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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

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

Utility analytics Consumer and grid analytics that improve operational performance and conditionbased maintenance to improve asset life-cycle management Operations Technology

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.

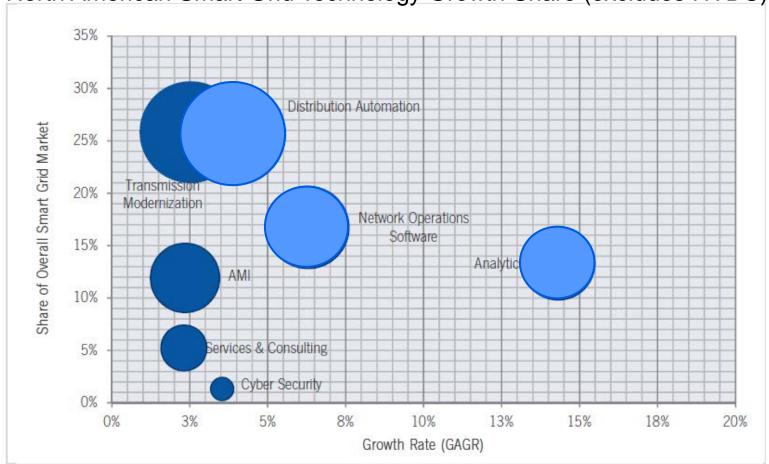
Communications

Utility operational effectiveness



Market Forecast Smart Grid Cumulative Market 2013 - 2020

North American Smart Grid Technology Growth Share (excludes HVDC)

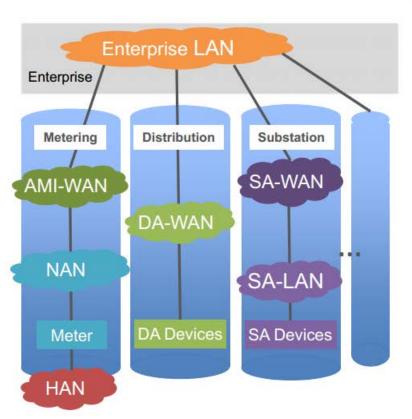


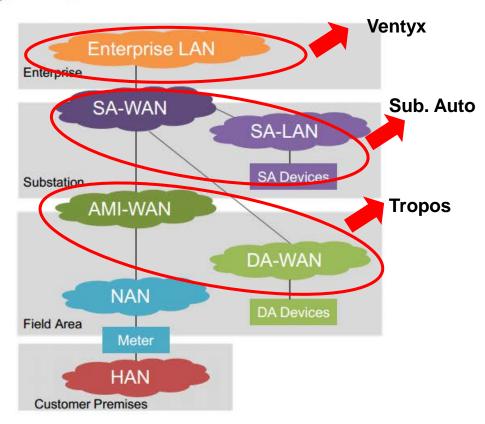
Source: GTM Research



End-to-end communication infrastructure

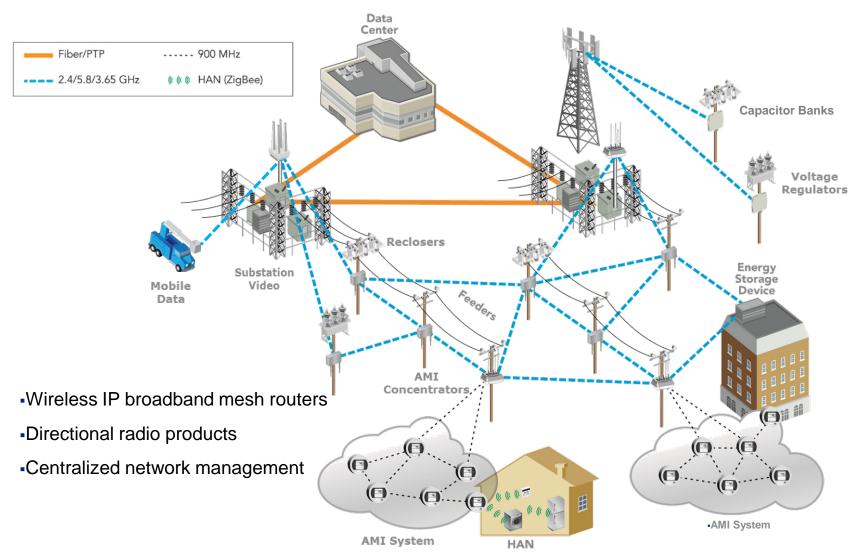
"Silo" Infrastructure Layered Infrastructure







Tropos GridCom network architecture





Networking for utilities and smart cities Broadband enables smarter grid applications

Distribution Automation & Control

Automated Metering







Renewables Integration

Field Data Applications





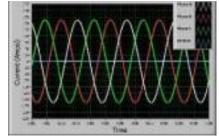


Demand Response

Outage Management







Power Quality & Planning

PHEV Integration



Employee Dashboards, Queries, Outage Reports, KPIs

OMS Applications

Trouble Call Management

External Communications to Customers, Media, Regulators

Operational Business Intelligence T&D Systems

Work & Asset Management

Outage Analysis

Interface to AMI

Outage Management

Crew Management

Operations Management

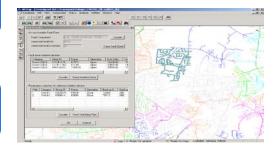
Switch Order Management

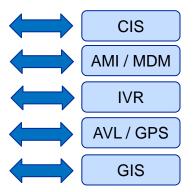
Mobile Work Management **Demand Response** Management

- **Network Applications**
- **Automated Restoration Switching**
- Overload Reduction Switching
- Volt/VAR Optimization
- State Estimation

- Fault Detection and Location

- Unbalanced 3-Phase Load Flow





Supporting IT systems

Network Model

SCADA

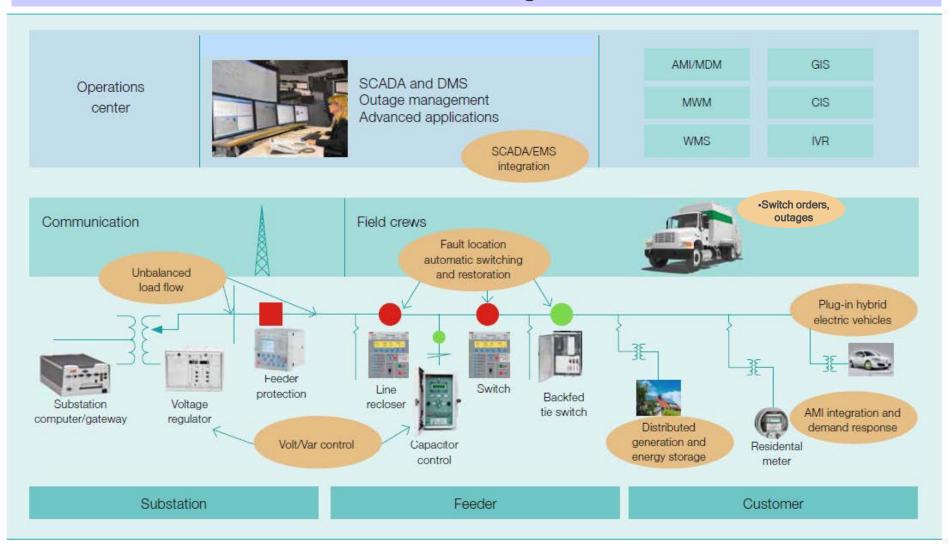
Communication Front Ends – Wireless Networks

- 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



Integrated distribution operations platform

Business Intelligence

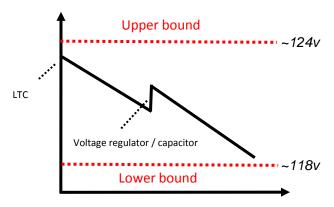




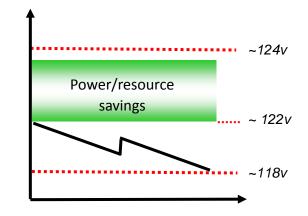
Distribution Grid Management Optimizing power for maximum efficiency



- 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.









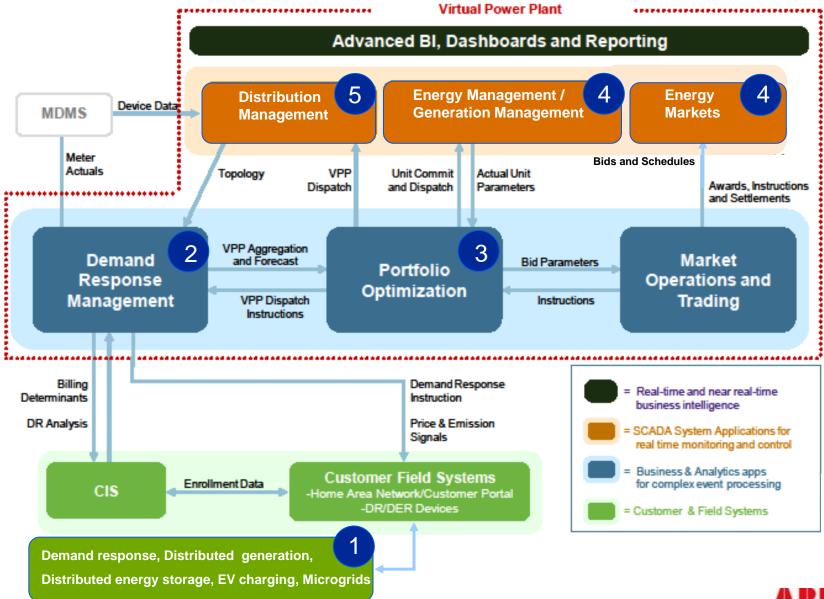
Distributed Energy Resources

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



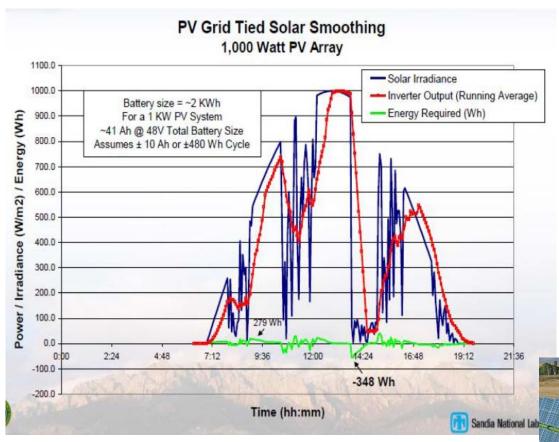


DERs – Integrating OT/IT with virtual power plants





Managing Distributed Generation



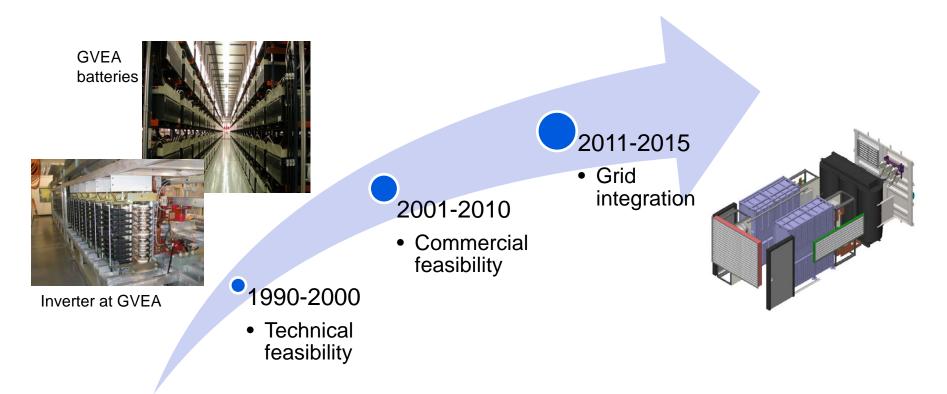
- Connecting solar energy to the grid – integration with microgrids and energy storage
- Feeders with high concentrations of PV can be problematic





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





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

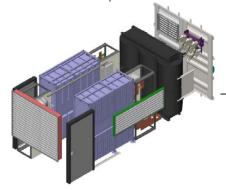
- Flicker compensation
- ·Voltage sag correction
- ·Reactive power control

minutes

- Spinning reserve (for voltage and frequency regulation)
- Uninterruptible power supply
- ·Blackstart

hours

- Load leveling
- ·Peak shaving
- Energy trading
- Integration of renewables
- Island operation

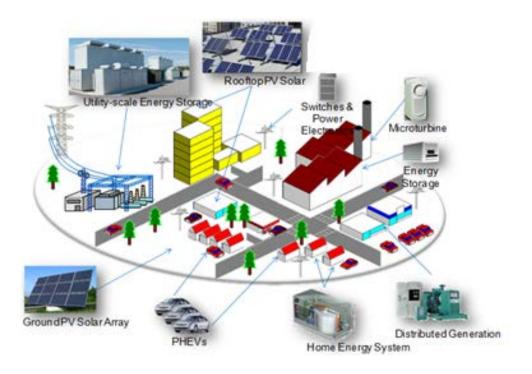




Microgrids

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.

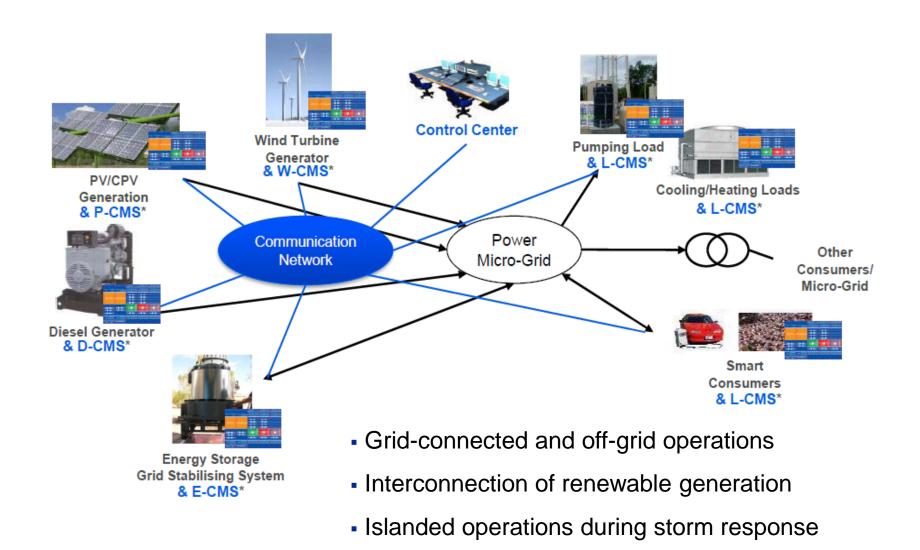


Microgrid Applications

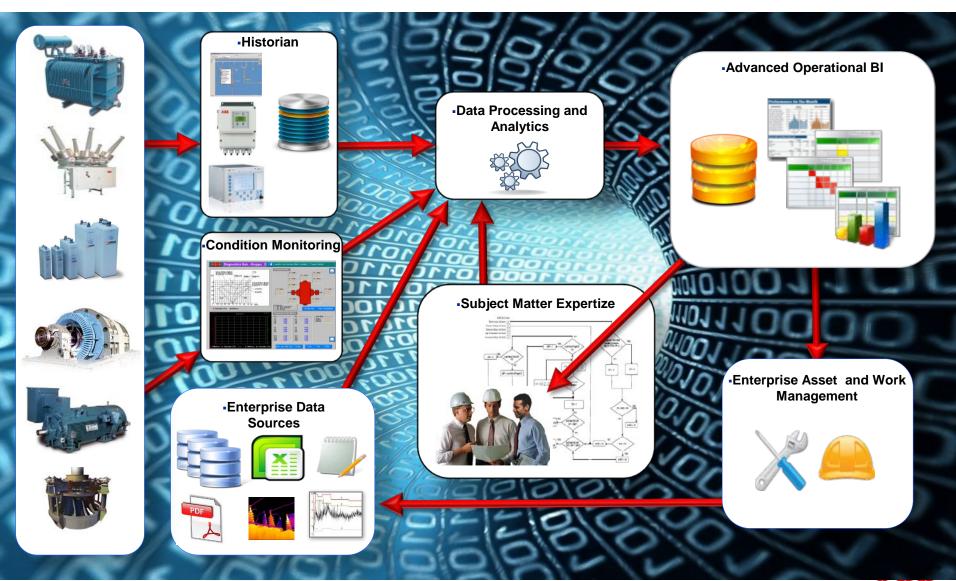
- Microgrids can range widely in size, source of electricity, heating and cooling, etc.
- Given this diversity and versatility, it is virtually impossible to map out a "typical" microgrid configuration
- End-use applications being developed today:
 - Institutional/campus microgrids
 - Data center microgrids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



Microgrid technologies – automated dispatch

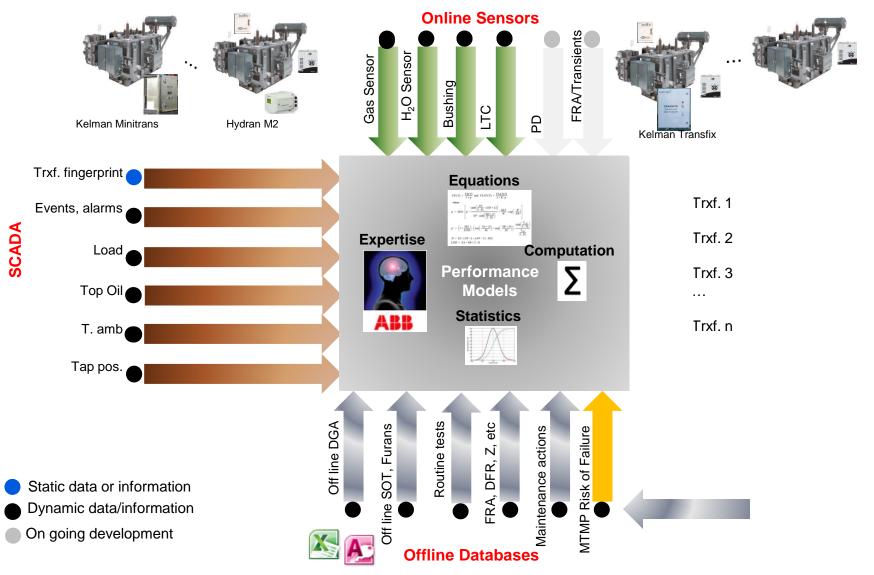


Asset Health Center



Information Flow & Analysis

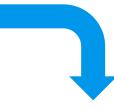
Asset Health





Asset Details - Levels of Detail





Drilldown

Summary



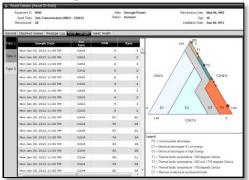
Trending



Messages & Notifications

Equipment ID Asset Clairs Resulted unit	Self-Transmission (Ville	r - 200kV)	Othy Seorge Pener Selon Demost	Westfacture Date: May 66, 1960 April - 38 Installation Date: - Sep. 46, 4573						
eneral Durched Casses (COLOGN ICE) Dural Transfer - Asset Health										
Named Trees	MIN CATE	Sanction .	Meringe							
	ES/27/2012 12:00 AM		Current sample from CAUSETO & show invitropen at \$10,0000 ppm. With 16 stateboats on the That heads further cartingtion.							
	69/27/3612 52:00 KM	Colleto I	This 90% name for this test 2 days of 6	lets is 477,5000 porn (including the author):						
	\$8/97/2652 52-08 AM	Caligno 5	The 90% name without the sulfair is to	65-0000 pg·m.						
informational	68/27/2902 52:00 HH	Coloto i	Culture may be recent by sensor malfunction (power supply motificions. 1917, from of collection, stall or real squar reside the transformer which might have to be identified.							
Breat .	09/27/2012 12:00 NM	Calisto I	Recommend verifying service and take	need serfying sensor and taking a manual oil sample.						
arformational	88/27/2012 12:00 AM	Column 1	manufarmer, of precoutions must be to manual of samples - including delena							
	63/27/2012 12:00 AM	datete 1	complition 1 least of 700 pages.	\$10,0000 ppm, which is still 20 years below the case						
	63/31/36/5 (5/06 W)	HTMI Gigen System	Cornell sample from CPFCHE share C	artion Clorida at 1424 0000 jupos, which is an emforation.						
	\$9/27/3612 12:00 KM	MTHIT BIGGET SYSTEM	The PCNs name for the fact or days of a	late is detellated part (mituding the sultar).						
	69/25/2613 12:00 KM	MTMI Report Names	The NITS name officer the buffer is 20	631,3010 ppm.						
Softenational	09/27/2012 12:00:69	STATE Reject Review	calibration, all: or real power incide the	Punition (power augusty papitytions, IPE, tass of he transfermer alson might have to be identified.						
	65/27/9612 LE-00 AN	MTMP Expert System	Prentius sample from OFFUNE showed showing community moreous from the a	Elithons at 252,0000 ppm, which has also an outle transport level.						
	03/27/2012 12:00 AM	HTMF Expert Distant	Province sample from CPPLINS should	Esthylane at 253,0000 ppm, which has also an						
	\$9/27/2012 12:09 AM	HITE Seast Sulten	Current sample from CML/UE above to	principles at SSEACCO parts, which is electrically an						
	69/27/2012 12:00 KM	MTMI Bopen System	The 90% norm for the feet 3 days of a	late a 472-4000 gam (including the outlant)						
	\$8/27/2012 12:00 AM	HTMI SHOWN SYSTEM	the son name exhaut the sultier is hi	42.0000 pg·m.						
Monatoral	68/85/3018 12:00 AM	MTMI Report System	Culture may be caused by sensor ma-	Pundon lower suppir secliptions. DFI, less of he transfermer ship in right have to be dentified.						
Sellomaterial	69/27/2012 12:00 NH	MTMIT Regard Resident	NYMP Analysis. The undated Total Ris							

Duval Triangle



Health Index

Equipment ID: 6645 Asset Class: Sub-Transmissio Harufacturer: GE		lty: Georgia Power lon: Damont		Manufecture Date Age Installation Date	38			
Dissolved Gosses Message Log Dural Triangles Assessments Dissolved Connective Maintenance Loading Assessments								
Health Index	Value	Factor	Weight	Score	Maximum Score	Health Index		
Ape	19 years	4	2	D		100 %		
Air Hydro Press - CM's	No CH's	4	1	4	4	100 %		
Ar Leek - CWs	3 CWs	2	1	2	4	30 %		
Alarm Repair - CWs	4 CM's	2	1	2		50 %		
Arc Ex Comp - CM's	1 CM	4	5	20	20	100 %		
Bushing Cond - CM's	No CM's	- 4	- 1	4	4	100 %		
Cb Trip Close - CM's	4 CHTs	2	5	10	20	50 %		
Contact Cond - CM's	No CH's	4	5	20	20	100.%		
Control Cabinet - CM's	2 CM's	3	1	3	4	75 %		
Control Circuit - CM's	1 CM		1			100 %		
Drain Air Tank H2o - CM's	3 CW s	2	. 5	10	20	50.74		
Emergency - CM's	No CH's	4	1	4	4	100 %		
Insulation Degrade - CM's	No CH's	4	3	12	12	100 %		
Lub Cond - CM's	3 CH's	2	2	6	12	30 %		
Mechanism - CM's	No CH's	4		20	20	100 %		
Miss Corrective - CM's	No CM's		1	4	4	100 %		
Oil Problem - CM's	No CH's		- 4	4		100 %		
Sf6 Gas Density - CM's	No CH's	4	1	4		100 %		
Milk Lands a Chillia	No Philip					100.00		



Circuit Breaker Sentinel, CBS Family Hardware

CBS



CBS-Lite



CBS-F₆



- 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

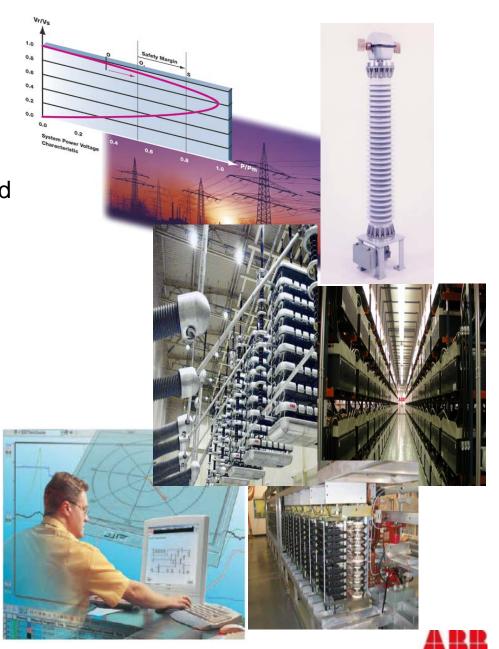


O ABB Group

•November 20, 2013 | Slide 23

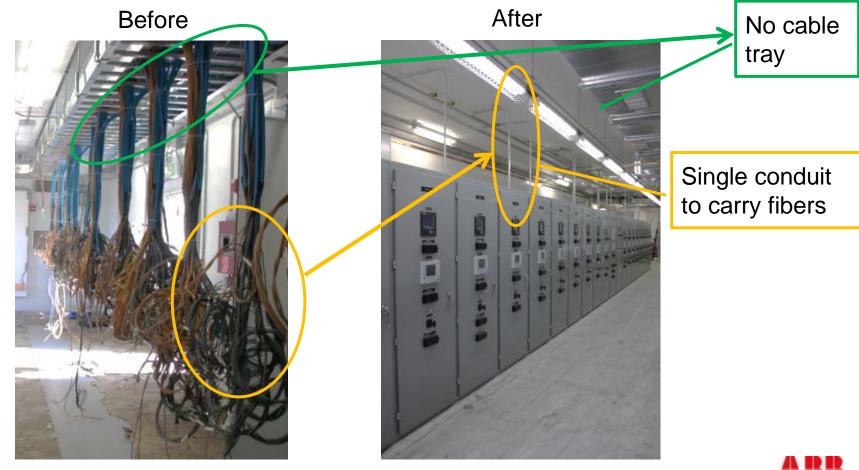
Smart Transmission

- 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

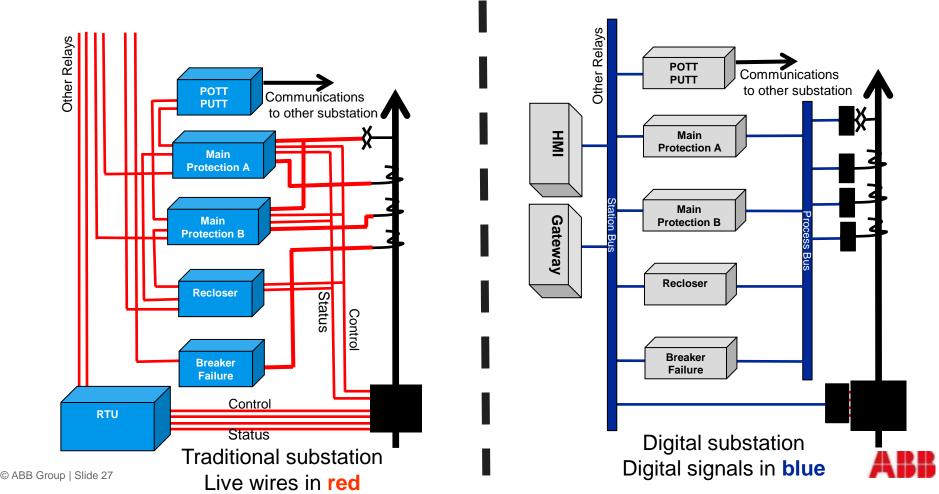
Digital substation reduces complexity with wiring and reduces risk for Operations & Maintenance personnel in the control house



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



Smart Grid Center of Excellence

Demonstrations





Power and productivity



Distribution Grid Management Integrated operations – convergence of IT/OT

Employee Dashboards, Queries, Outage Reports, KPIs External Communications to Customers, Media, Regulators

Operational Business Intelligence T&D Systems

Work & Asset Management

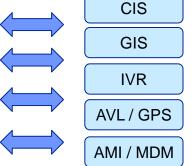
Mobile Work Management

Demand Response Management

Network Applications

- Fault Location
- Automated Restoration Switching
- Overload Reduction Switching
- Volt/VAR Optimization
- State Estimation
- Unbalanced 3-Phase Load Flow





Supporting IT systems

OMS Applications

- Trouble Call Management
- Outage Analysis
- · Interface to AMI
- Outage Management
- Operations Management
- Switch Order Management
- Crew Management

Network Model

SCADA

Communication Front Ends

Field Devices - RTUs, IEDs, Sensors





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

Network Model





Supporting IT systems



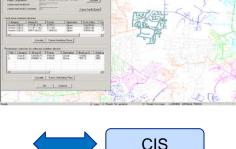
Distribution Management System

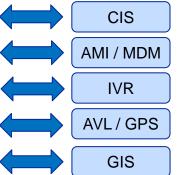
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Supporting IT systems

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SCADA

Communication Front Ends – Wireless Networks



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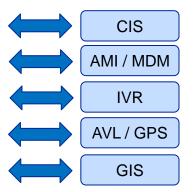
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