Process Bus for utility applications experience
- Test Bed for approval of IEC 61850 Edition 2 compliant Integrated Bay Protection and Control Units (IBPCUs)
- Form the nucleus of an autonomous system Controlling & Monitoring Distribution Plant outside the Substation as an Integral Advanced Distribution Automation (ADA) implementation (Load Break Switches, Capacitor Banks, Reclosers)
- Extend to Distributed Energy Resources (DER), like Solar & Biomass IPPs
- Advanced Autonomous DA (ADA) for VoltVar Control, Fault Detection, Isolation, Load Restoration, Automatic Load Shedding & Islanding.
- Integrated Interface to existing SCADA/DMS.

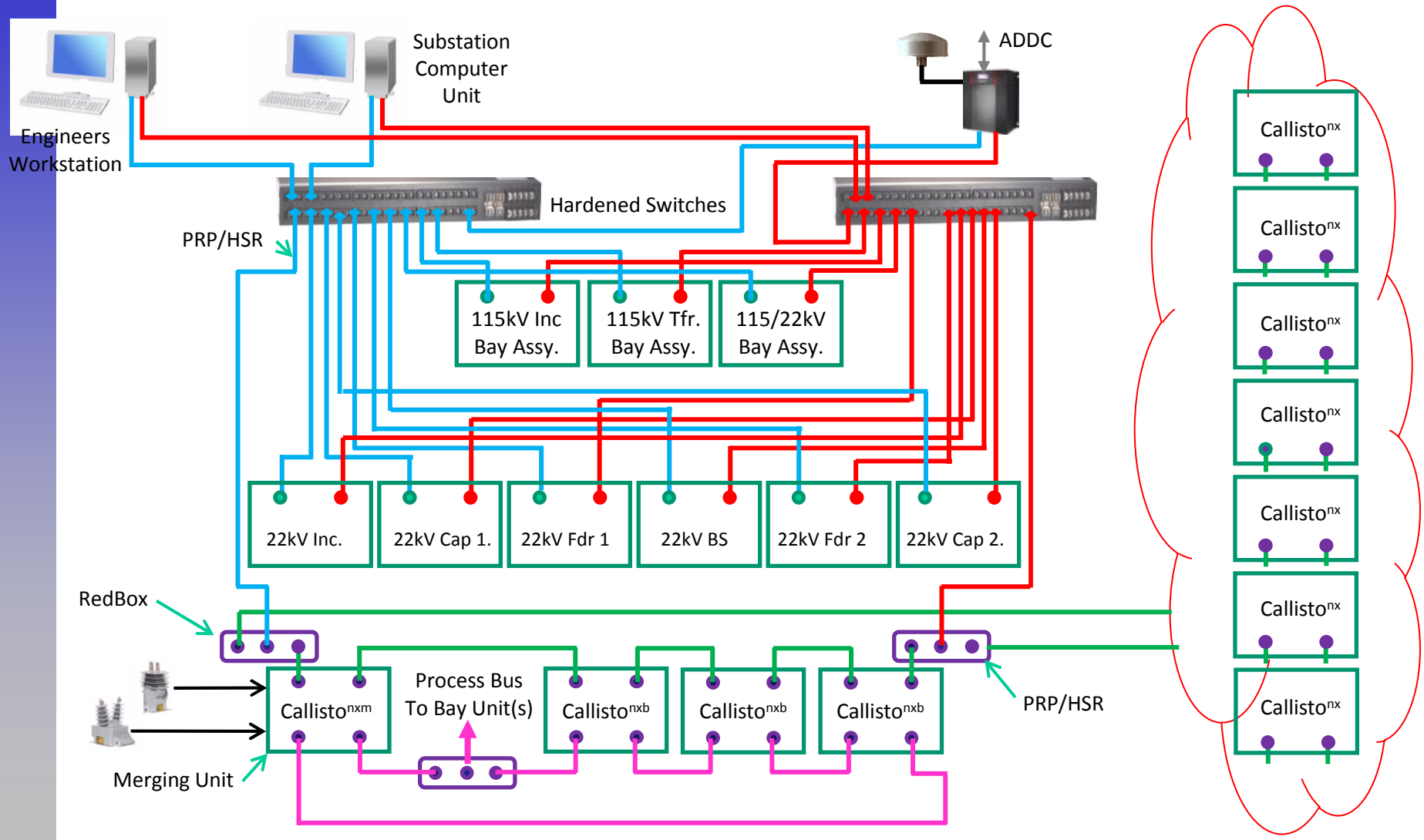
Smart Substation Mission Architecture



Smart Substation Scope



IEC 61850 Ed. 2 Smart Substation



IEC 61850 Specification

- Specification been in issued for around 10 years
- Widely adopted worldwide
- Open specification promoting interoperability
- 800 Technical Issues (TISSUES) listed and agreed
- Edition 2 addresses TISSUES and also adds some badly needed items
  - Defines communications redundancy for systems that cannot endure data loss on failure.
  - Addresses time synchronization weaknesses.
  - Improvements to GOOSE and Sampled Values.
  - Adds data models for DER, PQ, etc.
- Smart Substation Project fully embraces Edition 2 of IEC 61850

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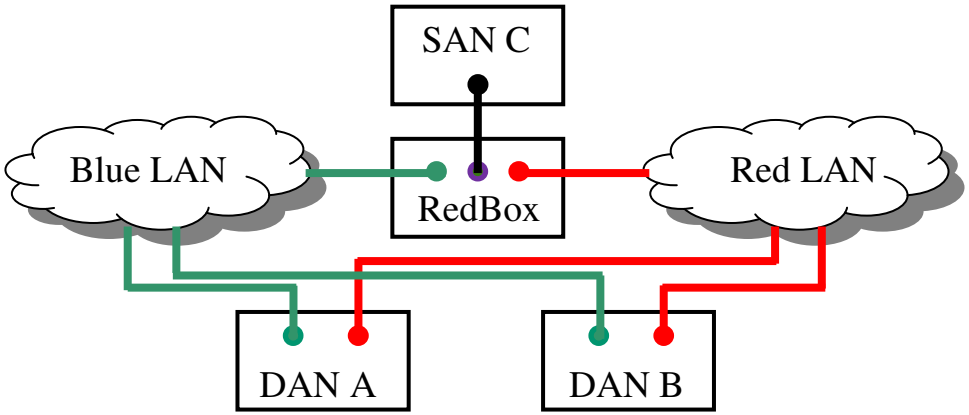
LAN Resilience

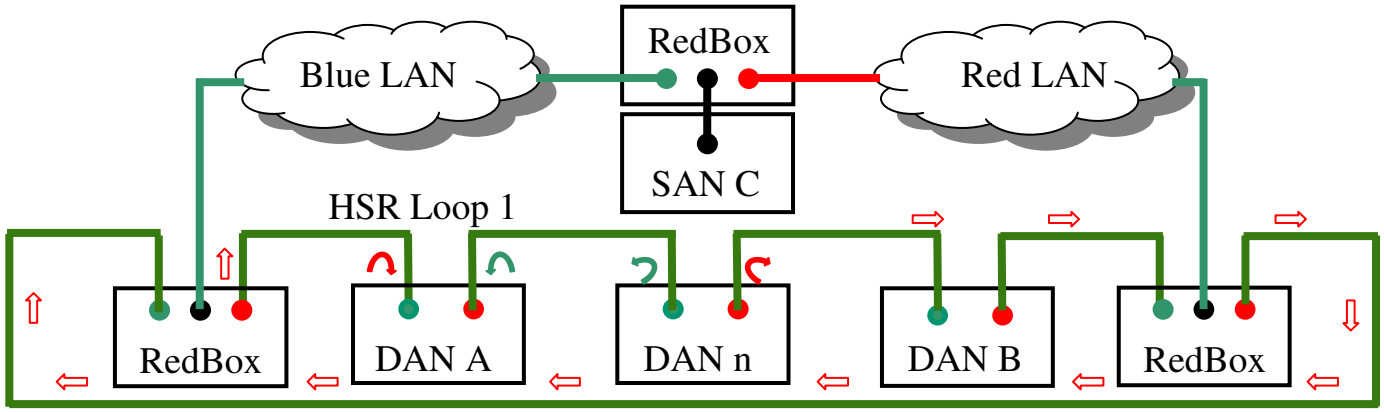
- Station Level SA facilities including Station & Process Bus should realize the same criteria
- Media Redundancy Protocol (MRP) physically closed, logically open ring. Ring Manager reconfiguration time ~ 100ms
- RSTP Rapid Spanning Tree. Topology reconfiguration time ~ seconds
- Real time substation applications require seamless redundancy (IEC 62439-3)
- IEC 61850 V2 specifies seamless redundancy
- Smart Substation complies with IEC 62439-3

Parallel Redundancy Protocol (PRP)



- Red LAN and BLUE LAN completely isolated.
- Dual Access Nodes DAN A & B dual ported.
- Single Access Node (SAN C) connects through Redundancy Box (RedBox) as VDAN (Virtual DAN).
- DANs and RedBox handle dual message rejection.
- All connections home run from IEDs.
- Zero downtime upon any network failure

High Availability Seamless Redundancy (HSR)



- Seamless Redundancy via dual ported nodes.
- Cost effective network with limited home runs.
- Operates compatibly with PRP via RedBox units.
- Multiple Loops can be set up via QuadBox.
- DANs and RedBox handle dual message rejection.
- Zero downtime upon any network failure.
- Smart Substation uses both PRP and HSR

Time Synchronization

- IEC 61850 Edition 1 specifies SNTP for network time synchronization
- Some (including Remsdaq) did not agree - Remsdaq used Precision Time Protocol (PTP)
- PTP conforms to IEEE 1588 and is more accurate than SNTP on LAN architectures
- IEEE 1588-2008 (PTP Version 2) is required to comply with the IEC 61850 Ed.2 microsecond based synchronisation requirements
- This is of prime importance for Sampled Value VT & CT Data
- Smart Substation uses PTP Version 2

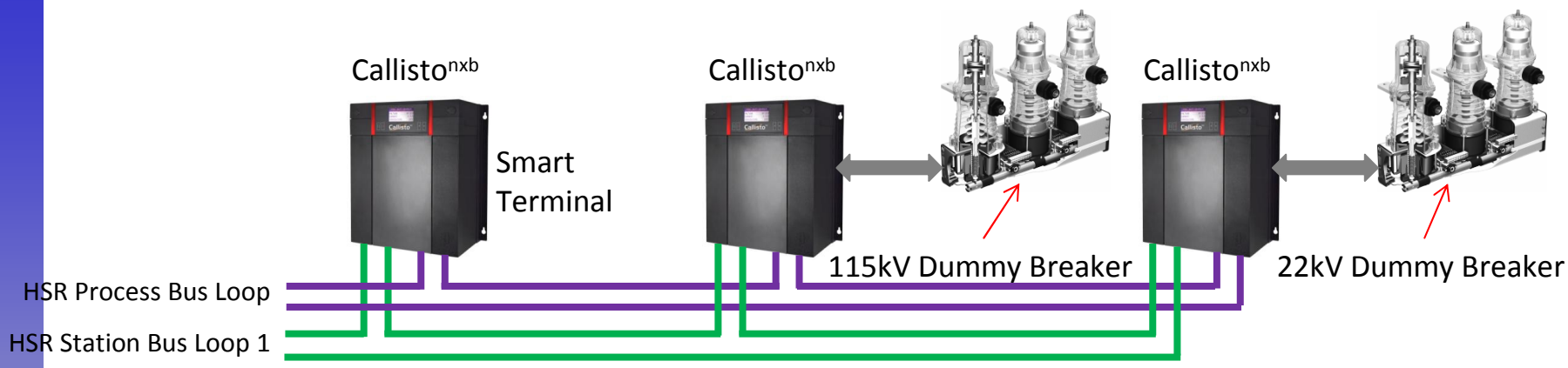
Smart Substation Goose Messaging

- GOOSE – Generic Object Oriented Substation Event
- Smart Substation Supports GOOSE on both Station and Process Bus
- Provides priority tagging for fast (~4ms) delivery
- Smart Substation supports Publisher and Subscriber, Unicast and Multicast messaging
- Confirmed to be as fast as hardwired logic
- LAN and system architecture allows for fault tolerant redundancy
- Important test of interoperability using third party vendor IEC 61850 Edition 2 IEDs

Smart Substation Merging Unit

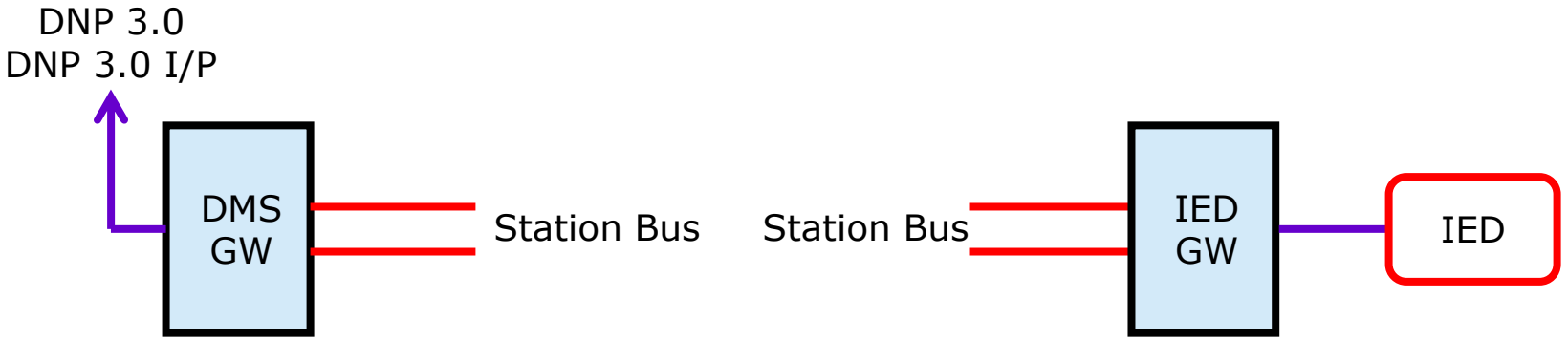
- Inputs - VTs plus Protection and Measurement CTs.
- Options for NCITs supported (Rogowski etc.).
- Smart Substation MU incorporates 80 and 256 Sampled Values per Cycle conforming to MSVCB01 and MSVCB02 for Protection and Measurements.
- Smart Substation MU supports both Sampled Values and Processed Value transmissions
- Dual Process Bus and Dual Station Bus Connectivity
- Optional Integral GPS Receiver

Smart Substation IBPC Evaluation



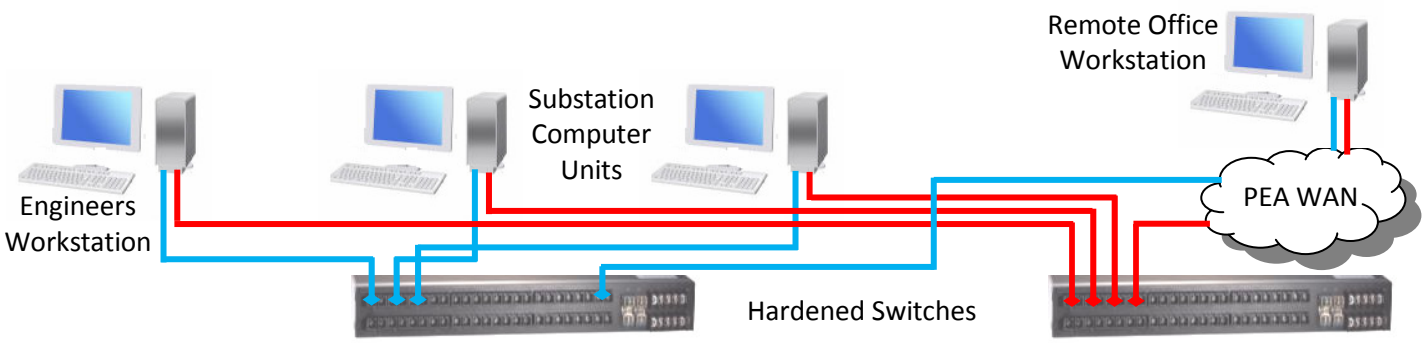
- **Permanent Test Bed for ongoing product evaluation.**
- **Uses Callisto^nxb IBPC units for protection (P) and protection related (R) Logical Node approvals**
- **IEC 61850 Server and Client. GOOSE Subscriber and Publisher**
- **Integrated IEC 61131-3 Programmable Logic**
- **Embedded IEC 61850 applications for Protection and Control**

Smart Substation Gateways



- DMS Gateway Operates as IEC 61850 Client and DNP 3.0 / IEC 101/104 Server
- Redundant Options for Resilience
- Support Dual Station Bus
- Legacy IED Gateway Facility
- Serial Interface to Gateway Client
- Standard Protocols DNP 3.0, DNP 3.0 I/P, IEC 80870-5-101/103/104, ModBus

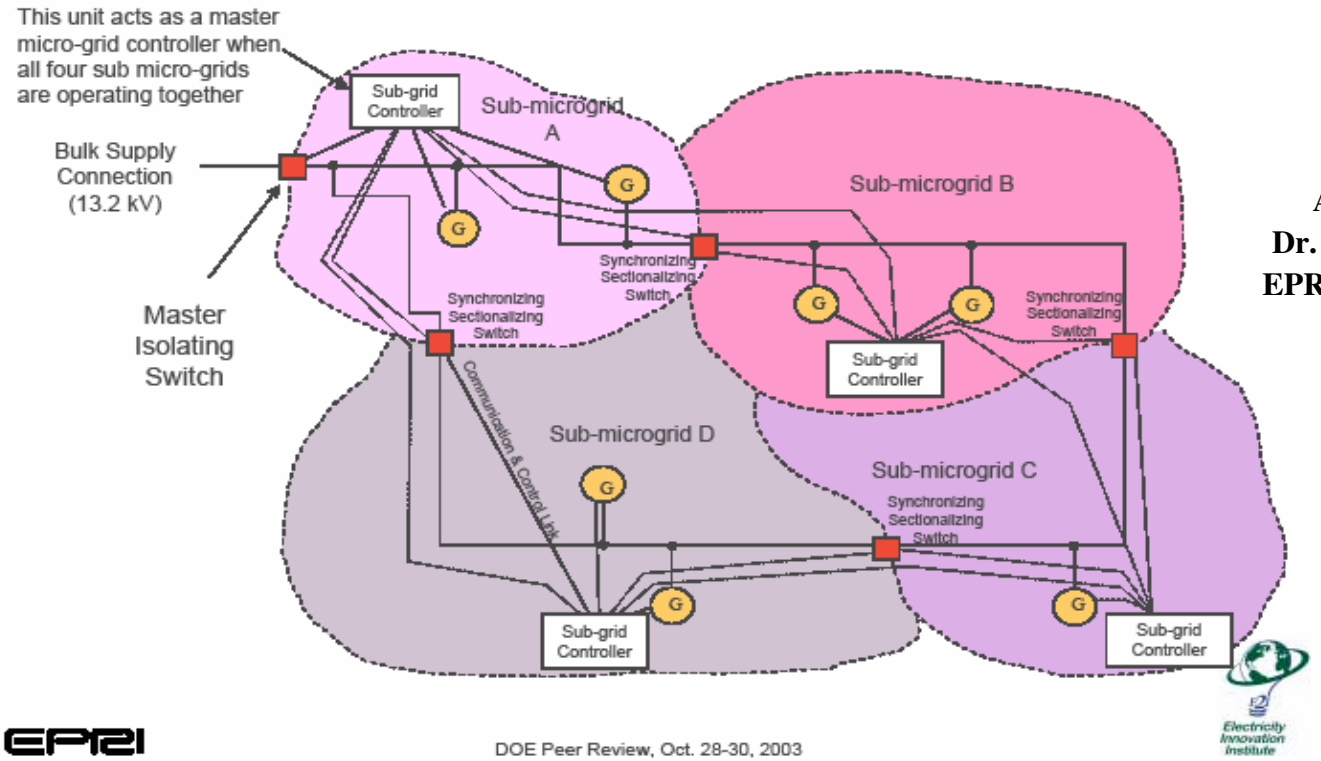
Smart Substation IEC 61850 HMI



- System IEC 61850 Client certifiable by KEMA
- Redundant Hot Standby Substation Computers
- Support of redundant HMIs
- Engineers Workstation and Remote Office Support
- User Configurable Operator and Management Applications

Microgrids and Sub-Microgrids

Example of New ADA Option: Adaptable Microgrid – breaks apart into multiple regions



As Presented by:
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EPRI DOE Peer Review

Smart Substation offers the Utility the tools to implement deliberate Islanding as perceived by EPRI

Thank You

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