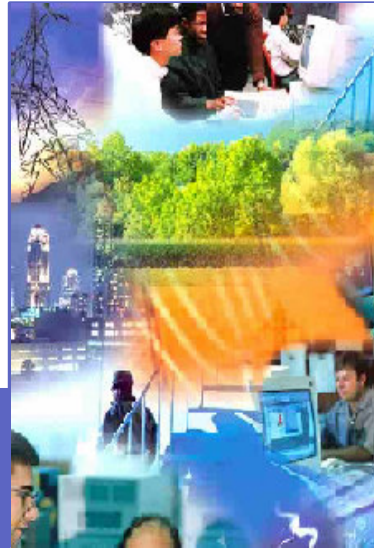




Klaus-Peter Brand

April 2006



Experience with IEC 61850 based Systems



IEC 61850 Experience with Systems

- First experiences**
- Experience – Case studies**
- Experience – Projects**
- Summary**



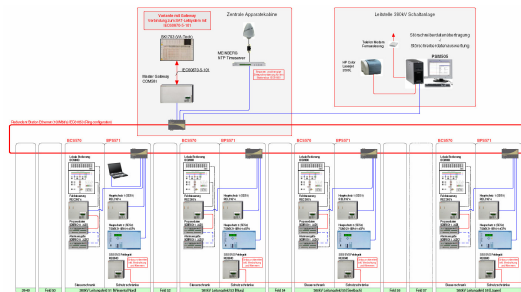
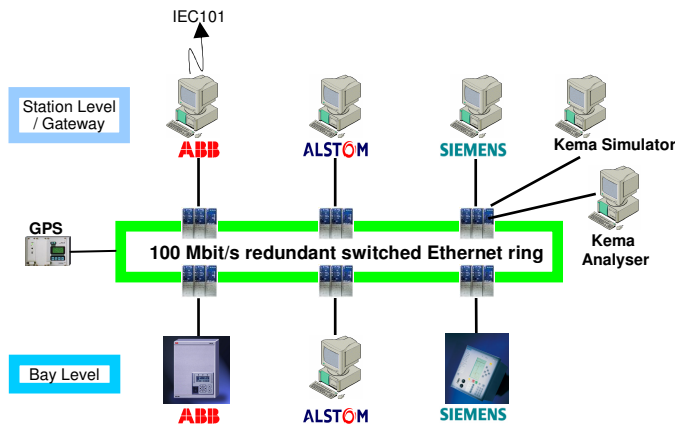
Introduction and overview	Part 1
Glossary	Part 2
General requirements	Part 3
System and Project management	Part 4
Communication requirements	Part 5
Communication model	Parts 7-1 to 7-4
Substation Configuration Language (SCL)	Part 6
Part 8-1 : Mapping for MMS, TCP/IP, Ethernet	Part 9
Part 8-x : for Future Use	
Part 9-1	
Part 9-2	
Conformance testing	Part 10

- Driving force in standardization committees
 - 13 permanent members in TC57
- Testing with Areva and Siemens since 2001

- Last tests concluded Q2 2004

■ IEC61850 References

- First IEC61850 installations in service since 12/2004
- Many stations in execution



Summary of the first experiences

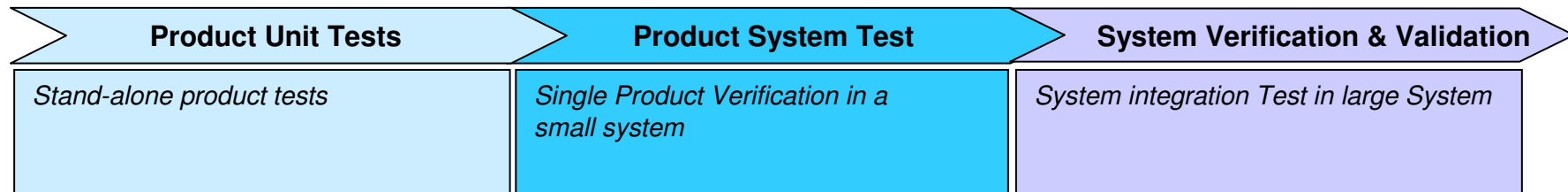
- ❑ **From the Development of the Standard**
 - Very high effort needed to combine the expertise of many participants to a global standard in 10 years
 - Global (for IEC and ANSI world) standard ready and usable
 - Unexpected diffusion of the standard in other domains
- ❑ **From the early Testing**
 - Early testing of systems combined by device from ABB, Siemens, Areva and Omicron has resulted in important feedback for the standard and the participating companies
 - Early testing has avoided a standard which is not usable at all
- ❑ **From the first project**
 - The standard request some learning for all (customer, supplier)
 - IEC 61850 is very well suited for complex retrofit projects also
 - SCL and system tools are the key for system integration



ABB's Strategy for quality assurance

- Technologies like IEC61850 affect many aspects of systems components and system integration
 - New or updated control and protection products
 - Adapted product and system engineering tools and processes
 - New communication infrastructure and topologies

→ Thorough System Verification is key



General Experience

Quality assurance by testing from Products up to Large Systems is essential



Project Characteristics

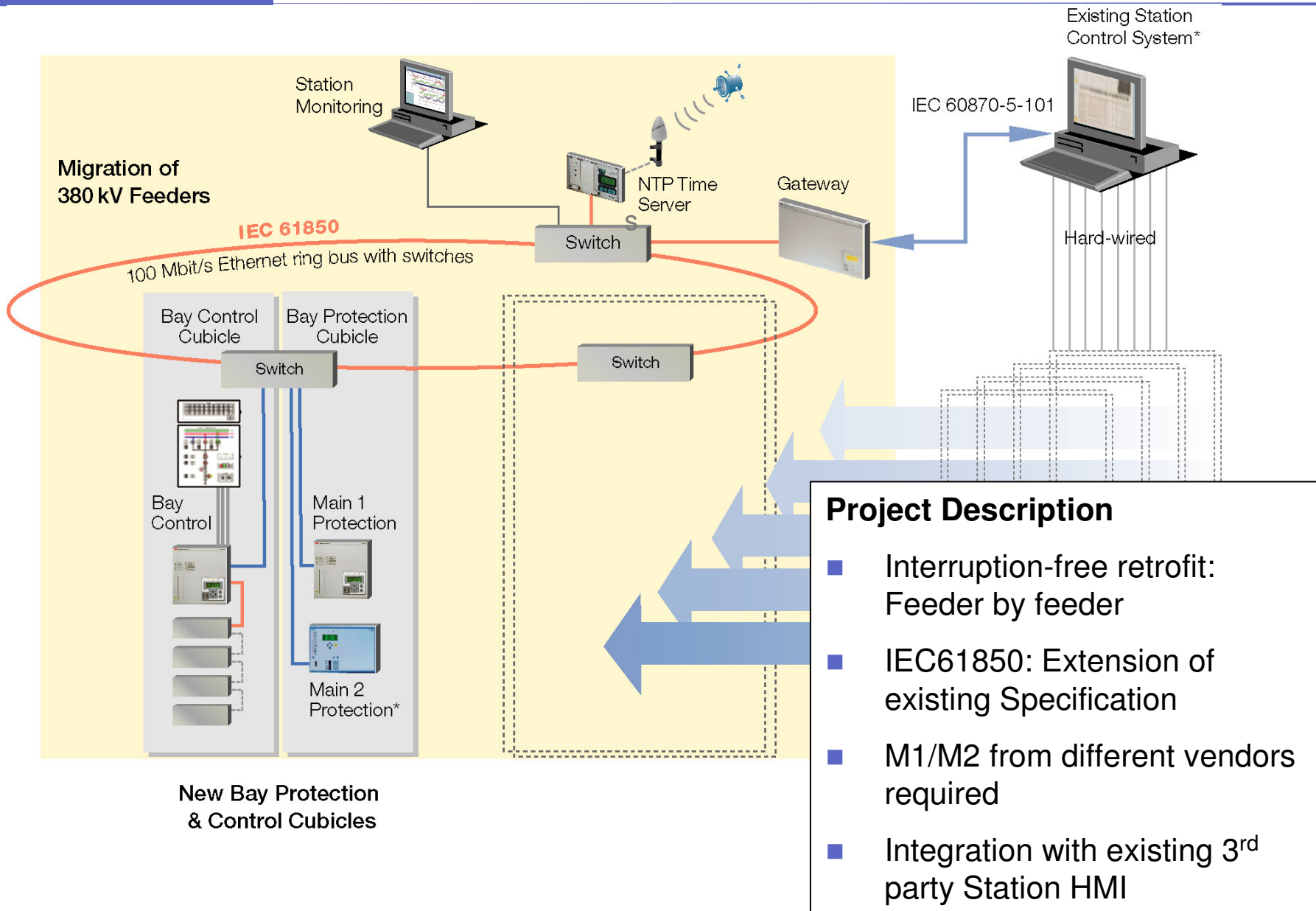
- **EGL – Laufenburg 380kV Substation Retrofit**
 - Bay-by-bay retrofit of Primary and Secondary Systems
 - IEC 61850 required

- **Search for an “Utility Standard” 380kV**
 - Standard Solution development for large retrofit and extension program
 - Retrofit of entire stations, Greenfield stations
 - IEC 61850 required

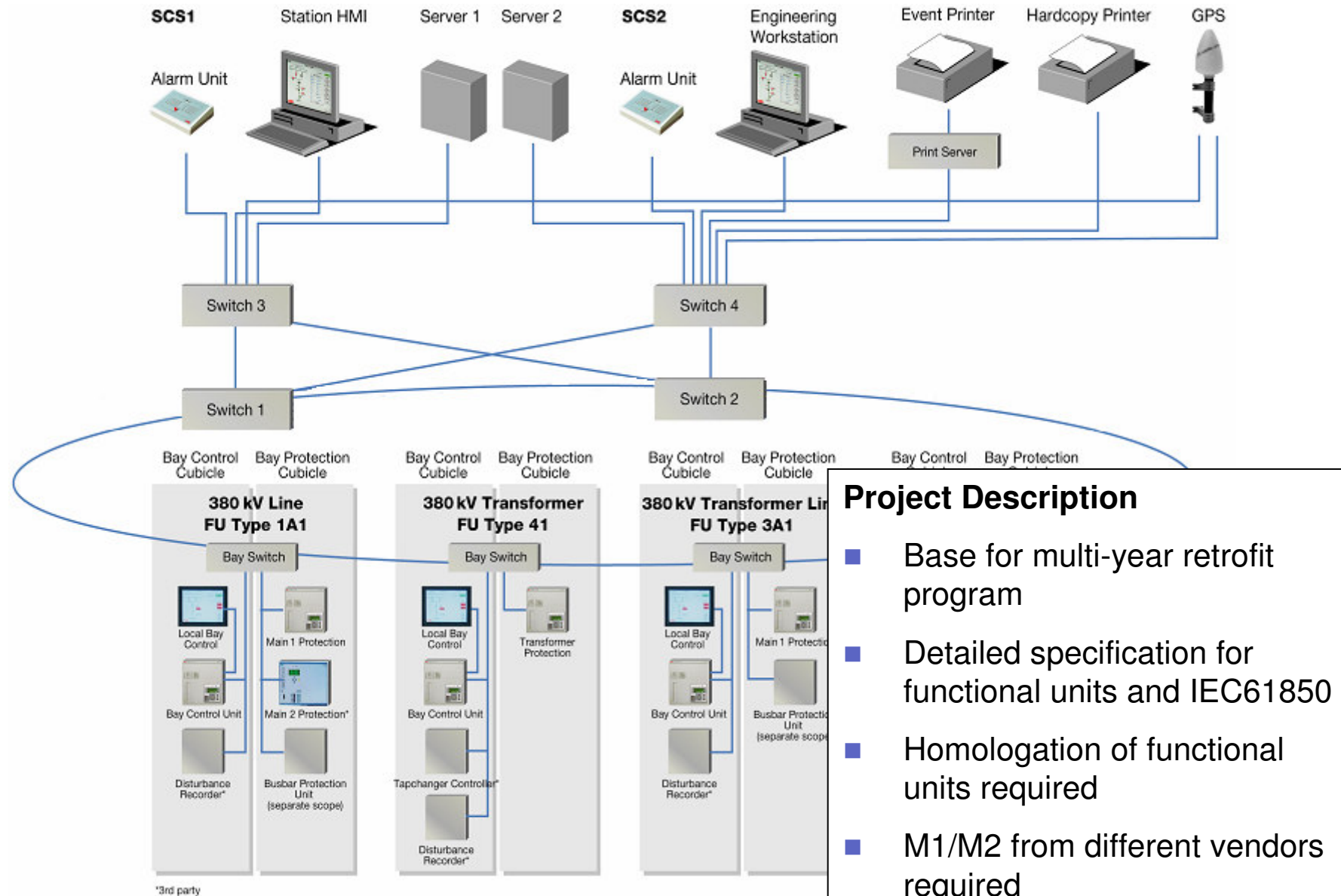
- **DEWA – Frame Contract 132/11 kV Substations**
 - Frame Contract for 20 (up to 40) new stations
 - Large number of systems to be delivered within short time
 - IEC 61850 required



EGL – Laufenburg 380kV Substation Retrofit



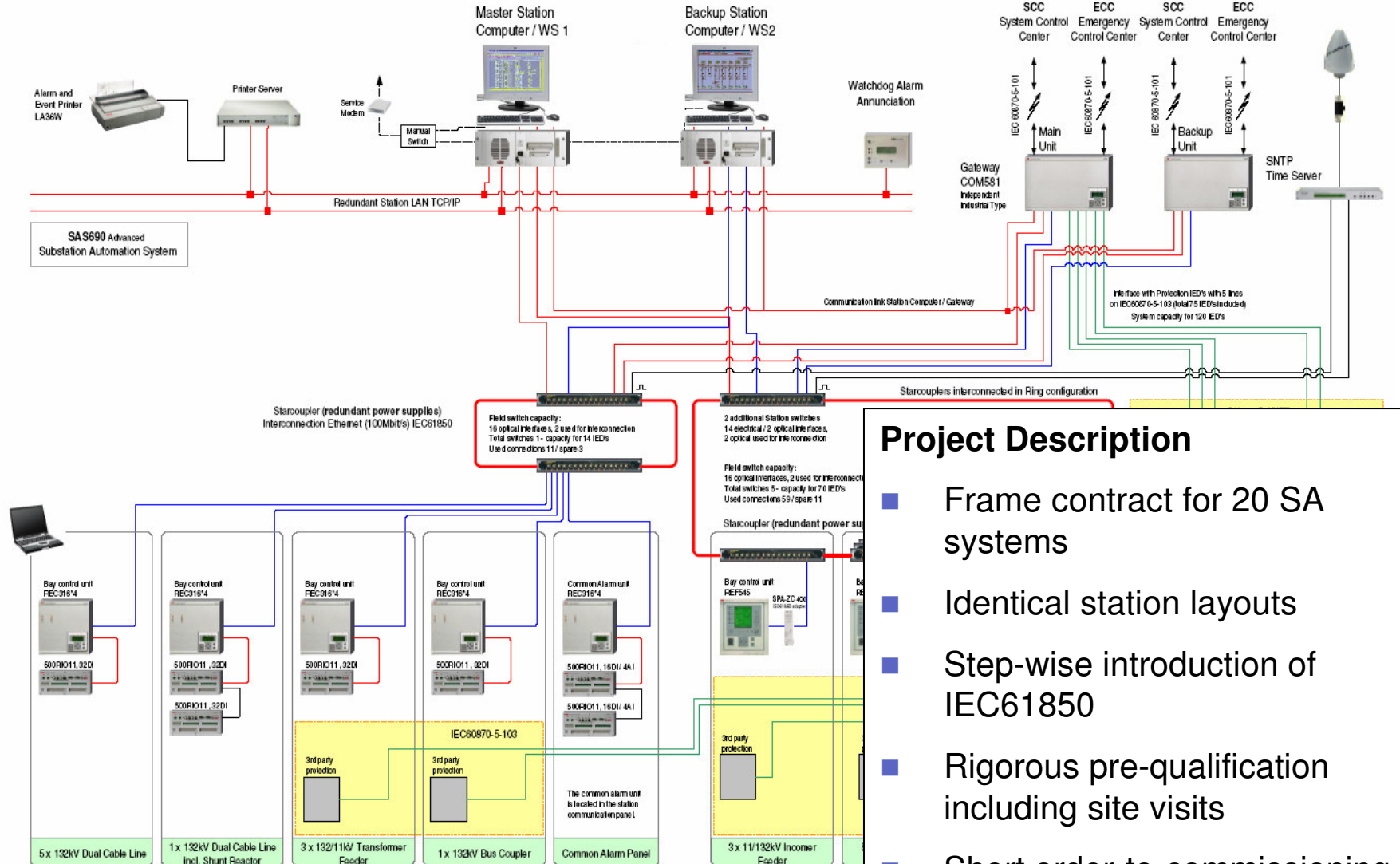
Search for an „Utility Standard“ 380kV



Project Description

- Base for multi-year retrofit program
- Detailed specification for functional units and IEC61850
- Homologation of functional units required
- M1/M2 from different vendors required

DEWA – Frame Contr. 132/11 kV Substations



Project Description

- Frame contract for 20 SA systems
- Identical station layouts
- Step-wise introduction of IEC61850
- Rigorous pre-qualification including site visits
- Short order-to-commissioning time

ABB's IEC 61850-compliant solutions

TERNASICAS Program for 380/220/150kV S/Ss, Italy
Large-scale standardization of IEC 61850-compliant solutions

Creation, homologation and supply of:

- 40 type-tested bay control and protection solutions
- High-quality user interface, standard logics and sequencer
- Incorporation of 3rd party IEDs and units with IEC 61850 communication interfaces

Efficient project implementation

EGL 380kV Laufenburg Substation, Switzerland
The world's first HV substation with IEC 61850-compliant SA

Stepwise retrofit of seven out of 17 bays:

- New control and redundant protection
- Gateway to existing station HMI
- Integration of 3rd party Main 2 IEDs with IEC 61850 communication interfaces

Sustainable concept for easy migration of remaining bays/station HMI.

DEWA Frame contract, Dubai
Supply of 20 IEC 61850-based SA systems

State-of-the-art systems for new 132/11 kV S/Ss:

- Short lead times realized by highly qualified project team
- Redundancy concept, independent key components and physically separated communication networks
- Proven technology and functionality

Safeguarded investment into interoperable systems for any make of switchgear.

NEK refurbishes its HV S/Ss Dobrudja & Vama, Bulgaria
The first 400/220/110 kV S/Ss to be refurbished obtain IEC 61850-compliant SA

- Different configurations: double busbar, 1½ c.b., ring
- Redundant station servers and operator workstations in hot standby mode
- Integration of some 70 new REX670 IEDs and four REB500 numerical busbar protection systems
- Integration of 110 kV signals via RTU as well as existing REL521 line protection

Optimal life cycle management through future-proof retrofit concept

Senelec's Hann 90/30kV S/S, Senegal
Refurbishment of Senelec's most important substation

- New IEC 61850-compliant bay control and protection
- Redundant station level system
- Integration with Network Control and Dispatching Centers

Future-proof solution for existing 90kV AIS as well as new 30kV GIS

ENELVEN's and ENELCO's Soler & Médanos S/Ss, Venezuela
IEC 61850 is key to the utilities' strategy for SA throughout their grids

- Uniform system architecture with redundant station level for high availability
- Redundant Ethernet ring with switches for direct connection of all control & protection IEDs with IEC 61850 communication interface
- High-quality operator interface with proven applications for control and monitoring of the entire 138/24 kV & 115/13.8 kV S/Ss

Enhanced efficiency with harmonized SA systems for new and retrofit substations

MEW's Financial Harbour, Sitra & Buquwwah S/Ss, Bahrain
The three 220/66/11 kV GIS substations will strengthen the grid and increase the reliability of the power supply

- Redundant Station HMI with redundant, independent gateways
- One product family, REX670, for Control and Protection
- Bay/Section control unit REC670 for all three voltage levels
- REB500 busbar and breaker failure protection (220 kV) with IEC 61850 communication interface
- Integration of 3rd party protection IEDs via IEC-103/IEC 61850 converter

IEC 61850 introduced in ABB's first substations for MEW Bahrain

Six new HV substations for PGCIL, India
400/220 kV GIS S/S at Maharanibagh, 400/220 kV AIS S/Ss at Bhatapara, Fatehbad, Raigarh and Rajagarh, 400 kV AIS S/S at Bina

PGCIL's new substations will be controlled and monitored by IEC 61850-based SA systems featuring:

- Redundant Station HMI using MicroSCADA Pro
- One product family, REX670, for Control and Protection
- REC670 bay control unit for all voltage levels
- REB500 numerical busbar protection system with IEC 61850 communication interface
- Integration of 3rd party Main 2 IEDs on IEC 61850 platform
- Redundant gateways for integration with Network Control and Dispatching Centers

The customer's philosophy as well as requirements for functionality and availability are being met

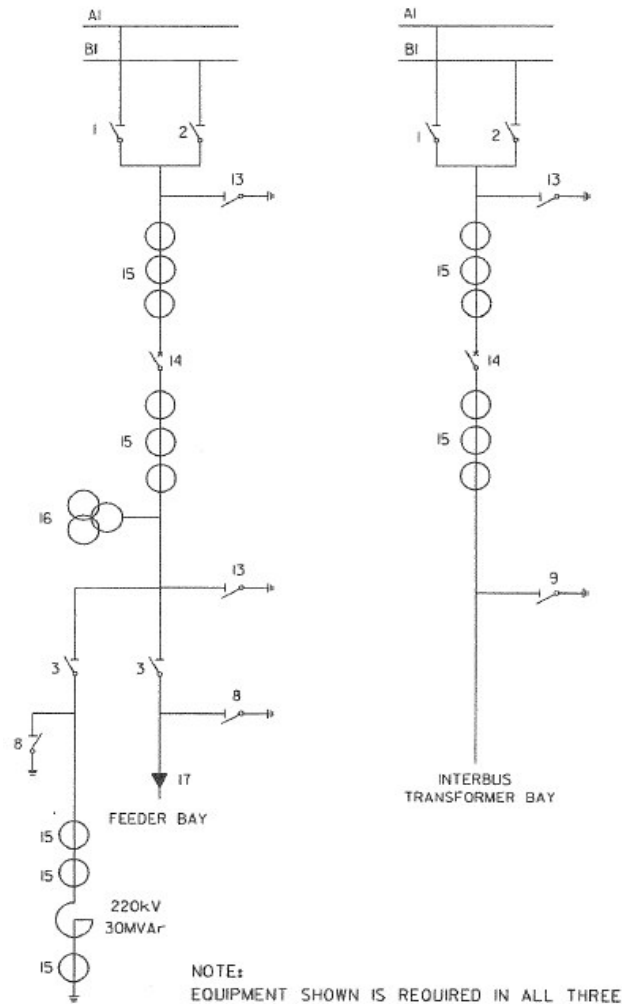
220/132/33kV S/S for Sohar Industrial Area, Oman
Automation with verified IEC 61850 implementation for new GIS substation

- Redundant Station HMI
- Scalable bay control unit REC670 for all three voltage levels

Enhanced operational efficiency and safety through optimized solution

● New installation
● Retrofit/migration



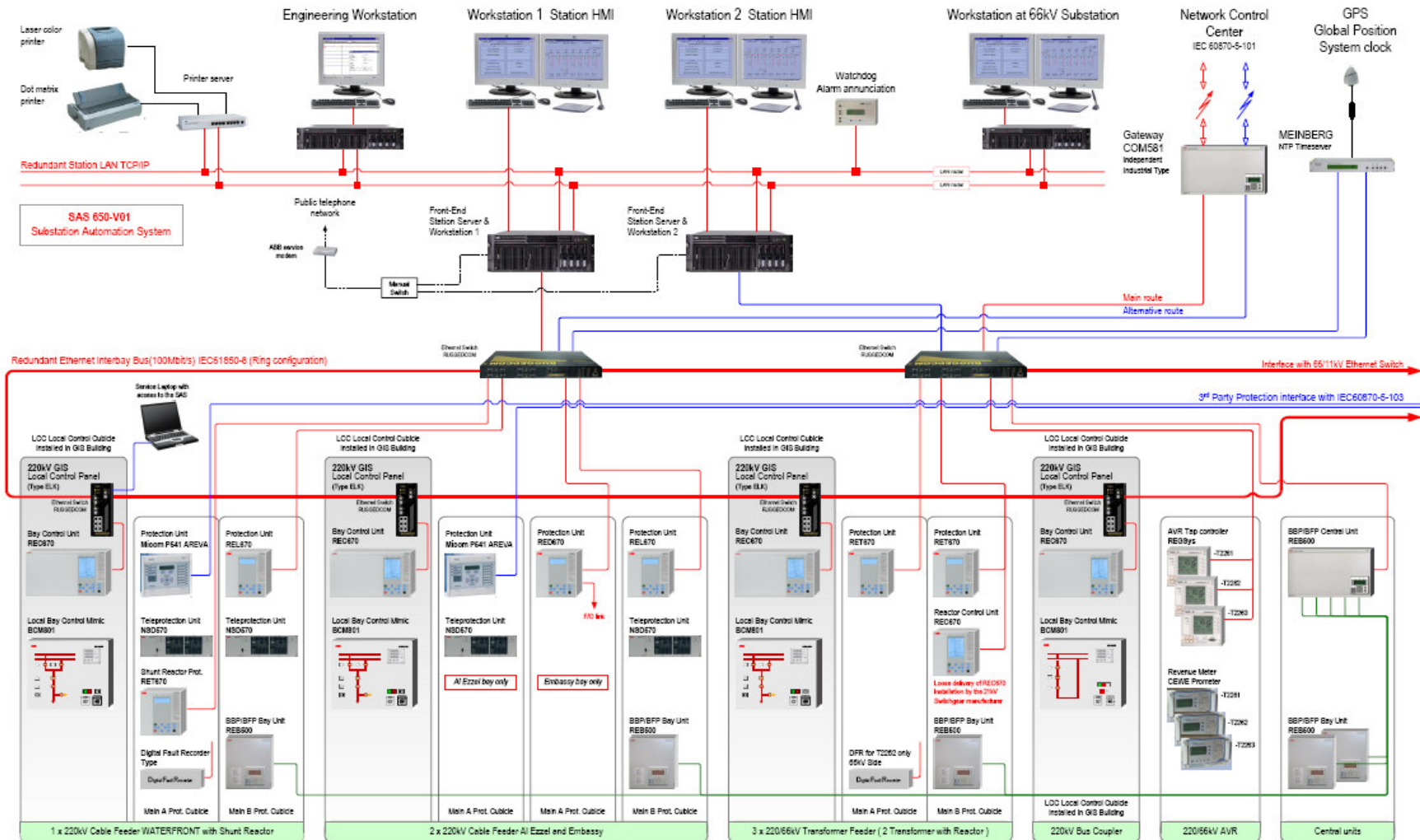


Requirements:

- Double Busbar arrangement
- Bay Controllers on IEC61850
- High availability, no single point of failure
- Fully redundant LAN network on 220kV
- Free LAN port for laptop computer at each bay

Solution:

- Small sized Ethernet switch for each bay unit.





- Independent managed Ethernet Switch from RuggedCom with IEC61850 configured in the redundant Substation Ring, de-central installed
- Single connection of IED and Ethernet switch within a panel, is provides as a fully redundant system, if switches are interconnected by a redundant ring
- Interoperability is still guaranteed
- Separation between switch and IED makes less problems like integrated switches
 - A faulty IED does not automatically open the Ethernet ring
 - Interoperability is still guaranteed
 - Open to choose a switch supplier, open to upgrade ring speed (e.g. 1GB)
 - Spare connectors can be used to interrogate the system or even to connect a laptop computer with SAS X-terminal functionality

IEC 61850 is well proven in substation automation systems and it is working as intended

There is some learning needed both by users/customers and providers/manufacturers to avoid misunderstandings

Clear functional requirements but flexibility in the implementation may be of benefits for the users/customers

The role of the system integrator has to be defined clearly

The “limits” of the standard IEC 61850 have to be respected to maintain interoperability and allow maintenance i.e. a standard modified by utilities is no standard anymore and has to be rejected

