2012 Smart Grid R&D Program
Peer Review Meeting

Real-Time Distribution Feeder Performance Monitoring, Advisory Control, and Health Management System

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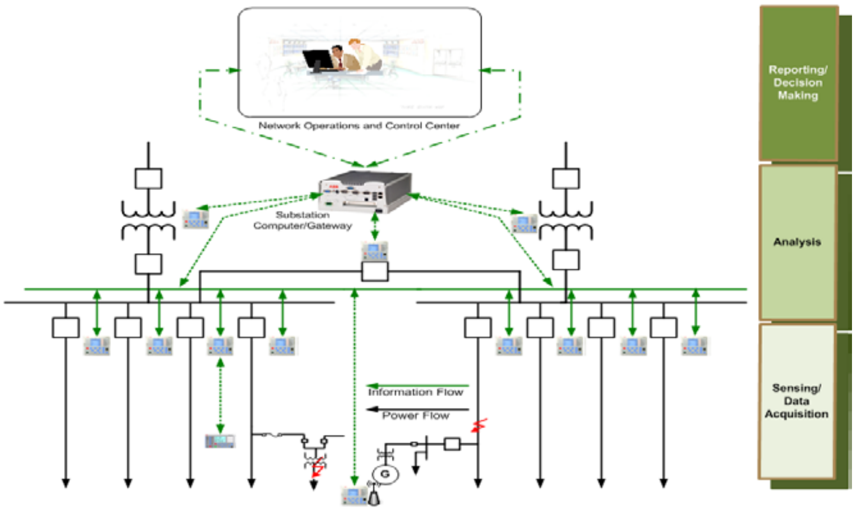
Real-Time Distribution Feeder Performance Monitoring

Objective

To innovatively leverage advanced sensing, monitoring, and control technologies to enhance asset utilization and grid reliability



Life-cycle Funding Summary ($K)

Prior to FY 12	FY12, authorized	FY13, requested	Out-year(s)
$200 k	$1.1 M	$1.3 M	$400k

FY2012 and beyond are estimated DOE funds to be spent

Technical Scope

Install state-of-the-art data collection, monitoring, and sensing equipment in distribution substations and on distribution feeders

Develop new feeder monitoring, advisory control, and asset health applications deployed on current circuits, and future circuits with DERs

Validate R&D with data collected in the field

Demonstrate basic and advanced applications

Significance and Impact

Long-term Goals

Self-healing Distribution Grid for Improved Reliability

Integration of DER/DR/PEV for Improved System Efficiency

2020 Targets

20% SAIDI reduction in distribution outages

>98% reduction in outage time of required loads

2020 Target

20% load-factor improvement

Annual Performance Targets				
2012	**2013**	**2014**	**2015**	**2016**
Demonstrate integration of renewable and distributed systems for 12% **load factor** improvement on a distribution feeder circuit	Demonstrate a smart **microgrid** at a military base for >98% reduction in outage time of critical loads	Enable fast voltage regulation technology to support integration of high penetration of distribution-level PV for 15% **load factor** improvement on the demonstration feeder circuit	Complete two integrated distribution management systems capable of reducing **SAIDI** by 5%	Demonstrate combined use of fault detection, isolation, and restoration technologies with integrated distribution management systems to reduce **SAIDI** by 10%

Significance and Impact

Mass deployment of the technology developed during the course of this project will greatly enhance reliability and efficiency, resulting in significantly reduced customer outage times and more efficient system and asset utilization, supporting the 2020 Program Targets.

Why?

- The more actionable information the control center operator has, the more informed and the better and faster the decision-making process will be, leading to quicker restoration of affected end customers.
- The more advanced and proactive the monitoring system, the faster a problem spot gets addressed, reducing the number of future disturbances on a system (i.e., enhanced reliability).
- The more advanced the end-to-end system, the better the advisory control information and support for asset utilization, helping the operator enhance system performance and efficiency overall.

Significance and Impact

- *Degree of Impact on System Reliability and Asset Utilization*
  - Addressing reported and non-reported disturbances in an automated way speeds up and supports prevention, detection, containment, and auto-restoration functions, leading to a self-healing grid
  - Directly impacting SAIDI/SAIFI, and CAIDI in support of the program targets
- *Degree of Broad Applicability*
  - Based on existing infrastructure while supporting standard interfaces and emerging communications technologies and interoperability standards including IEC 61850
  - Meets the requirements of the target market cost-effectively
- *Demonstrated Commitment to Commercialization*

Xcel Energy Reliability Statistics

- 3,300,000 customers in Xcel Energy service territory
- Distribution SAIDI – 70 minutes
- 230,000,000 distribution customer minutes out (CMOs) annually
- Consumer outage avoidance costs $0.20/CMO
- For each minute of outage reduction an expected consumer outage avoidance savings of $657kUSD

Technical Approach & Transformational R&D

Technical Approach

- Two Phases of R&D and Demonstration
- Lessons learned in Phase I will be applied to Phase II

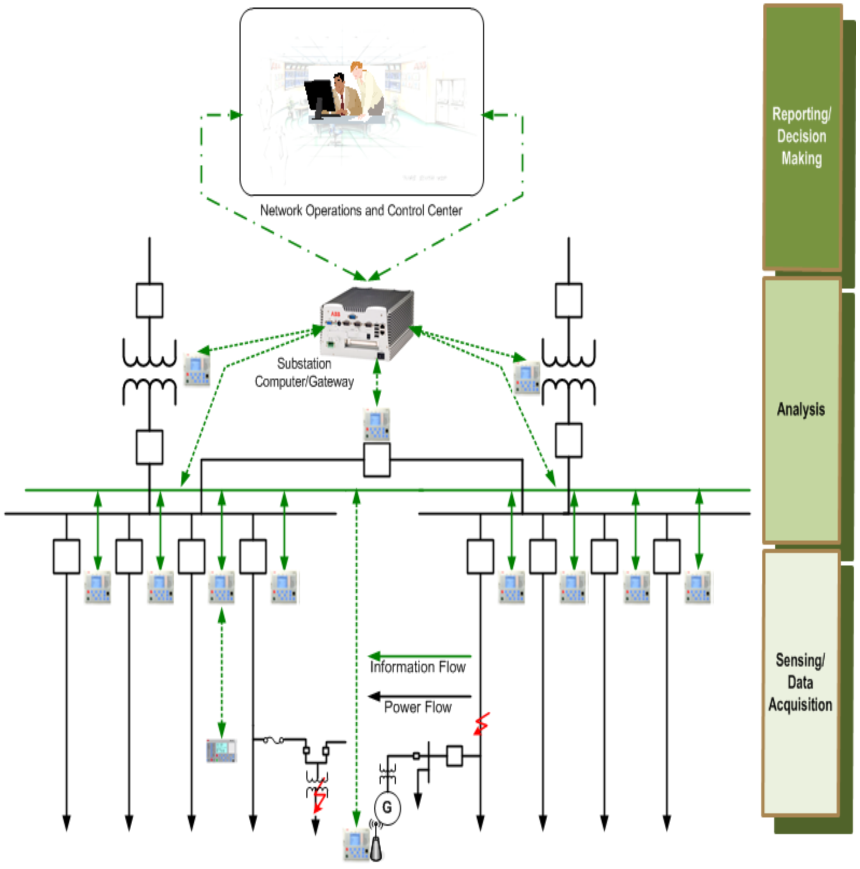
Project Summary Tasks

- Field Data Collection for R&D
- Modeling, Simulations, and Studies
- Application R&D and Algorithm Development and Validation
- Application Server Architecture Development
- System Integration
- Demonstration

Technical Approach & Transformational R&D

Technical Scope

- Machine algorithms for advanced real-time feeder performance monitoring, including sensor data
- Feeder advisory control algorithms
- Feeder health management and prognostics
- Integrated fault location calculations
- Integrated power quality monitoring
- Multi-IED event detection and classification
- Integrated system modeling and simulations



Technical Approach & Transformational R&D

Technical Innovations

- Proactive vs. Reactive Situational Awareness
  - The operator will know what is happening before receiving customer trouble calls, or when no/late calls are made.
  - Example: “OK on arrival” and “Incipient Faults”
- Online vs. off-line data analysis
  - Real-time monitoring, advisory control, and health management system
  - Example: Asset management vs. real-time monitoring
- Event MRI vs. X-Ray Alarms
  - Provides comprehensive set of information to operators to help them enhance the decision-making process
  - Example: SCADA alarm vs. pertinent data/waveform snapshot
- Multi-Feeder vs. Individual feeder approach
  - Gives a system-wide view and analysis
  - Example: Fault on one feeder causes voltage sag on adjacent feeders
- ALL disturbances vs. fault events
  - Gives concluding information on all events including non-fault events
  - Example: Switching event confirmations or transformer inrush events

Technical Accomplishments

2011 Key Accomplishments

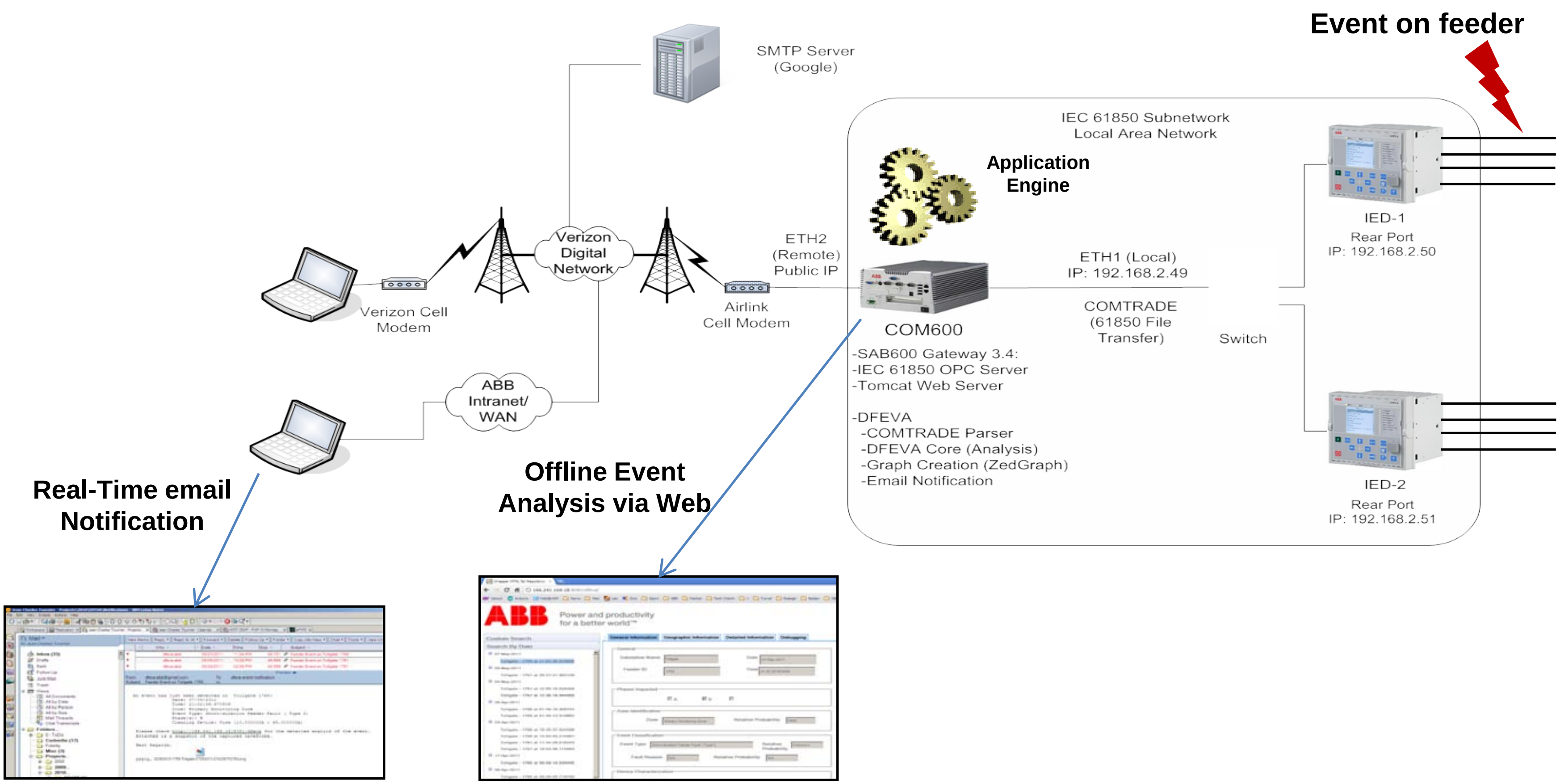
Field Data Collection for R&D

- First substation installation achieved in March 2011 (see next slide)
- Held 2 workshops with Xcel Energy to finalize substation and feeder selections for the project
- 5 existing and 2 new substations with expanded number of feeders
    - Mix of overhead and underground feeders
    - 3 feeder monitoring points outside substation maintained
    - Several banks of feeders to detect both primary and adjacent events
    - One solar farm installation monitoring both at the point of common coupling (PCC) and at the substation
    - One substation transformer monitor installation

Application R&D and Algorithm Development

- Fault location by segment
    - ABB preliminary algorithm under development for the last year
    - Feeder connectivity models being tested using GIS files
    - Deployment target is within 3 months

Technical Accomplishments



Technical Accomplishments

Budget Period	Milestone Title	End Date
Phase I R&D	Phase I Data Collection System in Place	June 2012
Phase I R&D	Phase I Integrated System Devt Complete	September 2012
Phase I Demo	Phase I Demo System in Place	November 2012
Phase I Demo	Phase I of Project Complete	March 2013
Phase II R&D	Phase II Data Collection System in Place	August 2013
Phase II R&D	Phase II Integrated System Devt Complete	April 2014
Phase II Demo	Phase II Demo System in Place	April 2014
Phase II Demo	Phase II of Project Complete	September 2014

Project Team Capabilities & Funding Leverage

Team Members:

ABB USCRC, ABB PPMV, Xcel Energy, and Texas A&M University

- **ABB USCRC** will be the overall project manager and speaking face to DOE reporting the progress made and milestones achieved.
- **ABB USCRC and Texas A&M (TAMU)** team will be the core R&D power houses for the project. TAMU's will contribute R&D in the areas of system modeling, simulations, integrated power quality analysis, and distribution fault location calculations in the presence of DERs.
- **ABB PPMV** will be the business partner, main product supplier, and application/system integrator for the demonstration projects.
- **Xcel Energy** will be the host utility providing vital utility feedback and access to installation sites, personnel, and data for advancement of the project R&D efforts, as well as assistance for operation integration.

Project Team Capabilities & Funding Leverage

Cost Share: ABB Inc, Xcel Energy, TEES

ORG.	3-Year Total
ABB Inc	$728,471
Xcel Energy	$152,448
TEES	$249,998
Total Cost Share	$1,130,917
DOE Funds	$2,993,006
Total Project Cost	$4,123,923

Project and DOE Value

- DOE is acting as the catalyst for this important research area in the power industry
- Many utilities are interested in this area, but are just starting to invest more in grid analytics, piggy-backing off the communications infrastructure that they have already/recently put in place
- DOE is helping to push improved grid reliability and asset utilization with this type of technology
- The outcome of this and related DOE-funded projects will provide a blueprint for future monitoring and sensing solutions that help the country achieve its future reliability improvement goals

Contact Information

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Back-up Slides

Include any back-up slides you would like to provide to the peer reviewers and DOE program managers for additional information. The back-up slides will not be shared with others, unless specifically stated by the presenter.

Technical Approach & Transformational R&D

Phase I Applications:

- Enhancement of existing underground cable fault algorithms
- Single-IED event analysis
- Fault location
- Volt/VAR monitoring
- Unbalanced capacitor switching monitoring
- Unbalanced feeder loading monitoring
- Feeder overload monitoring

Phase II Applications

- Feeder health management and prognostics
- Advanced fault location
- Asset health monitoring
- Power quality monitoring
- Multi-IED event analysis