Substation Integration and Automation – Approaches and Best Practices

IEEE PES Chicago Chapter
ComEd Commercial Center
Oak Brook, Illinois
Wednesday, March 12, 2003

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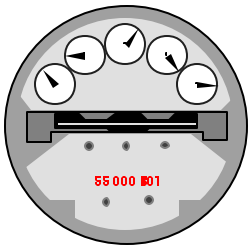
Overview – Approaches and Best Practices

- System Architecture
  - Substation Integration and Automation Levels
  - Primary and Secondary Substations
  - Architecture Functional Data Paths
  - New Versus Existing Substations
- Communication Protocols
  - IED Standalone Capabilities
  - IED Integration Capabilities
- Utility Case Study
  - Functional Architecture
  - Vendor Installed Architecture
  - Equipment Photographs

Intelligent Electronic Device (IED)

- Any device incorporating one or more processors with the capability to receive or send data/control from or to an external source (e.g., electronic multifunction meters, digital relays, controllers)

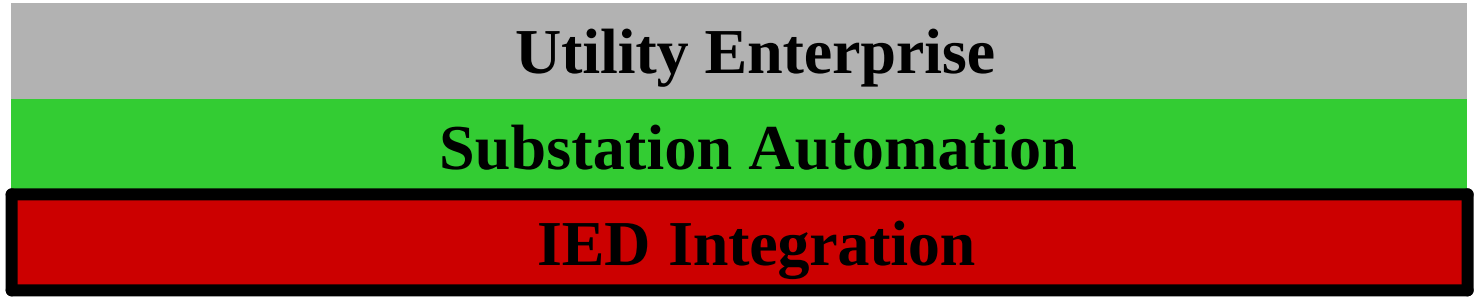


Substation Integration and Automation Levels

Utility Enterprise
Substation Automation Applications
IED Integration
IED Implementation
Power System Equipment (Transformers, Breakers)

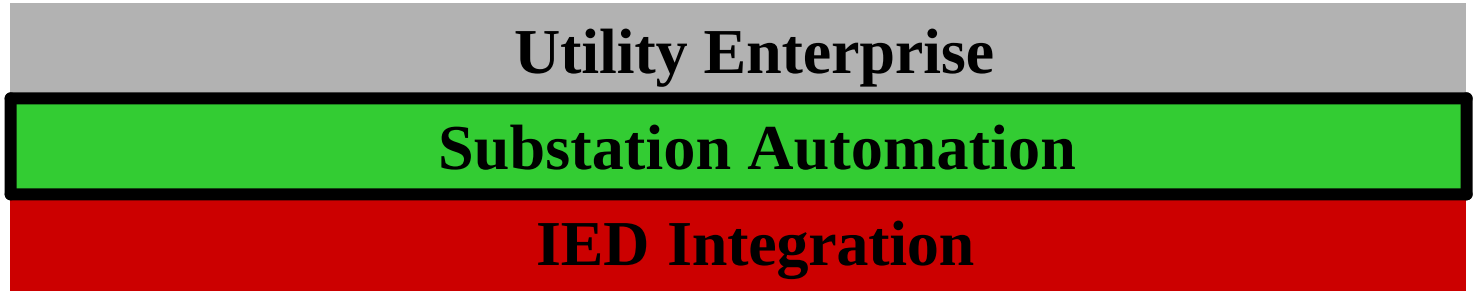
Substation Integration

- Integration of protection, control and data acquisition functions into a minimal number of platforms to reduce capital and operating costs, reduce panel and control room space, and eliminate redundant equipment and databases

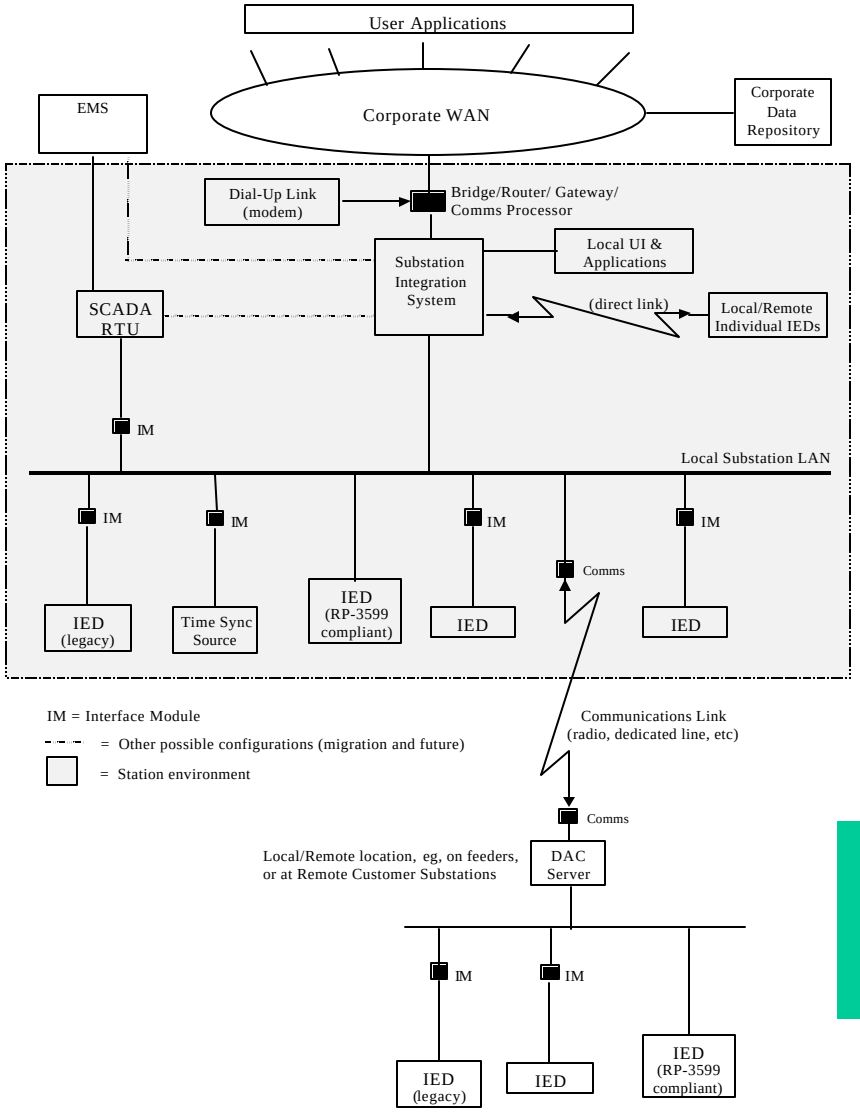


Substation Automation

- Deployment of substation and feeder operating functions and applications ranging from SCADA and alarm processing to integrated volt/VAR control in order to optimize the management of capital assets and enhance operation and maintenance (O&M) efficiencies with minimal human intervention



Example of "Primary" Substation and "Secondary" Substation



Primary Substation

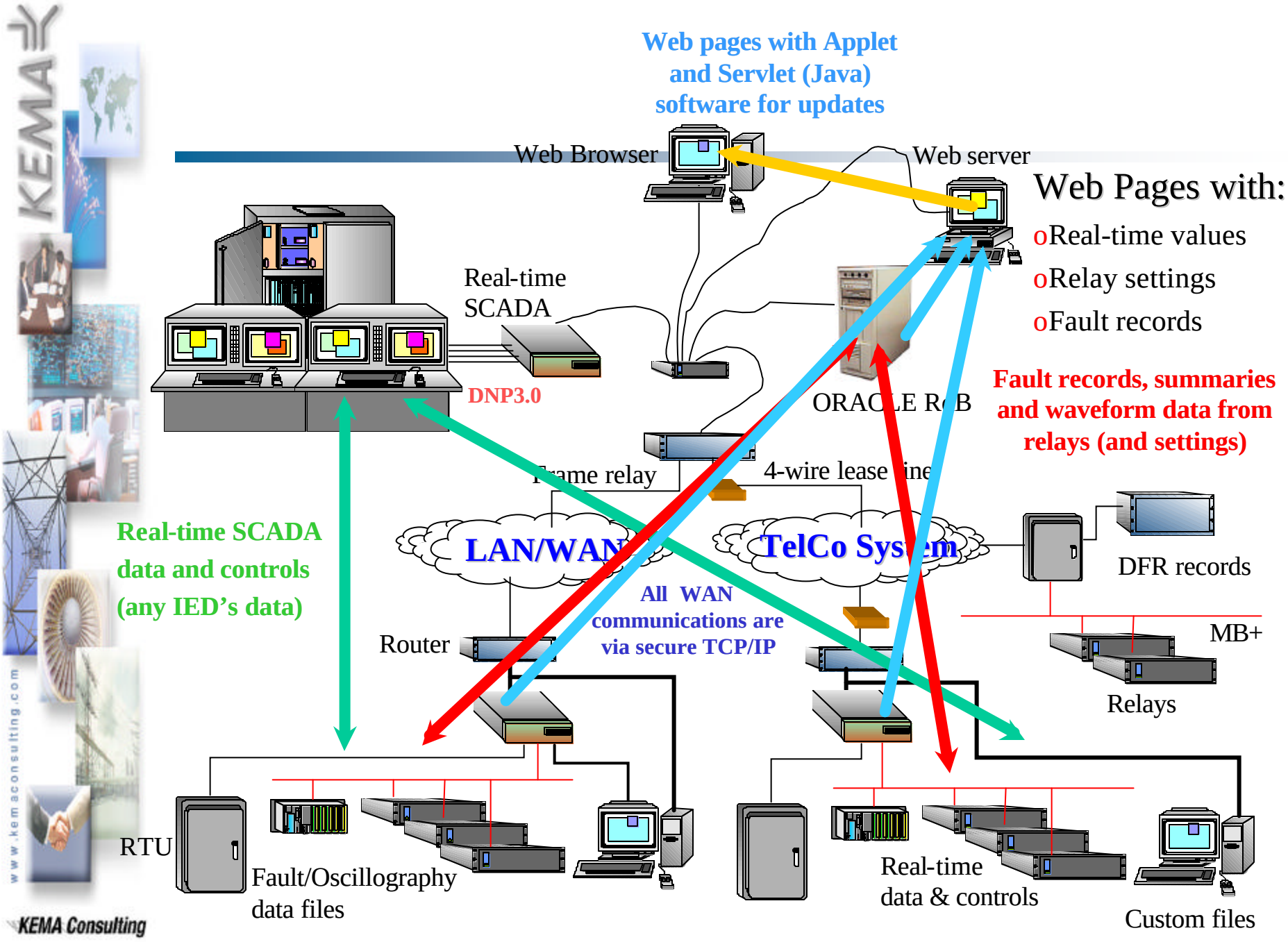
Secondary Substation

Primary Substation Automation System

Secondary Substation Automation System

Architecture Functional Data Paths

<table>
<tr><td colspan="3">Utility Enterprise Connection</td></tr>
<tr><td>SCADA Data to MCC</td><td>Historical Data to Data Warehouse</td><td>Remote Dial-In to IED</td></tr>
<tr><td colspan="3">Substation Automation Applications</td></tr>
<tr><td colspan="3">IED Integration Via Data Concentrator/Substation Host Processor</td></tr>
<tr><td colspan="3">IED Implementation</td></tr>
<tr><td colspan="3">Power System Equipment (Transformers, Breakers)</td></tr>
</table>


Web pages with Applet
and Servlet (Java)
software for updates
Web Browser
Web server
Web Pages with:
oReal-time values
oRelay settings
oFault records
Real-time
SCADA
DNP3.0
ORACLE RDB
Fault records, summaries
and waveform data from
relays (and settings)
Frame relay
4-wire lease line
Real-time SCADA
data and controls
(any IED's data)
LAN/WAN
TelCo System
All WAN
communications are
via secure TCP/IP
DFR records
MB+
Router
Relays
RTU
Fault/Oscillography
data files
Real-time
data & controls
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New Versus Existing Substations

- New Substations
  - IEDs With Digital Communications
  - PLCs for Direct I/O
  - No Conventional RTUs
- Existing Substations
  - May Integrate IEDs With Existing RTUs (Not Support Non-Operational and Remote Access Data Paths)
  - Integrate Existing RTU as IED or Eliminate Existing RTU and Use IEDs and PLCs for RTU I/O

Protocol Fundamentals

- Communication Protocol
  - Allows Two Devices to Talk to Each Other
  - Each Device Must Have the Same Protocol Implemented, and the Same Version of the Protocol
- Both Devices From Same Supplier, and Protocol
- Both Devices From Same Supplier, with Industry Standard Protocol
- Devices From Different Suppliers, with Industry Standard Protocol

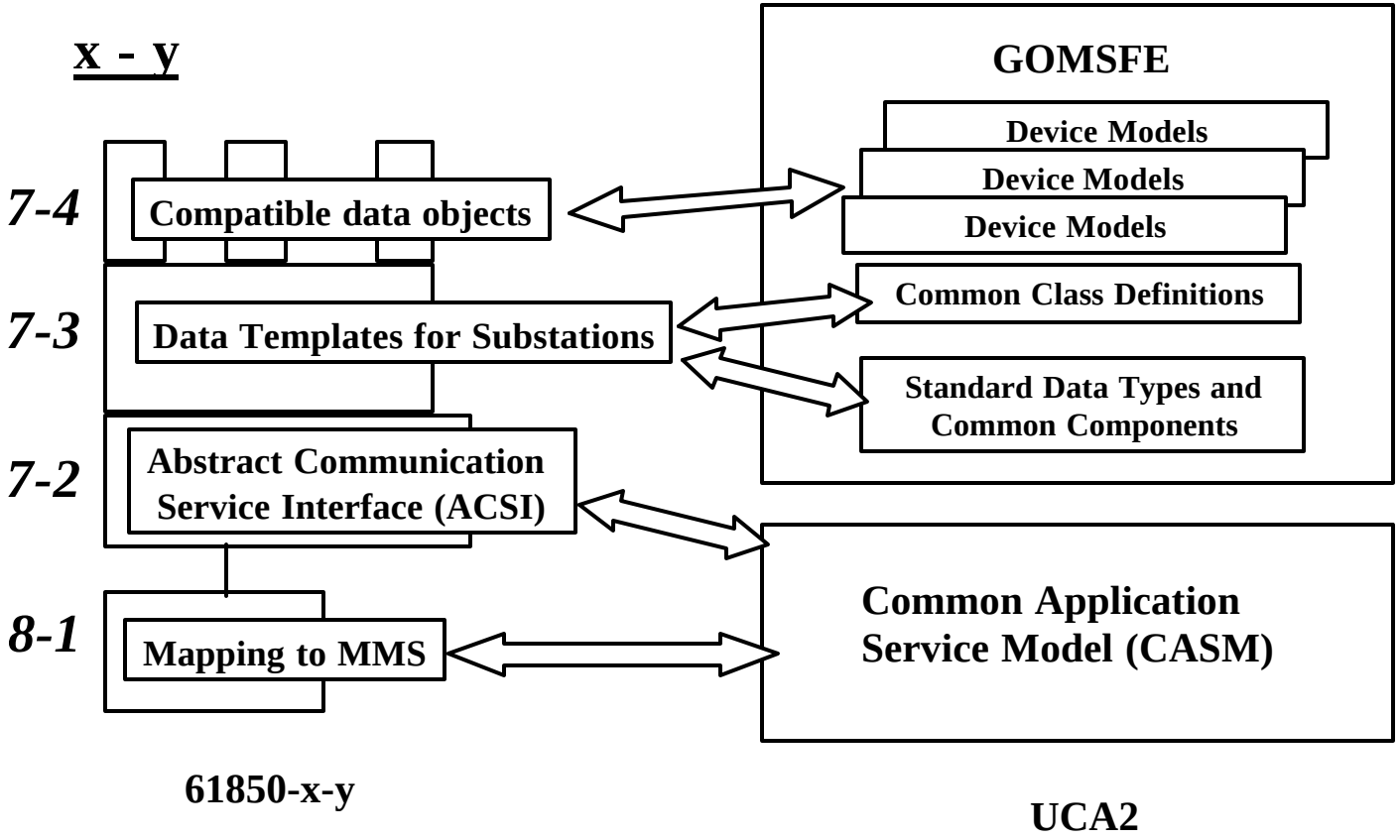
Protocol Considerations

- North American Electric Utilities Specify the IEDs to be Used in a Substation
  - Chosen Based on IED's Standalone Capabilities (Relay for Protection of Power System) and Not IED's Integration Capabilities
  - IEDs From Various Vendors (Will Not Accept Turnkey Approach From One Vendor With All IEDs From that Vendor)

Protocol Considerations… (continued)

- Once IEDs Specified by Utility Based on Standalone Capabilities, Then Consider Each IED's Integration Capabilities
  - IED Protocol Support
    - Modbus, Modbus Plus, DNP3
    - UCA2 MMS
    - May Lose Some IED Functionality When Choose Other Than IED's Native Protocol
  - IED Networking Support
    - RS-232 and RS-485 (Serial)
    - Ethernet

IEC TC57 Harmonization with UCA2



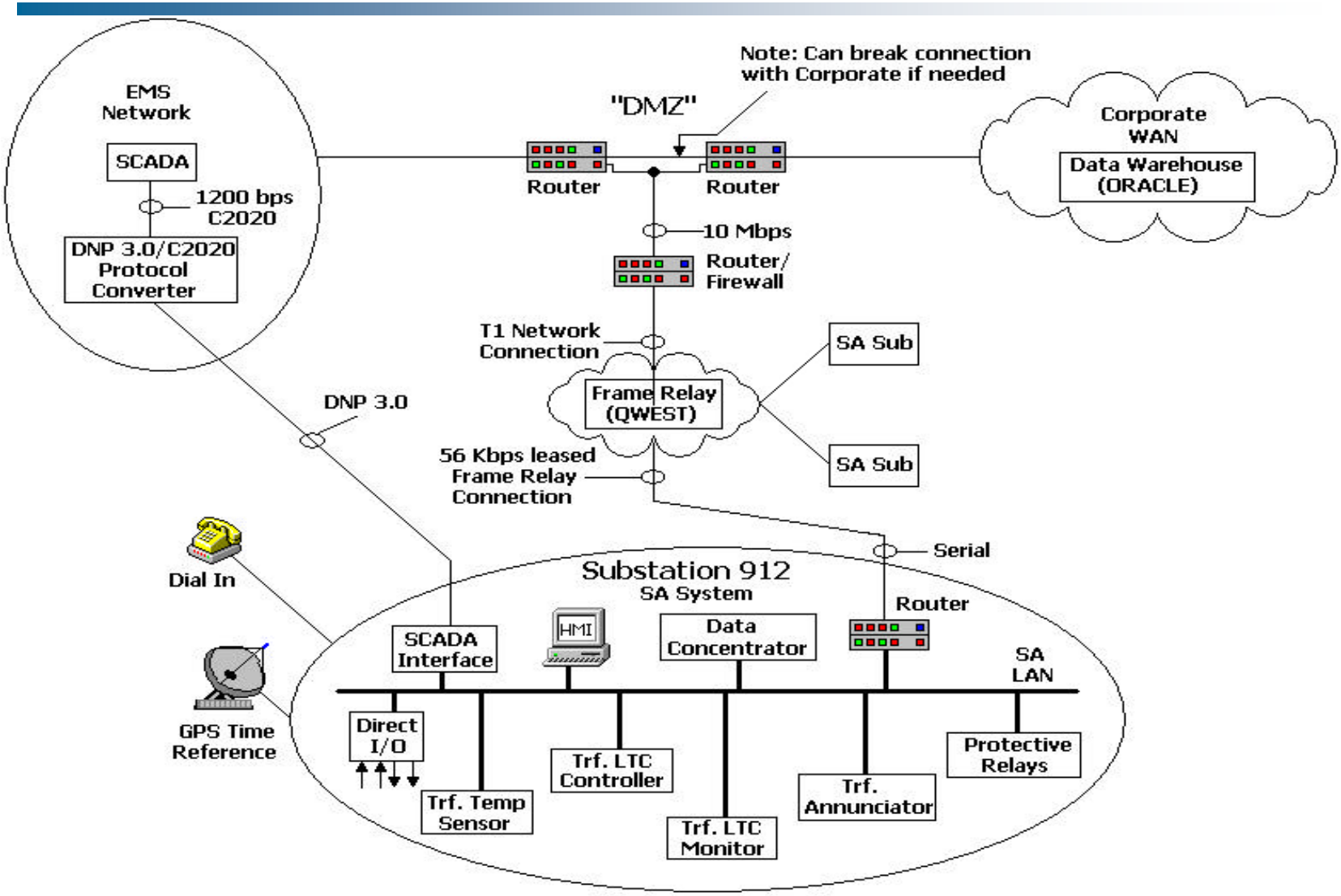
North American Projects

- Omaha Public Power District (OPPD) – Two Substations and One Training Simulator
- MidAmerican Energy Company (Iowa) – Two Substations and One Training Simulator
- Los Angeles Department of Water and Power – 179 Substations, Two Development Systems, One Training Simulator Over Five Years
- EPCOR Utilities (Edmonton) – Two Substations
- Minnesota Power – Strategic Plan
- Potomac Electric Power Company (PEPCO) – all 4kV, 13kV, 69kV and 230kV Substations
- Frankfort Electric and Water Plant Board (Kentucky) – Sixteen Substations and One SCADA System With Two Dispatch Centers

Omaha Public Power District (OPPD)

- EPRI Tailored Collaboration (TC) Project
- Two Substations, One Training Simulator
- Require all IEDs with UCA Capability to be Integrated Using UCA2 MMS Protocol and Ethernet Networking
- Discovered that IEDs Thought to Have UCA Capability Did Not (Beckwith M2002B LTC Control)
- Discovered that IEDs Achieve UCA Capability By Adding a Separate Box (Rather Than Integrating Into IED) (RFL 9745 Teleprotection)
- Integrators Not Need SEL 2030 Communication Processor – Integrate SEL Relays Directly
- One Substation System and Training Simulator System Being Installed

OPPD Simplified SA Functional Sketch



Simplified OPPD SA System