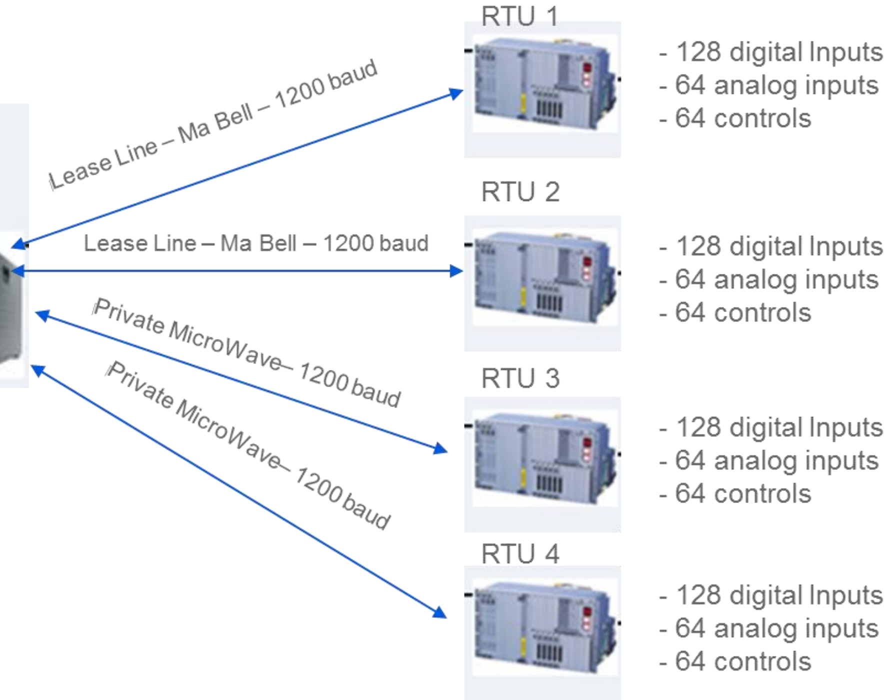
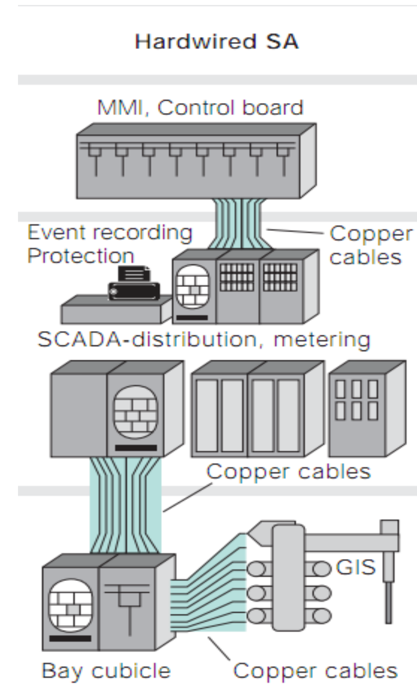
Howard Self, ABB , Program Manager Smart Grid, May 10, 2017

GMLC Interoperability Technical Meeting

Utility Network Control Overview
Transmission – 1970 - 1995

SCADA Control Center





Proprietary Protocols

Harris 5000
CDC I & II
Conitel 2020/3000
Telegyr 6500/8979
Valmet III & V
PG&E 2179
SES 92

Microprocessor Evolution(Integration Nightmare)
1988-1996, RS232,RS485 – 9600 Baud

RTU/Data Concentrator

PLC/Data Concentrator

Relay/IEDs

GETAC

Incom/Modbus ASCII

Incom

SEL ASCII

Regulator Controller

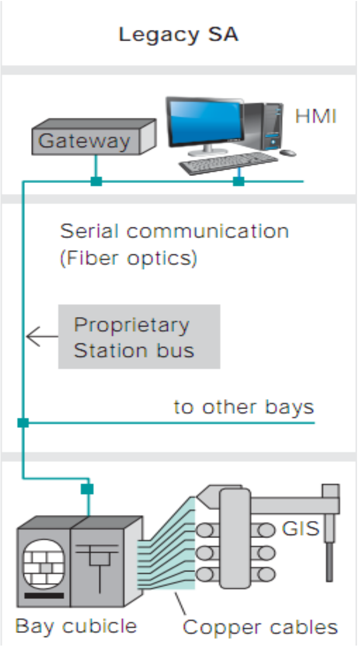
2179

Meter IED

Modbus/DNP

The Birth of DNP3
1992-1994 through today

- Open, non-proprietary
- SBO (Select Before Operate)
- Accurate Time Sync and Time Stamped Data
- Quality flags, Internal Indications
- Multiple Data Formats
- Layer Separation (Link, transport, application)
- Quiescent, Report-by-exception, polling
- File transfer
- UDP/TCP
- Secure Authentication V2/V5



Distributed
Network
Protocol

The Need for Speed
Inside the substation

- Modbus Plus – 1 mb/s (Serial Taken ring)
- Modbus TCP/IP – 10/100 mb/s
- Profibus – 12mbs
- DNP/IP – 10/100mbs
- LON
- UCA – 10/100 mb/s (Client/Server, Peer-to-peer)
- IEC 61850 – 10/100 mb/s (Client/Server, Peer-to-peer, Sample measured Values)

Introduction
UCA 2.0/IEC 61850 start-up

UCA Project Origin:

- Utility Communications Architecture (UCA) - enterprise-wide unified scheme to share all operating and management information
- 1994 - EPRI member utilities called for common standard for IEDs in substations
- EPRI RP 3599 defined requirements; looked at UCA compatible technologies for substations
- 1996 - UCA demonstration initiative by **AEP** and other major utilities.
  - Pushed to identify Ethernet protocol to be used for all data sharing, plus high-speed control
  - Solicited IED vendor and user participation
  - Specified replacing control wiring with LAN

IEC 61850 Origin

- 1980s - Large European manufacturers were selling expensive LAN-based substation control systems (SCS)
- Each design unique, and user committed to one vendor's equipment
- Later - IEC developed Standard 870-5 (now 60870-5)
- 1995 - IEC TC 57 began 61850 Standard to define next generation of LAN-based substation control

Introduction
UCA 2.0/IEC 61850 harmonization

Two projects were underway at same time:

- UCA™ for substations - EPRI
- IEC 61850 - Communication networks and systems in substations

UCA and IEC Join Forces

- Harmonization Goal - avoid two complex and incompatible standards

1997 - Two standards management teams committed to create an aligned standard

- One technical approach for the whole world
- Two standards aim at different details and different levels of system design.

A global standard for IEC and ANSI ...

- Today UCA International Users Group heavily involved in technical issue resolution and device level conformance testing
- IEC TC57

Smart Grid Standards Assessment and Recommendations for Adoption and Development – EnerNex 2009

Domain	Standard/Specification/Technology
Control Centers	IEC 61970 Common Information Model (CIM) IEC 60870-6 Inter-Control Center Protocol (ICCP) NRECA MultiSpeak
Substations	IEEE C37.1 SCADA and Automation Systems IEEE C37.2 Device Function Numbers IEC 61850 Protocols, Configuration, Information Models IEEE 1646 Communications Performance Distributed Network Protocol (DNP3) Modbus IEEE C37.111-1999 – COMTRADE IEEE 1159.3 PQDIF
Outside the Substation	IEEE C37.118 Phasor Measurement IEC 61850-90 (in development) IEEE 1588 Precision Time Protocol Network Time Protocol
Security	IEEE 1686 IED Security IEC 62351 Utility Communications Security NERC Critical Infrastructure Protection (CIP) Standards
Hardening / Codes	IEEE 1613 Substation Hardening for Gateways IEC 61000-4 Electromagnetic Compatibility IEC 60870-2 Telecontrol Operating Conditions IEC 61850-3 General Requirements

Smart Grid Standards Assessment Continued
Interoperability weak spots

ANSI C12, IEC 61850, and IEC 61968/61970

- Committees have developed them over a long time, perhaps a decade or more, and the standards therefore represent heroic efforts on the part of multiple vendors to compromise. The fact that some of them exist at all is remarkable.
- Nevertheless, the process in which they were developed means the standards contain options for most of the possible ways that vendors have implemented these utility applications over the years.
- The standards therefore contain many implementation choices with few mandatory items, and implementations are difficult for utilities to specify without significant internal expertise.

Smart Grid Standards Assessment Continued

Interoperability weak spots

ANSI C12, IEC 61850, and IEC 61968/61970

- Utilities use these standards in areas that have traditionally been dominated by single-vendor implementations, and for economic reasons *unfortunately continue to be so dominated* despite the use of the standards. Therefore, significant multi-vendor interoperability testing in real-world situations is slow to arrive and sometimes painful when it does.
- In some cases, such as ANSI C12, no organization exists even to provide certification testing. Although it is less effective than true interoperability testing, certification would at least represent a major step toward interoperability.
- Devices implementing the standard typically can establish basic communications and exchange simple information very easily. However, when trying to deploy more advanced functions, utilities discover that vendors follow differences in philosophy that cause them to not work well together. The GridWise Interoperability Framework [reference] would identify these philosophical differences as a lack of interoperability at the level of Semantic Understanding, Business Context, or Business Procedures

ABB

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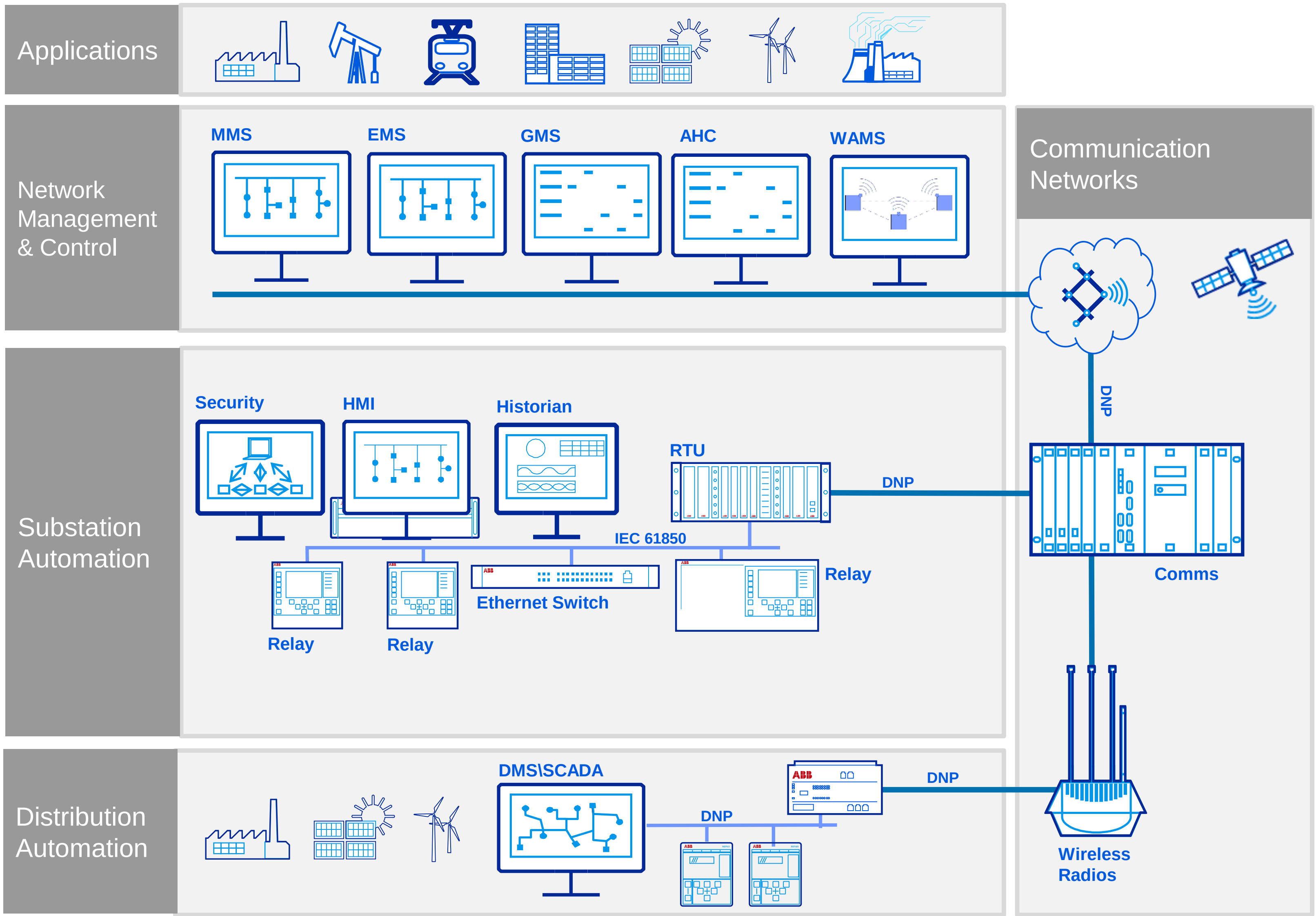
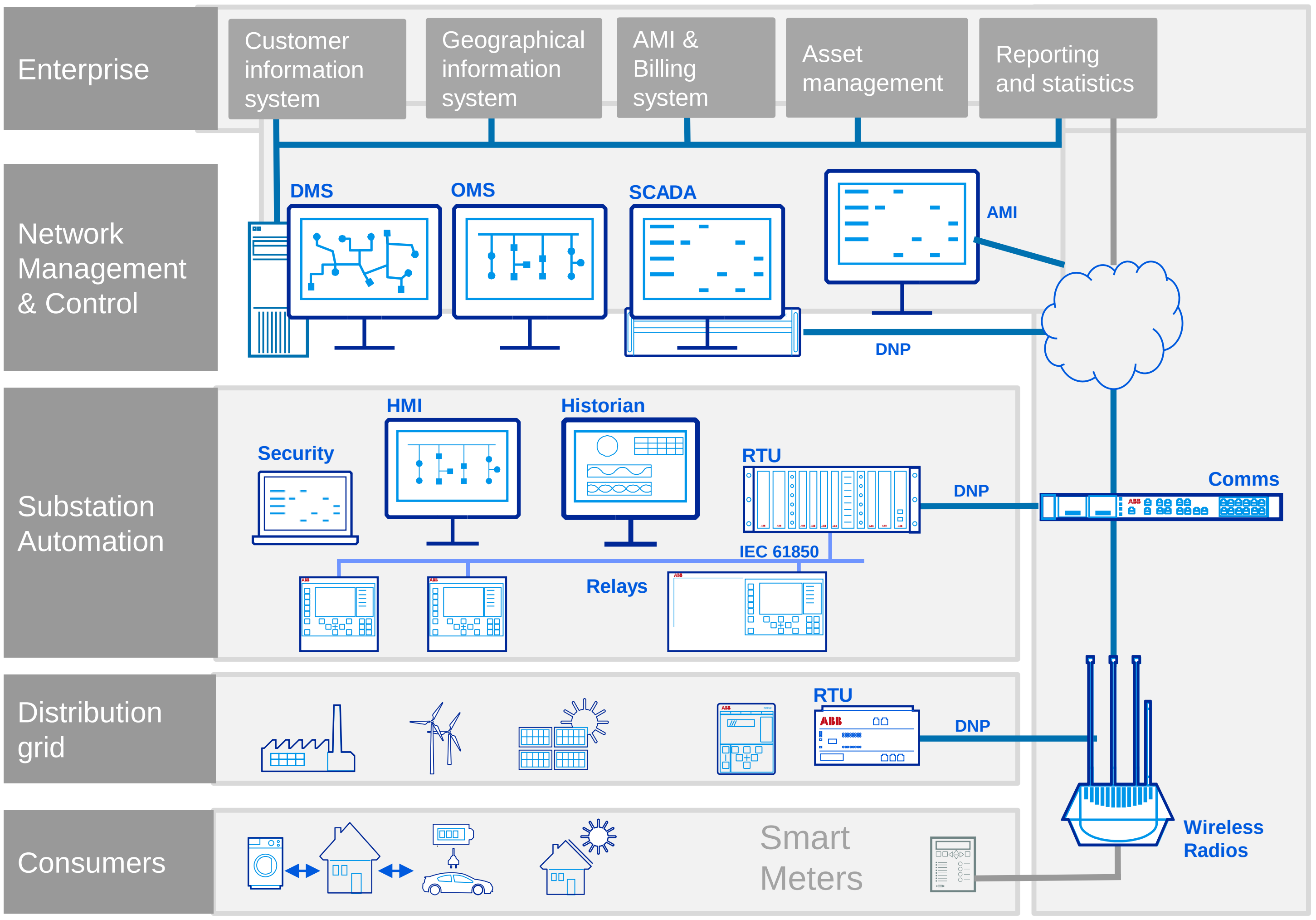
Transmission



Distribution Network Overview



Digital Transmission portfolio and architecture