

## Smart Grid Substation



**EPRI**

ELECTRIC POWER  
RESEARCH INSTITUTE

# EPRI Smart Grid Substation Laboratory

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Technical Executive

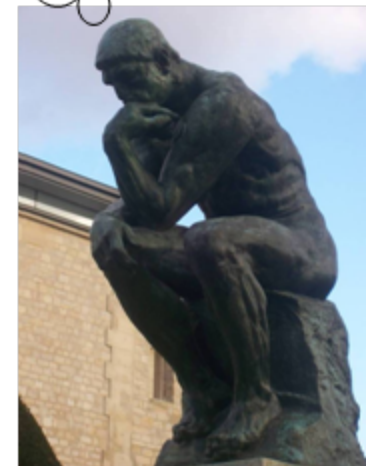
# Overview

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- Background
- Applications for IED application, configuration, integration
- Applications for PMU integration
- Applications for substation security
- Data Integration

# Origin of the SGS Lab

- Development of the lab started approximately two years ago.
- Stakeholders requested a platform to implement new technologies.
- Vendors began to provide intelligent electronic devices in late 2008.

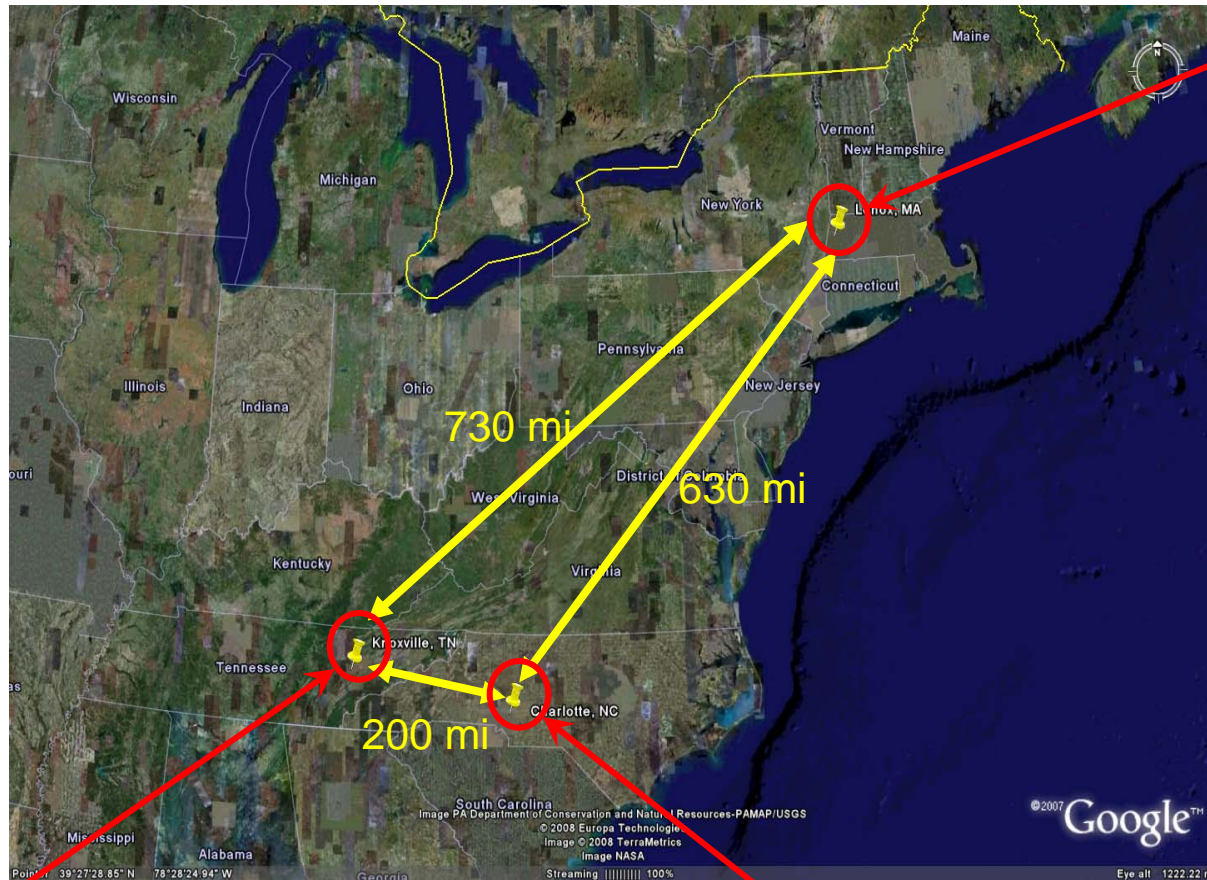


# Original Focus of the SGS Lab

## Management of Intelligent Electronic Devices within a smart grid environment.

- Tools to manage firmware, configuration and settings
- Development of non-vendor specific software for configuration and management
- Next generation relays
- Demonstrate 61850 benefits, wide area GOOSE
- Wide area communications issues
- Synchrophasors
- Effective security scenarios
- And much more.....

# SGS Lab Spans Three Geographic Locations



**Lenox**  
(Substation)

**Knoxville**  
(Substation & HQ)

**Charlotte**  
(Substation)

# Lab Vendor Collaboration



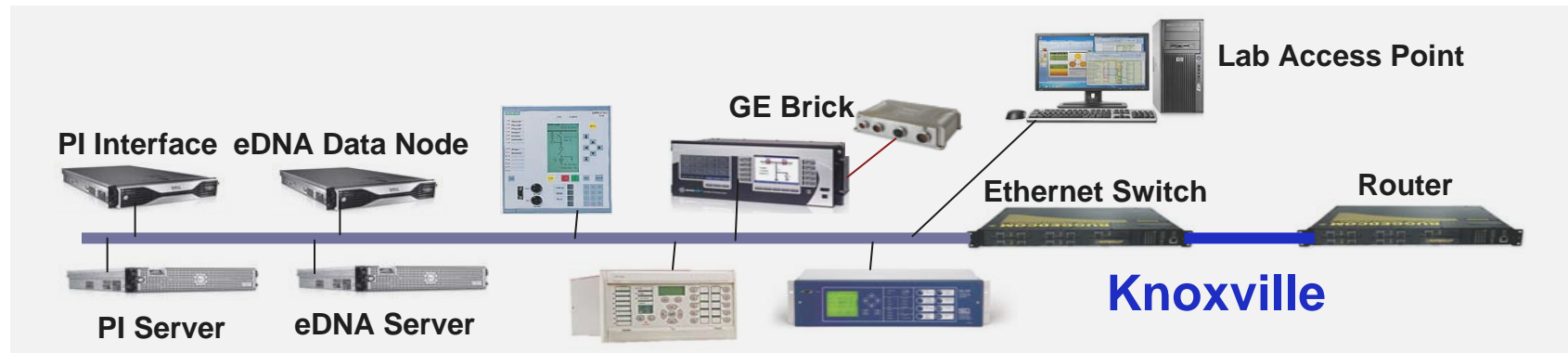
**SIEMENS**



**SEL** SCHWEITZER ENGINEERING LABORATORIES, INC.



# Architecture of the Lab



# Hardware Overview

- Relays/PMUs
  - 10+ PMUs
  - 20+ Relays
- Data Concentrators
  - 3 SEL 3378 SVPs
- Computing Platforms
  - 6 Dell Workstations
  - 2 Dell Servers
  - 1 HP Server
  - 1 HP Workstation
- Merging Units/Process Bus
  - GE Brick
- Security
  - 3 Cooper Power Substation Gateways
- Industrial Communication Equipment
  - Ethernet Switches (RuggedCom, Cisco)
  - Routers (RuggedCom, Cisco)
- Relay Test Sets
  - 2 Omicron CMC 256 Test Sets
  - 3 SEL 4000 (AMS)
- GPS Clocks
  - 3 SEL
  - 2 AREVA

# Software & Media

- Substation Automation

- **Siemens**

- IEC Configurators

- **Kalkitech**

- Data Historians

- **OSIsoft PI**
- **Instep eDNA**



- Security

- **Cooper Power**

- Virtual Machines

- **VMware**

- Media at each site

- **Large LCD display**
- **PTZ Webcam**
- **KVM switches and VGA splitters allow for centralized control and display at each location**

# Equipment View



**Charlotte**

**Lenox**



**Knoxville**

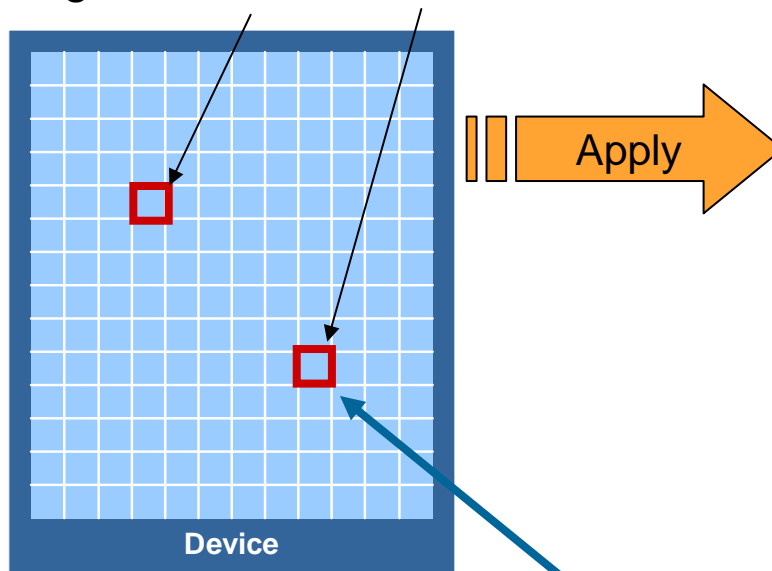
**Historians  
(Knoxville)**



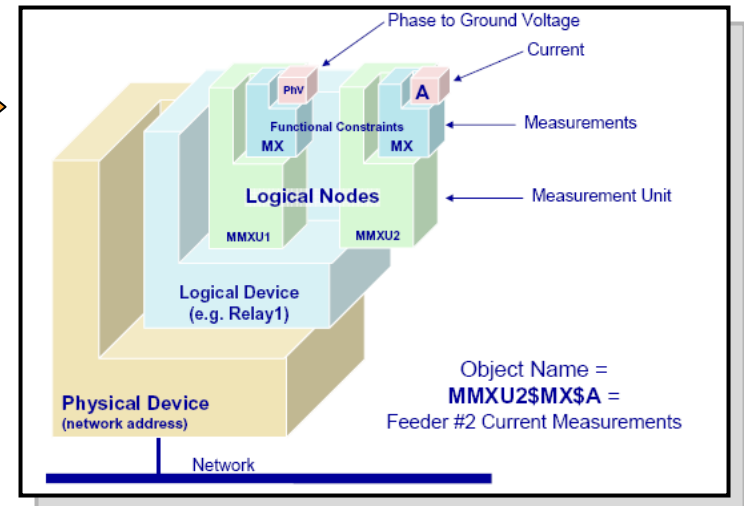
# Key Benefit of IEC 61850 Data Model

## Typical Legacy Protocol Data Model – DNP3

I need to find the MW loading on Circuit 123 -  
Is it in register 1154 or 5411?



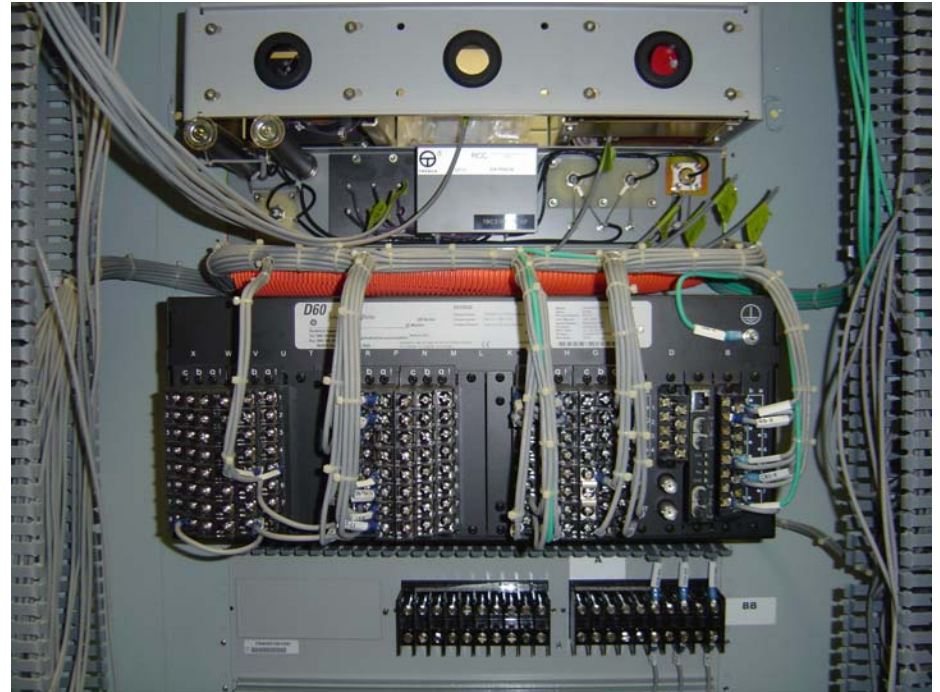
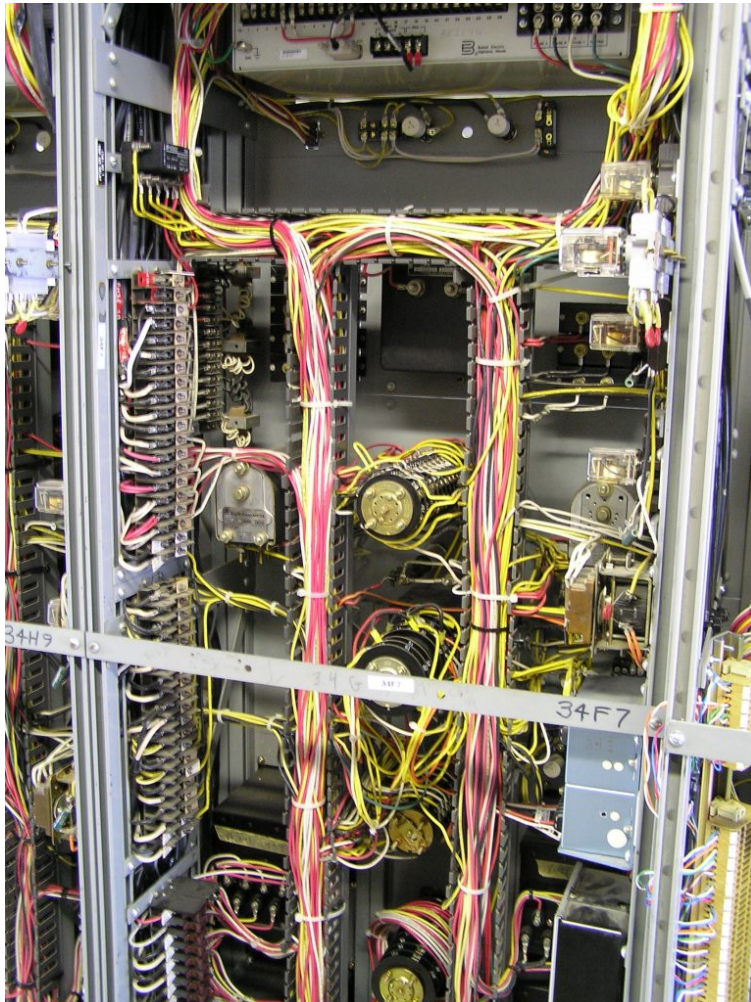
## IEC 61850 Protocol Data Model



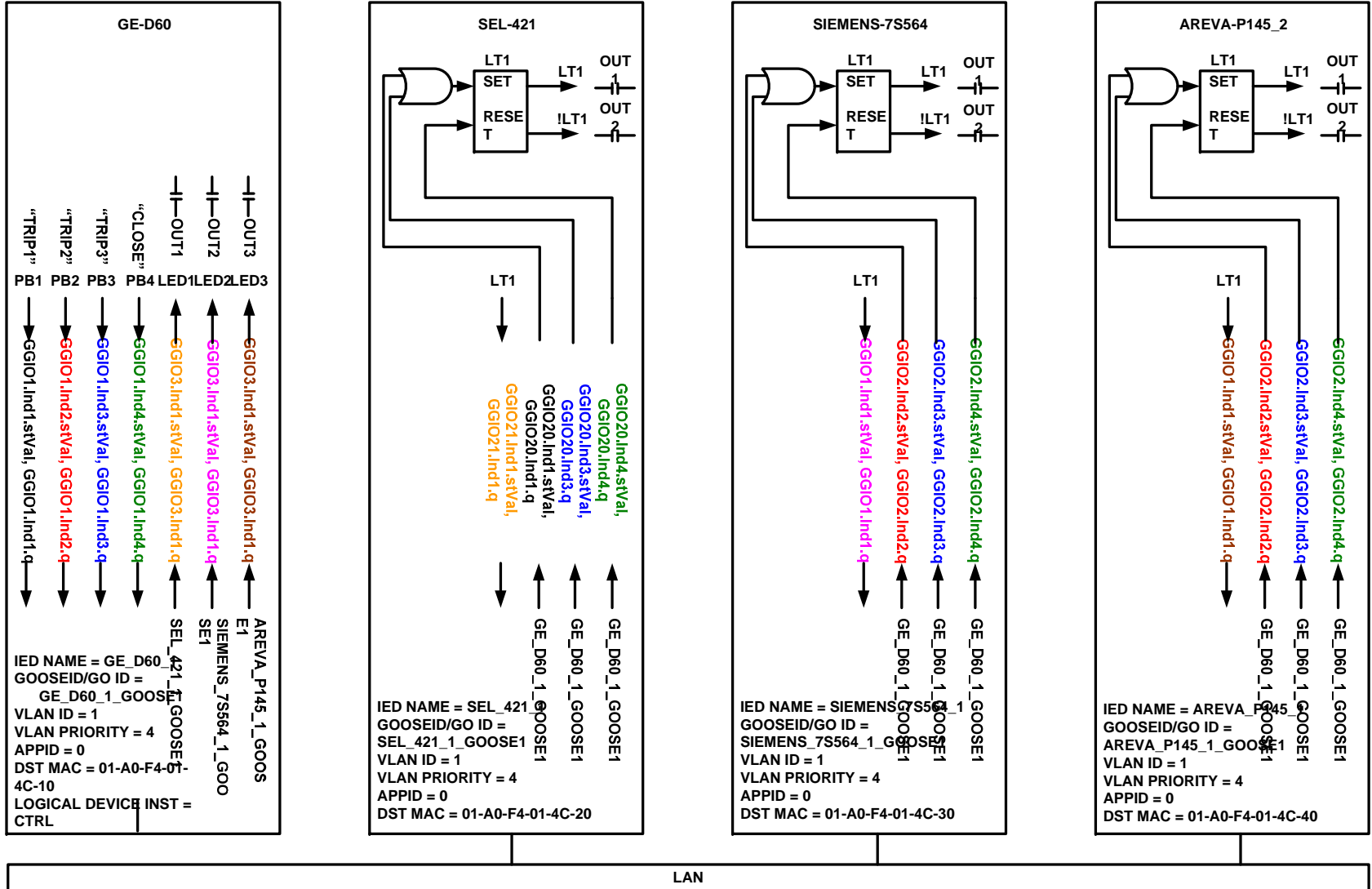
I need to find the MW loading on Circuit 123  
-MMXU1\$MX\$PhV\$PhsA\$cVal\$mag\$f

IEC61850 makes the Power System context visible  
and reduces long-term operating cost

# IEC61850 Substantially Reduces Panel Wiring



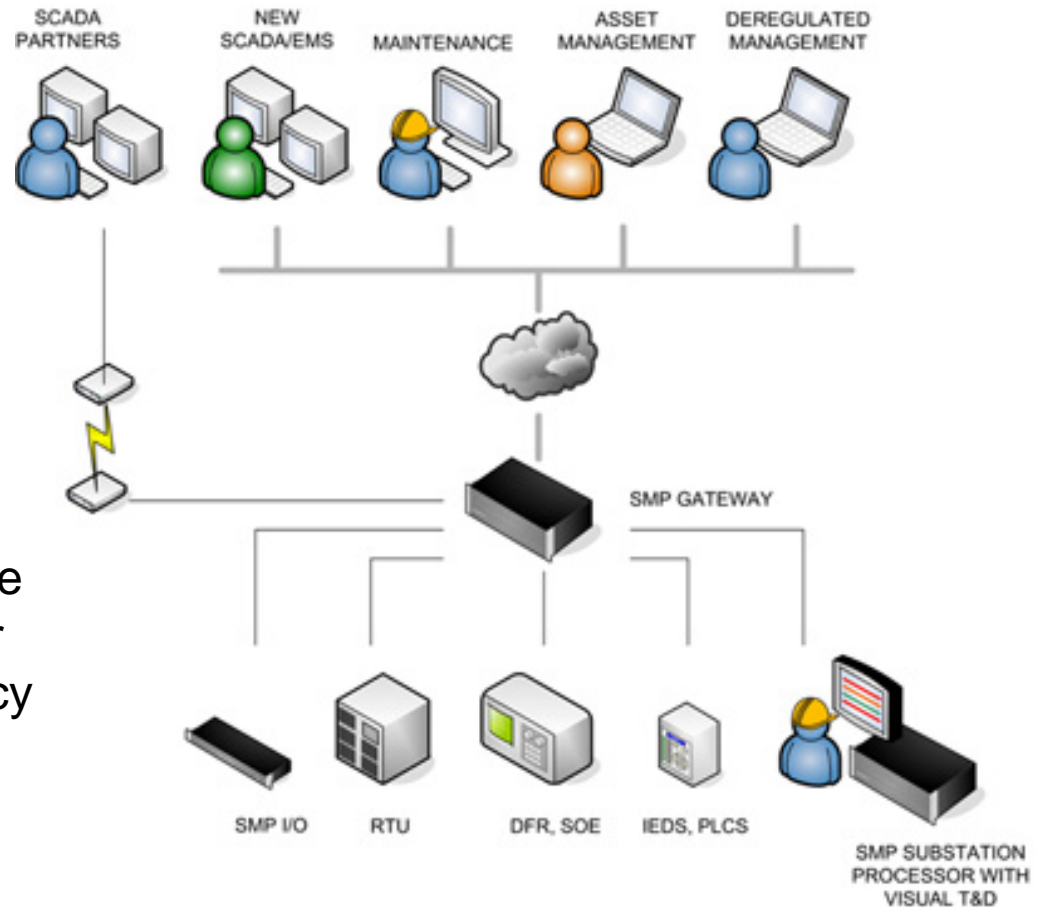
# IEC 61850 GOOSE Demo



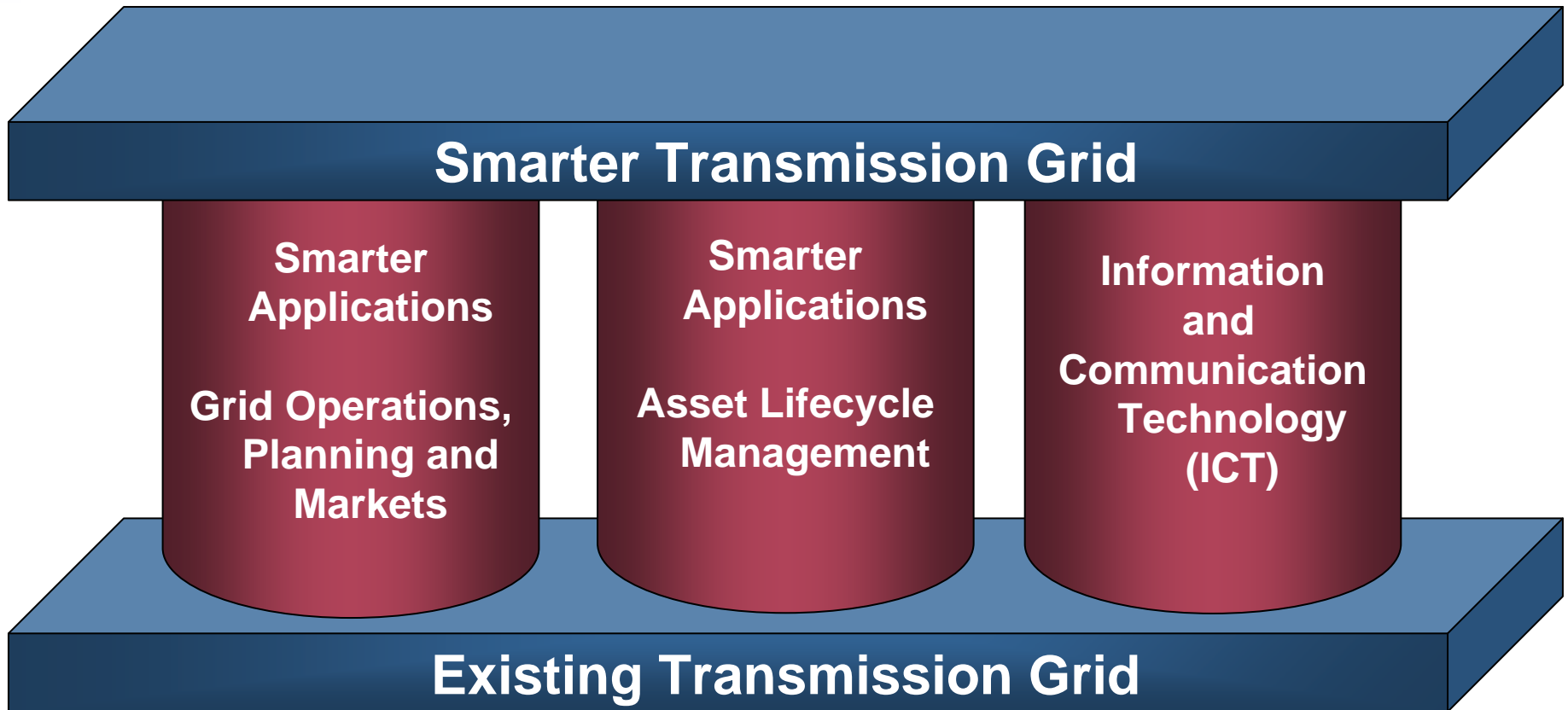
# Cybertec Substation Gateway (Cooper Power)



**SMP Gateway** creates a secure NERC CIP compliant perimeter to integrate both new and legacy IEDs.

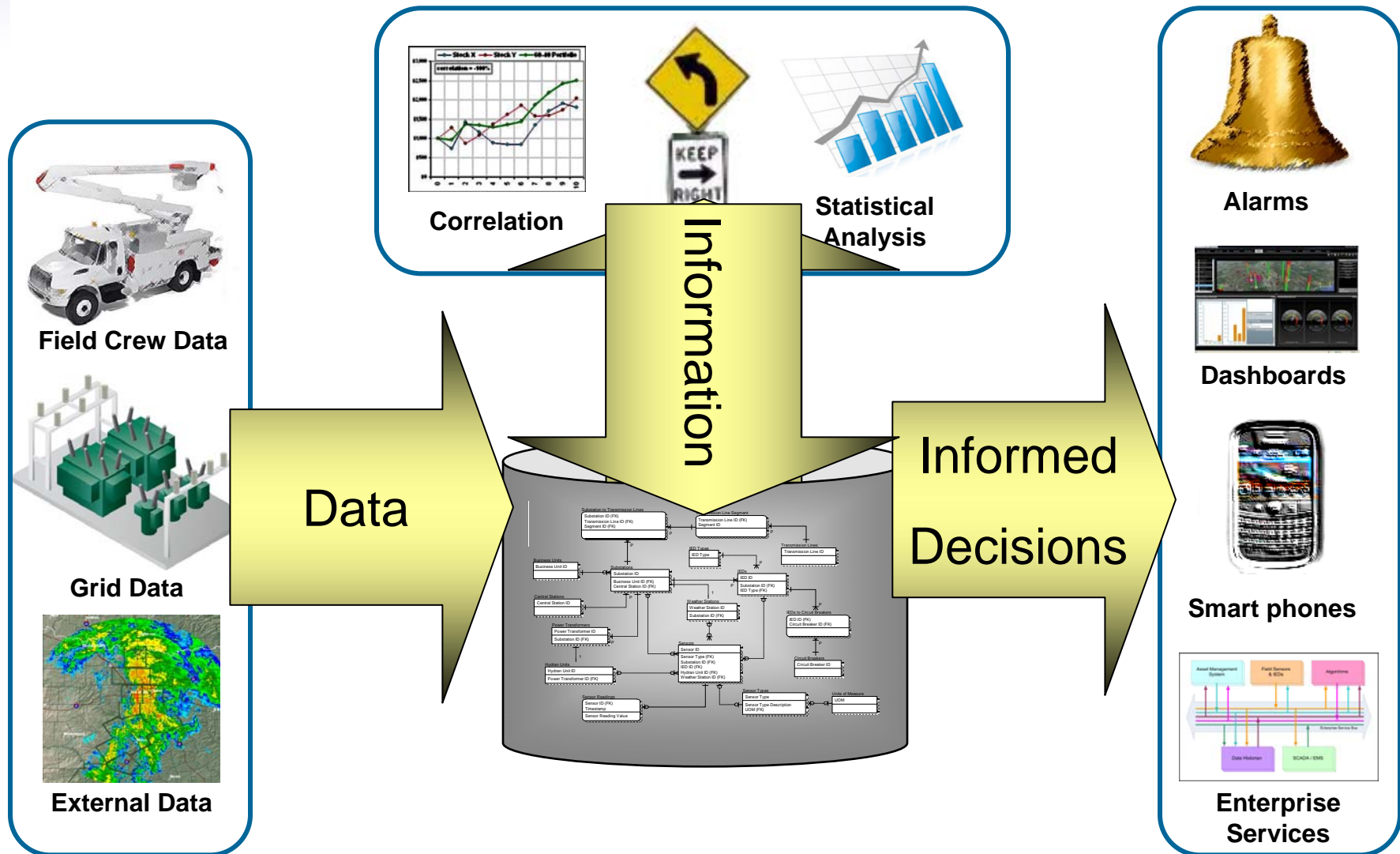


# Smarter Transmission Grid - Foundation



**Collaborative Long Term Vision Achieved Through Well Aligned Tactical Near Term Actions**

# Conceptual Approach



# Smart Grid Substation Lab

## 2010 Accomplishments:

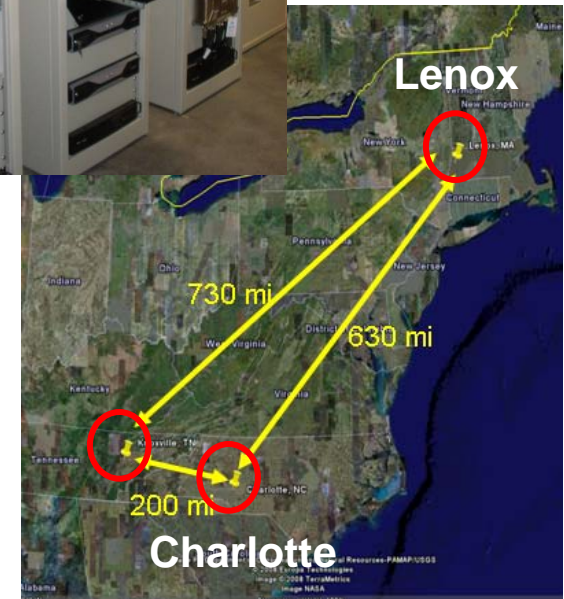
- Established Fully Functional Multi-site lab
- Streaming synchrophasor data
- IEC 61850 training sessions

## Features:

- Wide area communications
- Multi Vendor environment
- Latest technologies deployed

## Benefits:

- Readily adaptable testing environment
- Reduced testing costs with shared results
- Vendor involvement accelerates problem resolution



# Applications for IED application, configuration, integration

- Base programs involved
  - P37H – Protective Relaying
    - Configuration Management
    - IEC 61850 Training
      - Introductory
      - Advanced
- Data Integration project – Technology Innovation
  - Data integration from variety of sources related to a transmission system based on the NIST Smart Grid Interoperability Report
  - Automatic conversion of data to information with visualization
  - Data to be integrated includes sensor data, relay data, weather data, system topography, operational data and more
  - Integrates real-time data, with web based resources in a format suitable to a variety of personnel

# Applications for PMU integration

- Base programs involved
  - P37H – Protective Relaying
    - Multifunction Devices under test along with stand alone PMUs to determine if filtering does have an effect on measurement.
  - Grid Operations
    - Wide area situational awareness
- Supplemental projects
  - ???

# Applications for substation security

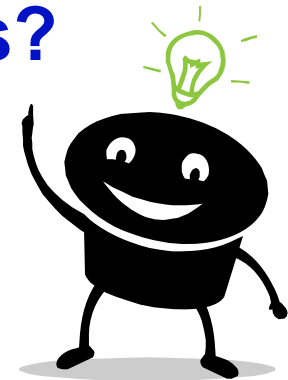
- Base programs involved – PS161E
- LEMNOS Testing project (base program)
- DNP Security project (base program and supplemental)
- Other supplemental opportunities

# Now.....It's time for Feedback!

With the capabilities of the SGS Lab, how could it best be used in work to improve/develop security of the power grid?



**Any ideas?**



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