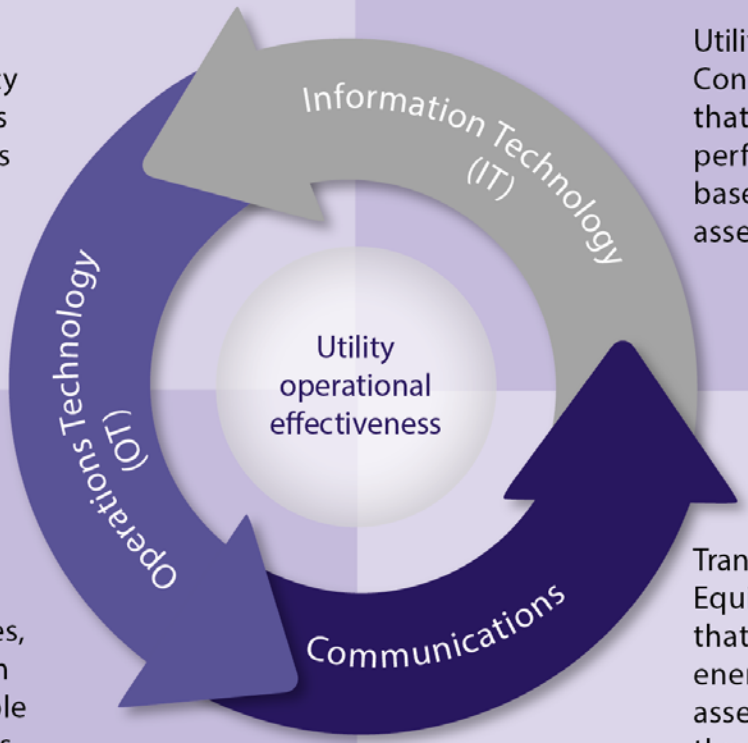
Gary Rackliffe, Vice President, ABB Smart Grids North America

NRECA Smart Grid Overview
Raleigh November 12, 2013

Smarter Grids – Integration of OT and IT

Smart grid investment for improved operational effectiveness
ABB smart grid solutions help control costs and meet consumer demand with fewer resources

Distribution grid management
Increase reliability and efficiency while reducing operations costs through better communications and control



Utility analytics
Consumer and grid analytics that improve operational performance and condition-based maintenance to improve asset life-cycle management

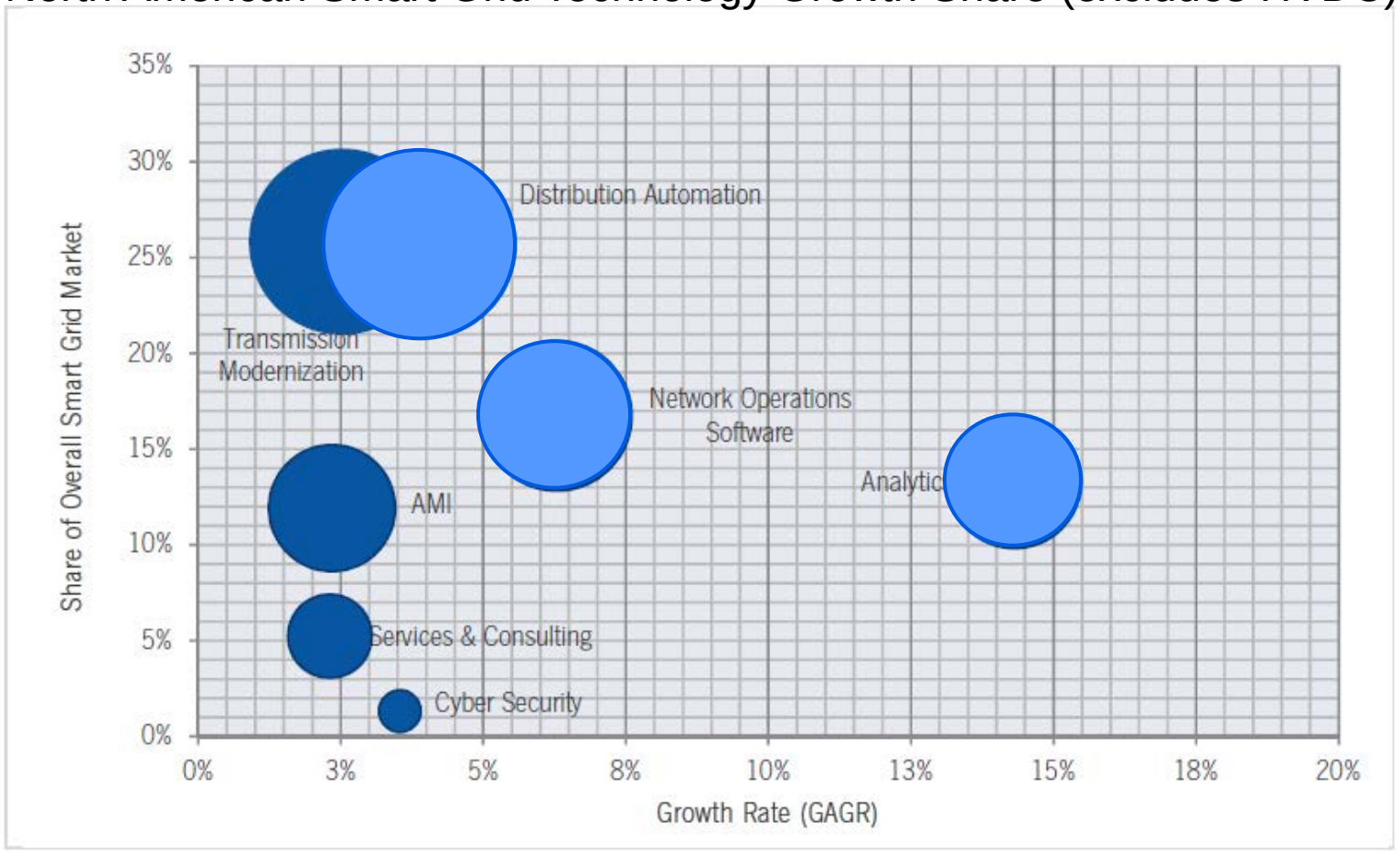
Distributed energy resources
Enable groundbreaking operational flexibility for utilities, providing utility customers with lower costs and more sustainable electricity-consumption options

Transmission grid management
Equipment, process and tools that interconnect renewable energy sources to legacy grid assets from transmission through distribution

The convergence of operations technology (OT) and information technology (IT) integrates enterprise-level IT applications with grid systems and equipment, elevating overall system performance.

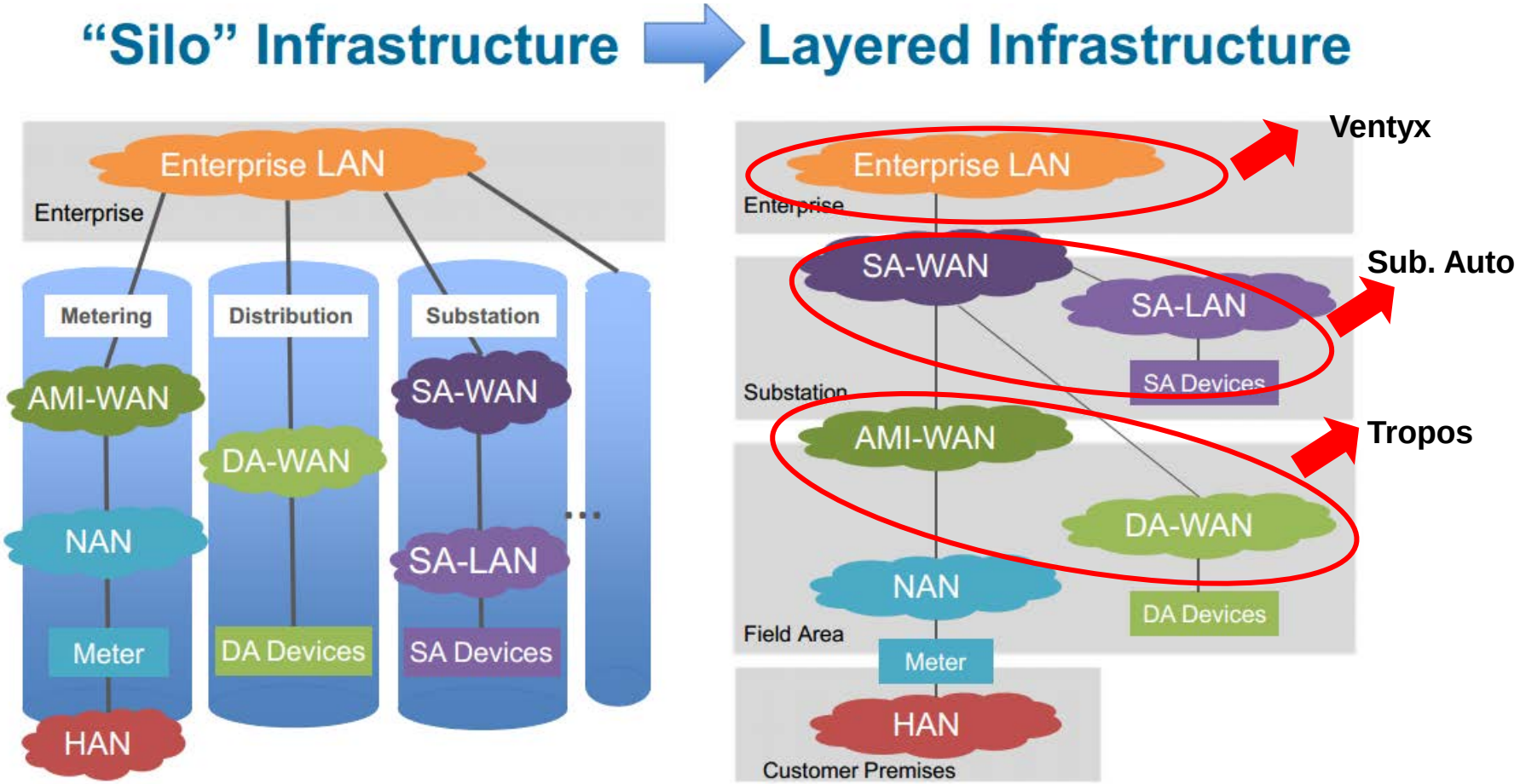
Market Forecast
Smart Grid Cumulative Market 2013 - 2020

North American Smart Grid Technology Growth Share (excludes HVDC)



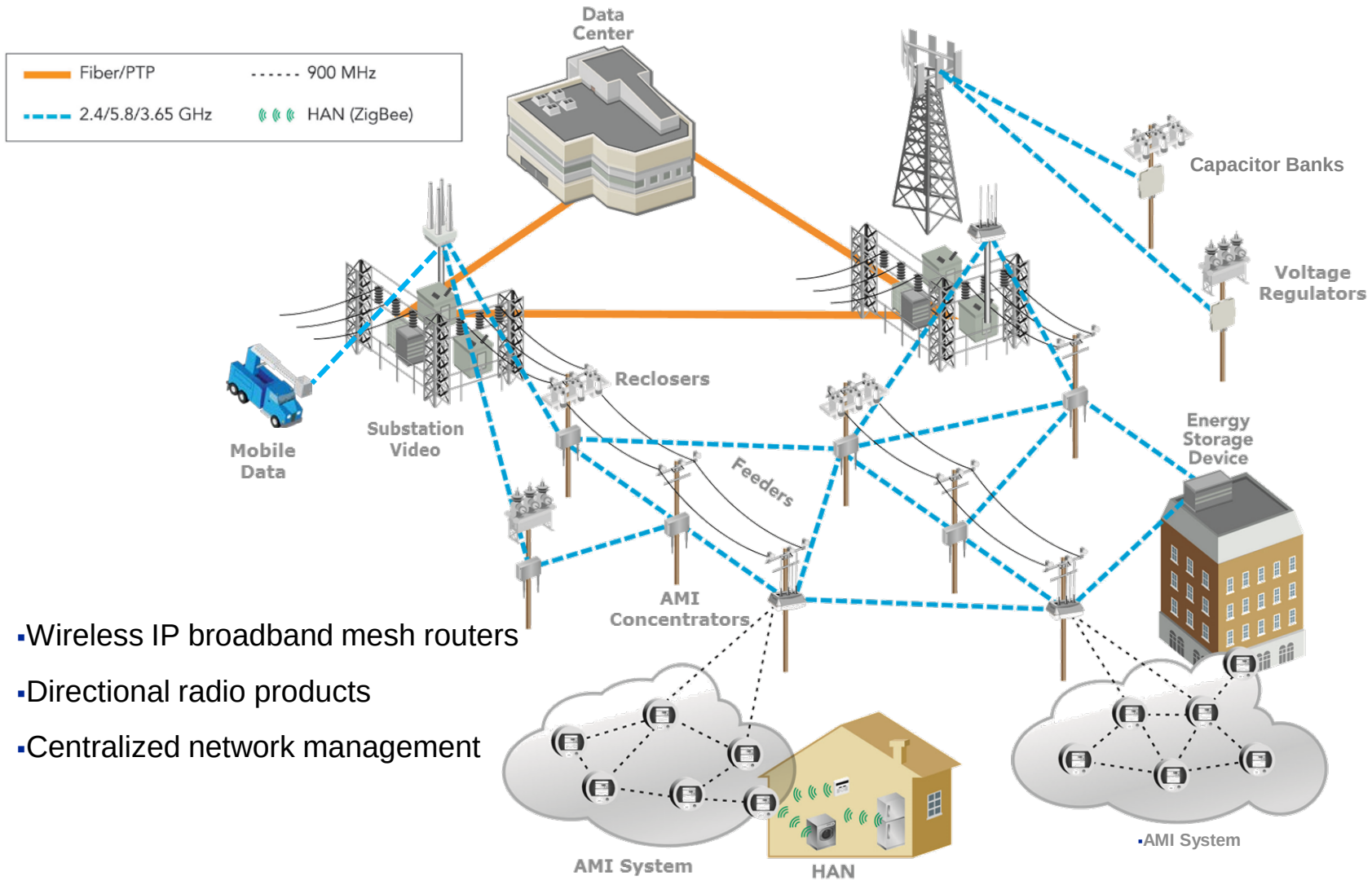
Source: GTM Research

End-to-end communication infrastructure



- Source: Pike Research

Tropos GridCom network architecture



- Wireless IP broadband mesh routers
- Directional radio products
- Centralized network management

Networking for utilities *and smart cities*
Broadband enables smarter grid applications

Distribution Automation & Control

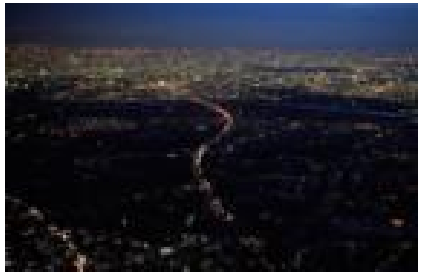
Automated Metering

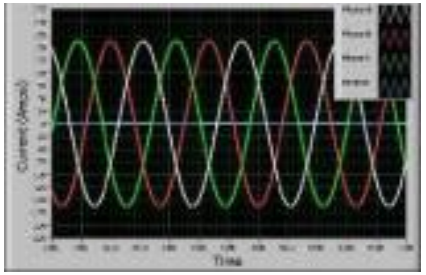
Renewables Integration

Field Data Applications

Demand Response

Outage Management





Power Quality & Planning

PHEV Integration

Distribution Grid Management: IT/OT convergence

IT/OT Convergence

Employee Dashboards, Queries, Outage Reports, KPIs

External Communications to Customers, Media, Regulators

Operational Business Intelligence T&D Systems

Work & Asset Management

Mobile Work Management

Demand Response Management

OMS Applications
- Trouble Call Management
- Outage Analysis
- Interface to AMI
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Network Applications
- Fault Detection and Location
- Automated Restoration Switching
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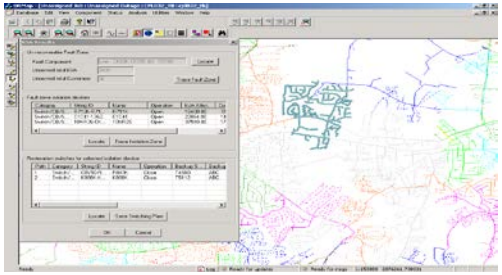
- Volt/VAR Optimization
- State Estimation
- Unbalanced 3-Phase Load Flow

Network Model

SCADA

Communication Front Ends – Wireless Networks

- Field Devices – RTUs, Relays, Controllers, Sensors
- Distribution Automation Equipment – Reclosers, Switches, Capacitors, Line Voltage Regulators, Load Tap Changers
- Substation Automation Systems
- Distributed Energy Resources – Load Control, Storage, Distributed Generation, EV Charging Infrastructure, Microgrids



CIS

AMI / MDM

IVR

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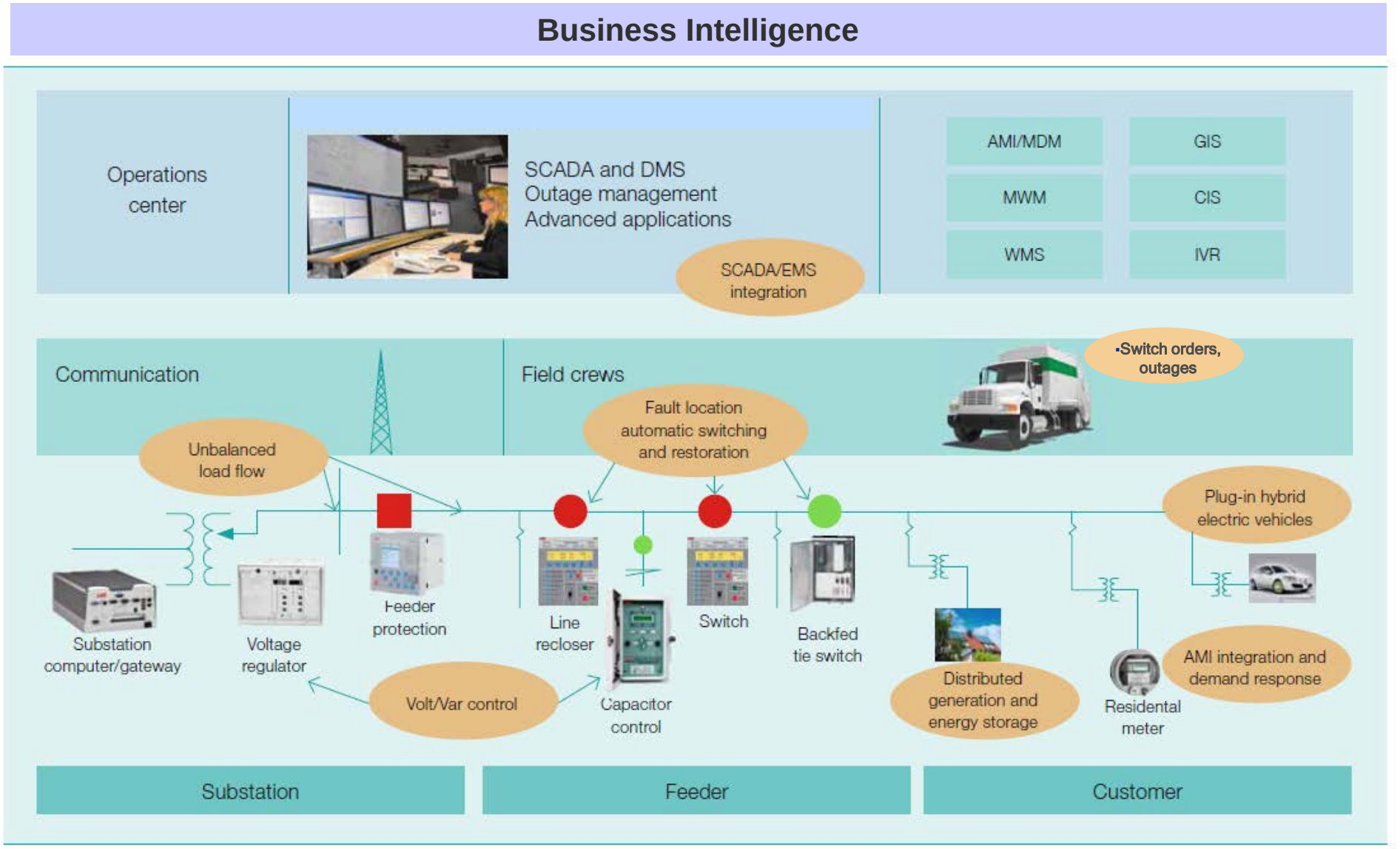
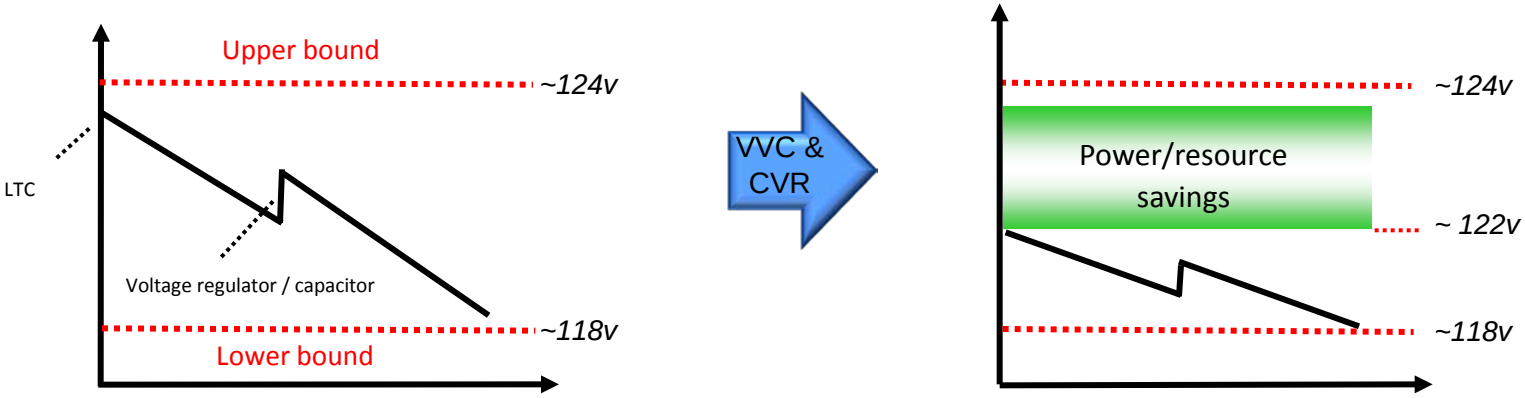
Supporting IT systems

Integrated distribution operations platform



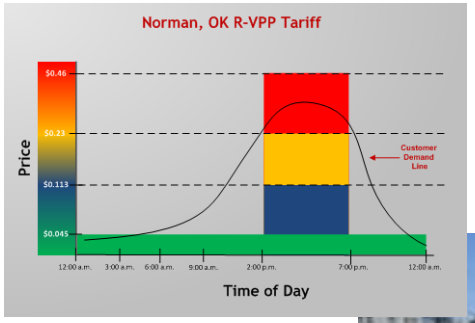
Distribution Grid Management
Optimizing power for maximum efficiency

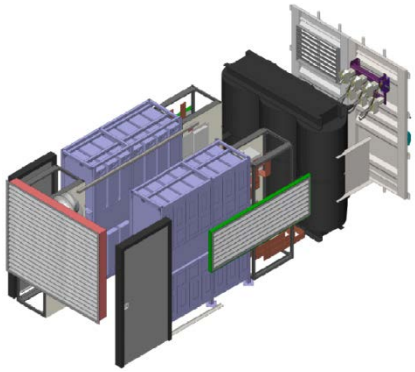
- Reactive power can account for a significant portion of distribution losses. Utilities need to manage the amount of reactive power on the grid to ensure maximum efficiency. A 1% improvement in efficiency is estimated to eliminate 100 million tons of CO2.
- Volt/VAr Optimization – Optimizing the balance between active and reactive power can allow for reduction of energy losses on distribution feeders. Savings of 4 – 5% can be achieved through loss reduction and conservation voltage reduction. The optimization can also be used to reduce peak demand.



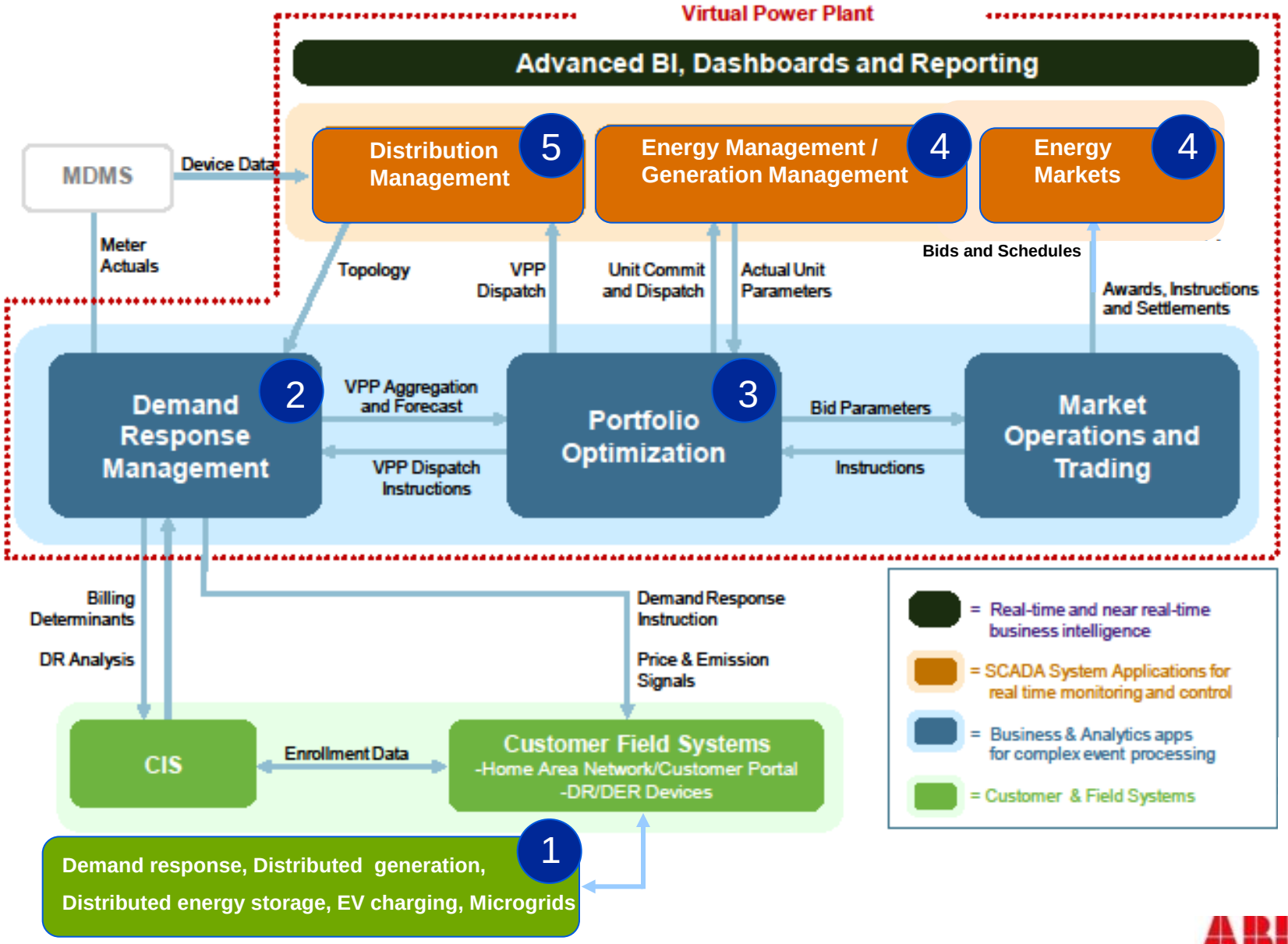
Distributed Energy Resources

- Demand Response
- Distributed Generation
- Distributed Energy Storage
- EV Charging Infrastructure
- Microgrids

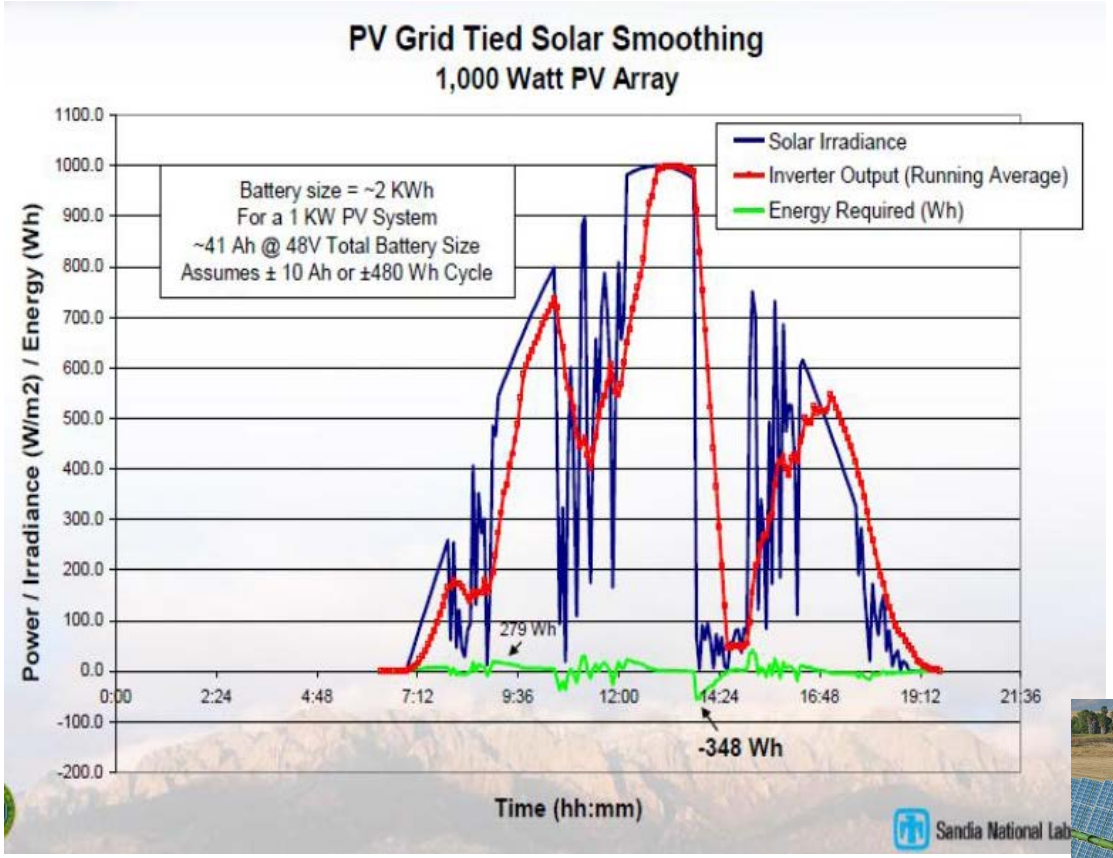




DERs – Integrating OT/IT with virtual power plants



Managing Distributed Generation



- Connecting solar energy to the grid – integration with microgrids and energy storage
- Feeders with high concentrations of PV can be problematic

Energy storage

- Balancing power is a major issue for utilities and especially critical with large amounts of variable wind and solar energy in the supply mix
- Storage of electrical energy helps to bridge the time of reduced or missing power to activate reserves

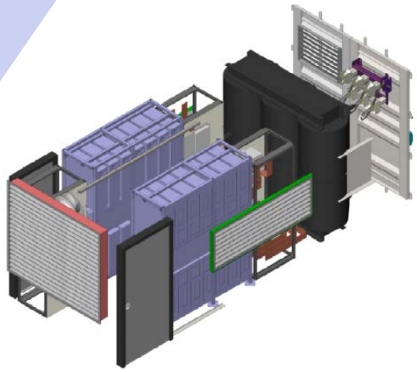
GVEA batteries

Inverter at GVEA

1990-2000
- Technical feasibility

2001-2010
- Commercial feasibility

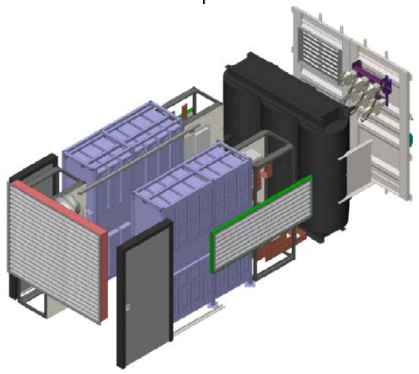
2011-2015
- Grid integration



Energy storage

Electricity Storage Spectrum in Utility Grids

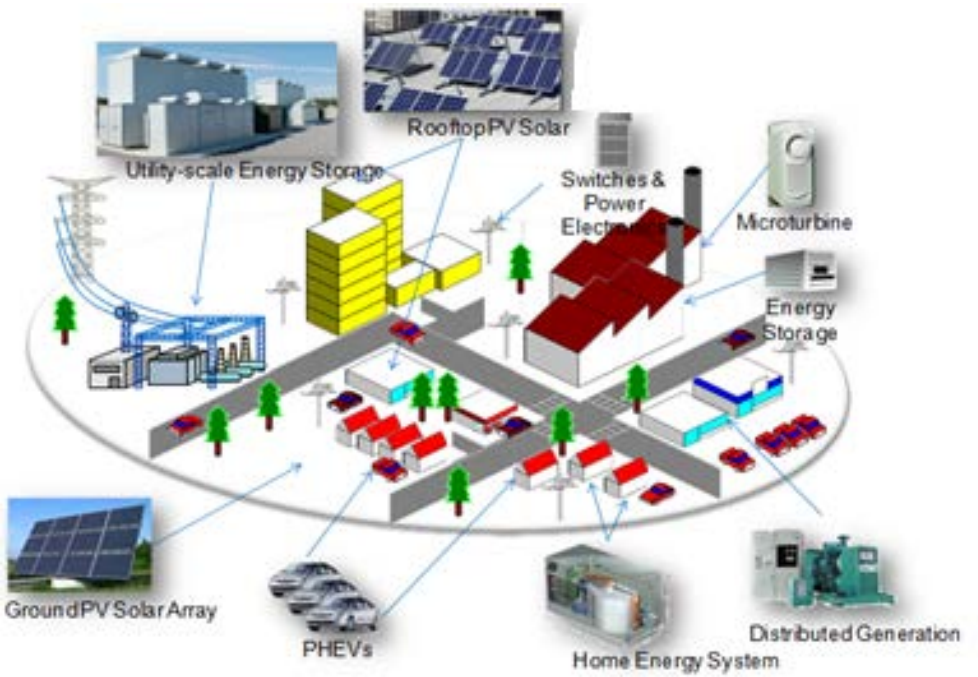
Power Quality Applications: "increase of power grid reliability"		Energy Management Applications: "production can be decoupled from demand"
seconds or less	*minutes*	*hours*
•Flicker compensation •Voltage sag correction •Reactive power control	•Spinning reserve (for voltage and frequency regulation) •Uninterruptible power supply •Blackstart	•Load leveling •Peak shaving •Energy trading •Integration of renewables •Island operation



Microgrids

Microgrid Definition

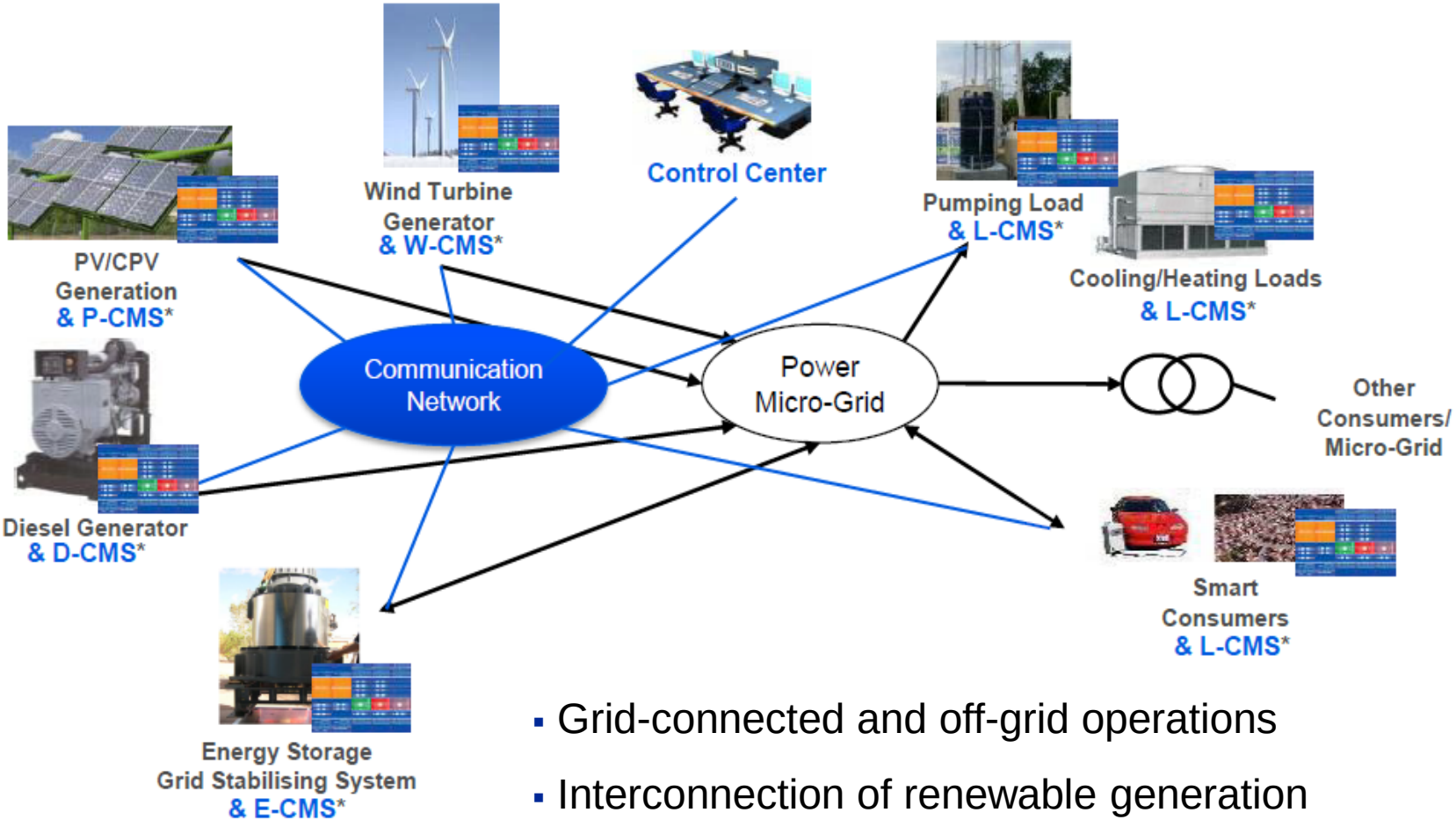
A microgrid is an integrated energy system consisting of interconnected loads and distributed energy resources which, as an integrated system, can operate either in parallel to or "islanded" from the existing utility power grid.



Microgrid Applications

- Microgrids can range widely in size, source of electricity, heating and cooling, etc.
- Given this diversity and versatility, it is virtually impossible to map out a "typical" microgrid configuration
- End-use applications being developed today:
  - Institutional/campus microgrids
  - Data center microgrids
  - Military base microgrids
  - Community microgrids (private investment)
  - Remote "off-grid" microgrids
  - Microgrids for integration of renewable generation

Microgrid technologies – automated dispatch

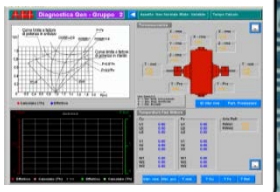


- Grid-connected and off-grid operations
- Interconnection of renewable generation
- Islanded operations during storm response

Asset Health Center

- Historian

- Condition Monitoring



- Enterprise Data Sources

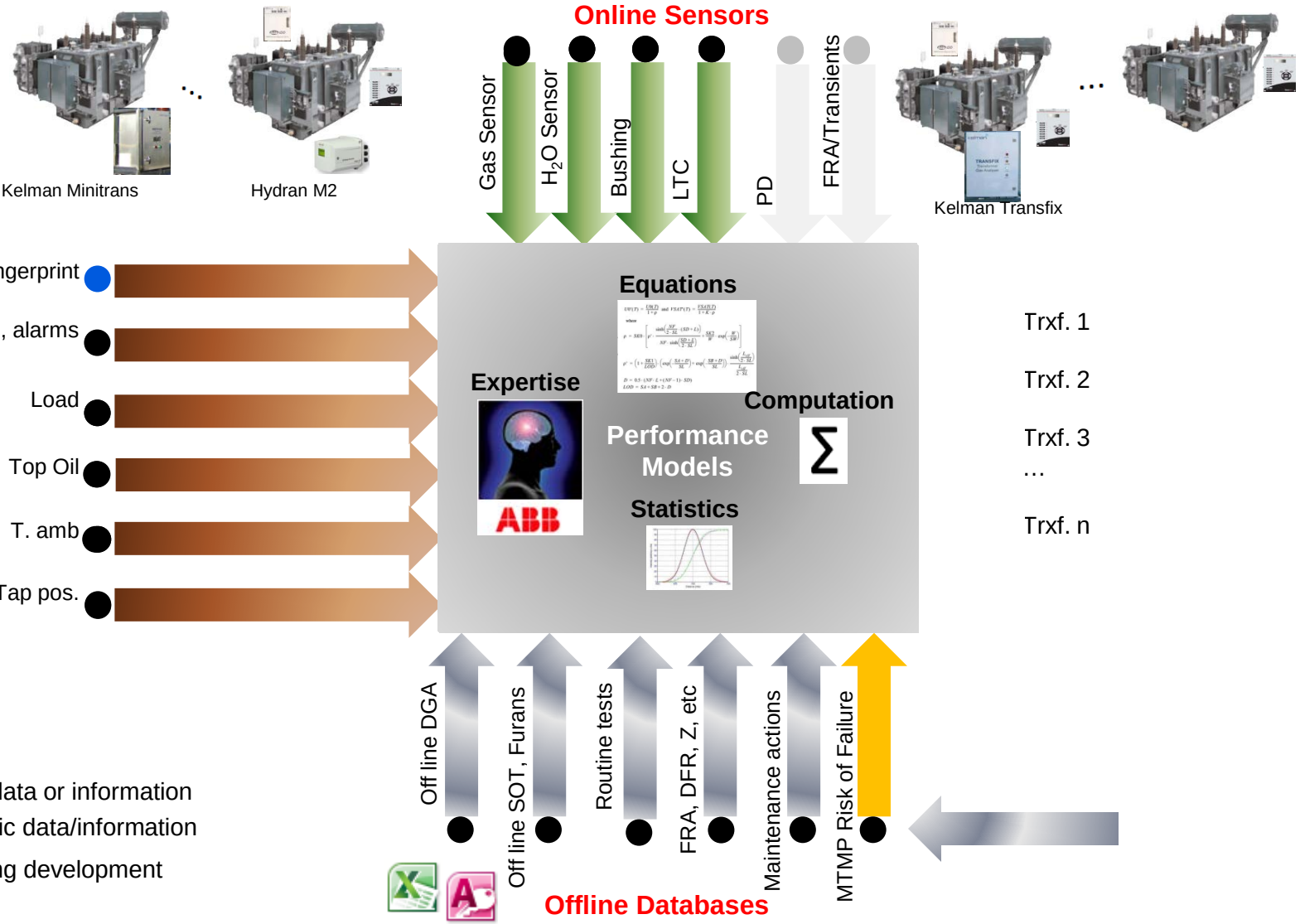
- Data Processing and Analytics

- Subject Matter Expertize

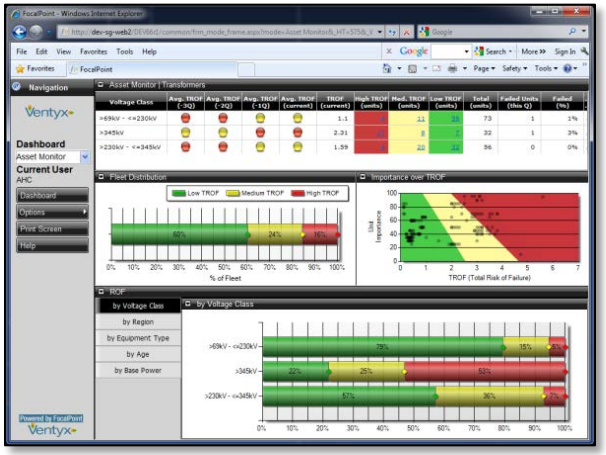
- Advanced Operational BI

- Enterprise Asset and Work Management

Asset Health

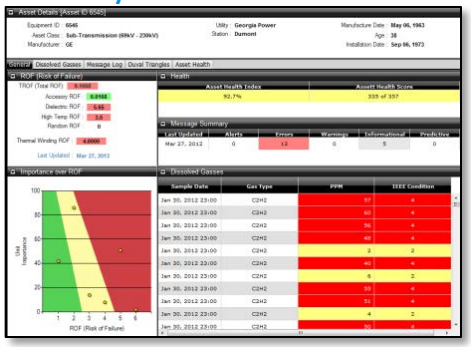


Asset Details – Levels of Detail



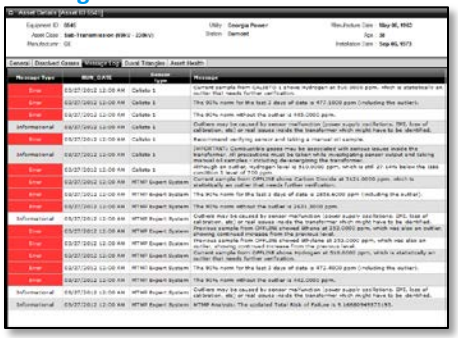
Drilldown

Summary

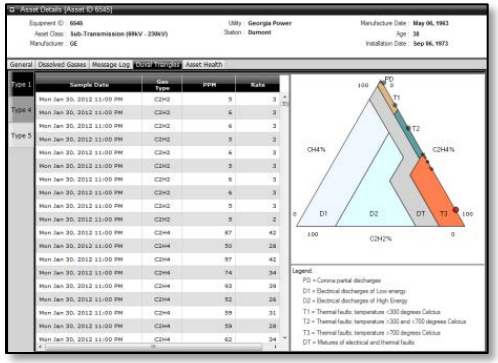


Trending

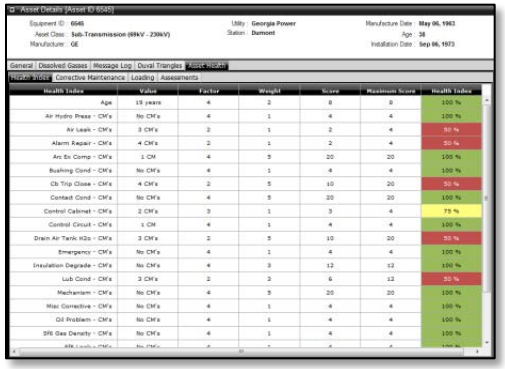
Messages & Notifications



Duval Triangle



Health Index



Circuit Breaker Sentinel, CBS Family
Hardware

CBS

CBS-Lite

CBS-F_6

- ABB has provided systems since 1995
- Universal monitoring system for ALL brands and types (DTB, LTB, GIS)
- Microprocessor design
- Advanced mathematical processing
- Alerts to changes in conditions
- Long term data storage (60 months)
- Supports hardwire and wireless solutions
- Uses Modbus or DNP3.0 protocols
- Provides alarm contacts

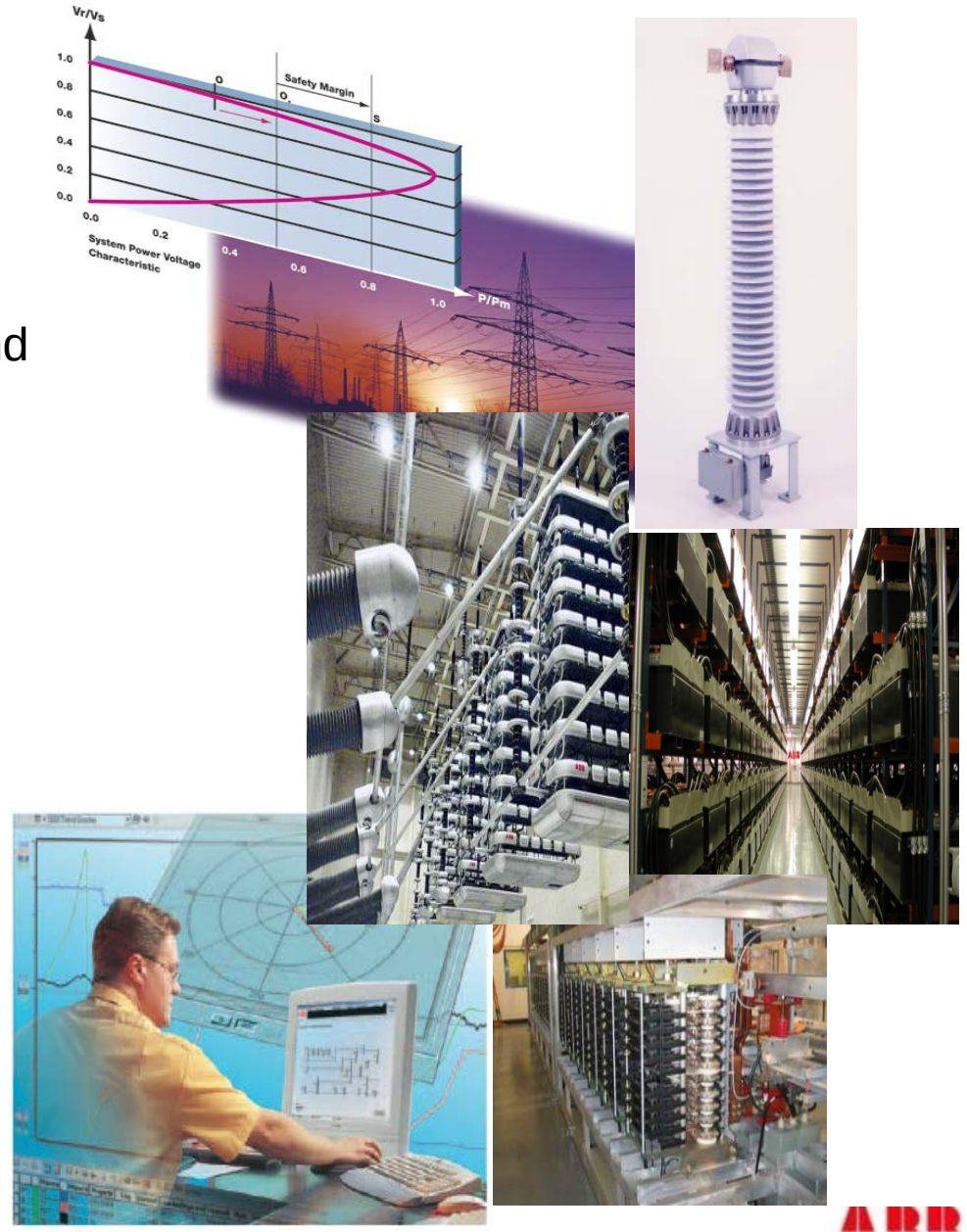
- SF6 gas system
- Interrupter wear
- Mechanical System
- Electrical Controls & Aux.

Built-in Benefits

- Data acquisition and analysis occurs automatically
- Increases reliability and identifies potential problems early
- Eliminates need for time-based or operation based maintenance

Smart Transmission

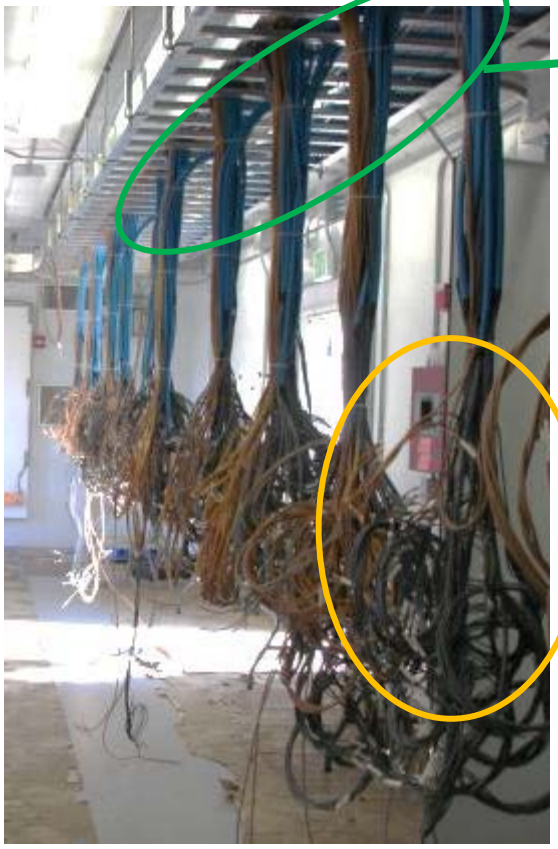
- Digital Substations
- Phasor Measurement Units and Wide-Area Monitoring
- HVDC
- FACTS – SVCs and Series Capacitors
- Utility Scale Energy Storage
- SCADA/EMS



Enhanced Safety
Reducing the risks in the control house

Digital substation reduces complexity with wiring and reduces risk for Operations & Maintenance personnel in the control house

Before



After

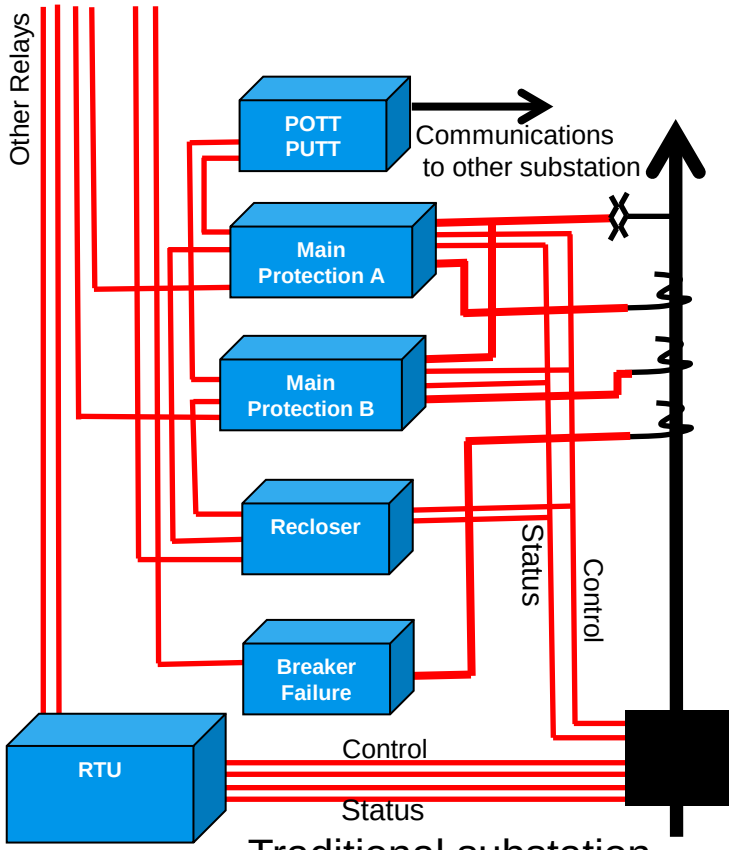
No cable tray

Single conduit to carry fibers

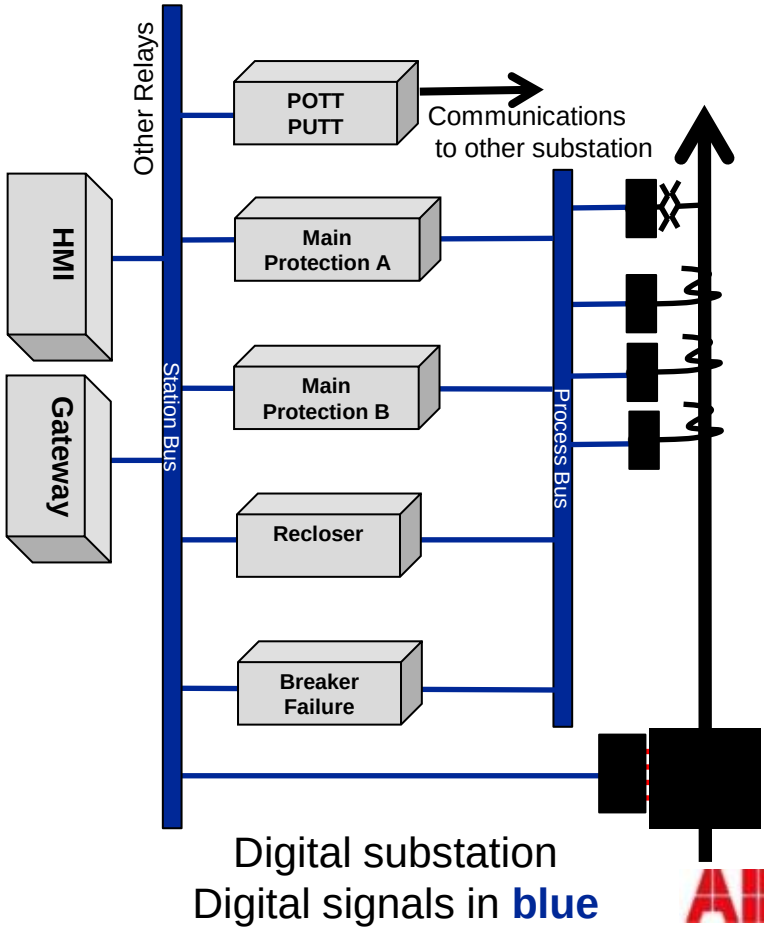
Enhanced Safety

Reducing the risks in the control house

Digital control signals isolates the primary equipment from the protection and control system by eliminating physical interconnections of live copper wires to the control house and in the control house



Traditional substation
Live wires in **red**



Digital substation
Digital signals in **blue**

Smart Grid Center of Excellence

Demonstrations

ABB's COE provides utilities a single point of contact for the demonstration, design, verification, and deployment of sustainable smart grid solutions

Applications and Testing

Power and productivity
for a better world™

Distribution Grid Management
Integrated operations – convergence of IT/OT

IT/OT Convergence

Employee Dashboards, Queries, Outage Reports, KPIs

External Communications to Customers, Media, Regulators

Operational Business Intelligence T&D Systems

Work & Asset Management

Mobile Work Management

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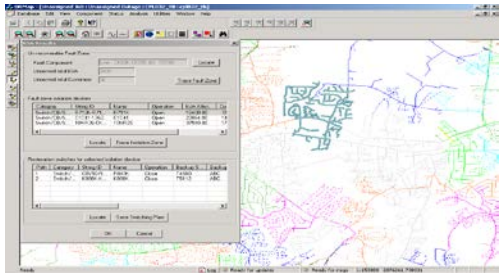
Network Model

SCADA

Communication Front Ends

Field Devices – RTUs, IEDs, Sensors



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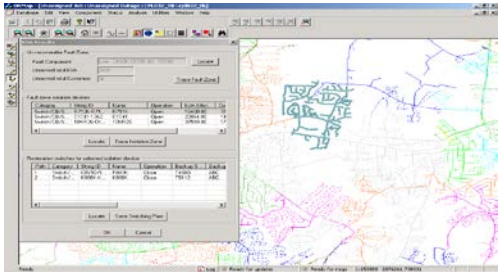
Supporting IT systems

Distribution Grid Management: IT/OT convergence

IT/OT Convergence



Distribution Management System

- Distribution Operator Graphics User Interface
- Unbalanced 3-Phase Radial and Network Load Flow
- Network Applications
- Outage Management

Network Model

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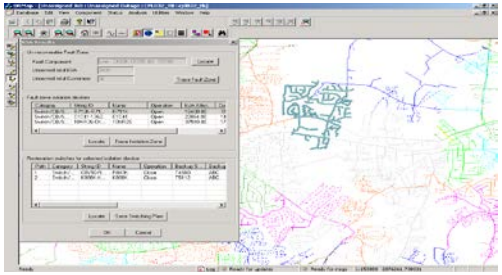

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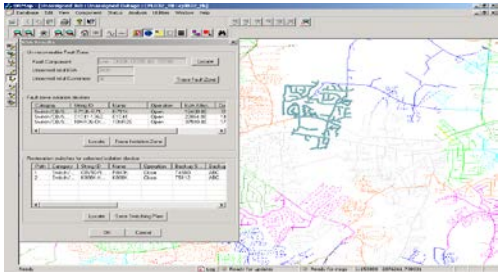

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