DIGITAL ENERGY

Modern Energy Management Systems

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IPCGRID, San Francisco, February 27th, 2019
The energy utility landscape is going to transform more in the next ten years than it has in the previous one hundred.

*Somehow the utilities have to transform their operations, improve network efficiency and reduce cost... while never letting the lights go out.*
Connect & Orchestrate
Path to Network Level Optimization

A path to **self-healing grids** across T&D with a **self-learning model**
Network Level Optimization

LEVEL 01
REACTIVE + RESPONSIVE

Waiting for a power loss to analyze stability issues

WAMS Improve
- Situational awareness
- Fault location
- Power restoration process
- Model quality

LEVEL 02
PREDICTIVE

Model true demand & generation, predict impact of generation intermittency on network stability, capacity and failure.

LEVEL 03
PRESCRIPTIVE

AI driven app optimization & orchestration from edge to cloud to prevent & minimize impact of disturbances. Automated Advisory Mode

LEVEL 04
AUTONOMOUS

Automated Network optimization and Wide Area Control with reduced human intervention.

elevate every facet of your network operation

MODULAR APPS  COMMON DATA LAYER  BRILLIANT UI/UX  INTEROPERABILITY
Advanced EMS
Network Model Manager (NMM)

Built upon EPRI NMM specifications and ENTSO-E CGMES requirements

Solution Highlights

A collaborative modeling and data engineering solution

- CIM Import / Export of multiple formats
- CIM DL and GL profiles
- Bus branch, nodes-breaker
- Graphical Model editing
- Multi-users environment
- Manage model evolution over time
- Analyze and validate in CIM native
- Integrate EMS power application

Key Outcomes:

- Enterprise view
- CIM 16 / CGMES compliance
- Power system validation
- Automated and streamlined process
- Engineering efficiency
- Open and non-proprietary
- Meta data driven schema

A leap forward in traditional modeling of electric network
Extensible FEP

Supported Operating Systems
- Microsoft® Windows Server 2016
- Linux 7

HTML5 Web-based UI

Supports integrating with multiple host systems (primary site, backup site, QA)

Protocols this year
- DNP3 (serial, TCP/IP, and secure)
- IEC 870-5 101 and 104
- IEC 61850 client (telecontrol use case)

More will follow
- ICCP
- OPC-UA

Providing a common software based FEP that is used across the existing 4 platforms will eliminate the need to develop new protocols multiple times, thereby reducing cost (to GE and our customers) and accelerate the availability of new protocols to our customers.
UX Site Visits Aug – Oct (Various)
GE / Blink team customer site visits for UX Design Vision Inputs

“Show & Tell” Webinars
Remote webinar session featuring latest UI/UX

January 2019
Solution Highlights

Efficient, fast alarm processing

Just focus on what occurred
- create alarm synthesis
- eliminate nuisance alarms
- Diagnosis: location, persistent or transient fault

Fully integrated with EMS and DMS
Transparent model based processing
Knowledge base under user control
Advanced energy management system – The EMS

**Experience Situation Awareness and User Interface**

**Network and Generation**

**Real-Time Data Across the Enterprise**

- Network Model Manager
- Scada
- Intelligent Alarming
- Outage and Switching Management
- Cyber Security
- Data House
Solution Highlights

Assess & Control Renewable in Transmission

Assess renewable generation situation in time, in location, by type, by utilization factor,

Estimate renewable generation from multiple forecast sources, evaluate ramp, stability, levels

Evaluate impact in power flow and contingencies via Look Ahead analysis

Evaluate Dynamic impact with WSAT

Automate response via EMS levers

Optimal renewable dispatch to avoid large curtailment
Solution Highlights

Expectations
• Fast generation and demand variations requiring frequent voltage adjustment
• Operator efficiency with hundreds of controls (AEMO was over 300 reactive controls per day)
• Secure base case voltage range through the system
• Maintain secure voltage post contingencies
• Restoration to secure voltage after event

Voltage Dispatch System - VDS
• Real time and Study application complementary to SENH
• Minimize controls over time > save asset live time
• Optimal cost activation of multiple available controls: shunts, transformer taps, SVC and aggregated control schemes
• Conformance monitoring

Automation of voltage control task
Increase Power Transfer & reduce costs
Advanced energy management system – EMS + DER

Experience Situation Awareness and User Interface

Renewable and DER

Network and Generation

Real-Time Data Across the Enterprise

Network Model Manager

Scada

Intelligent Alarming

Outage and Switching Management

Cyber Security

Data House
WAMS: A new vision of the network

WAMS provides unequaled insight network vision unlocking flexibility, bandwidth and controllability.

Increase Reliability and Resiliency
- Stability limits, Island recovery, Wide area defense
- Restoration and fast resynchronization

Increase capacity
- Corridor transfer, Voltage stability

High renewable penetration
- Angle constraints control
- Fast frequency response with low inertia

Accelerate disturbance analysis with true data

See and Act at the Speed of Electrons
Addressing Key industry challenges

**System Dynamics**  
Operating near to True real Time Limits

**New Electrical Equipment**  
(FACTS, HVDC, ...)

**Big Data**  
Meters, PMU, ...

**System Scalability**  
From energy cluster to large Interconnected Grids
EMS – WAMS - TIMING AND AUTOMATION

GRID STABILITY ASSESSMENT
WAMS + TOPOLOGY

ONLINE SECURITY
WAMS + NETWORK + DSA
TENS OF SECONDS

Correct
Assess
Predict
Monitor
SECURE

Impact of PhasorAnalytics apps into further optimization and risk reduction

Impact of Hybrid phasor apps into existing apps and network utilization and EMS automation

Impact of PhasorControl on EMS fast automation and monitoring

Online Stability Management
Alarm Management
Angle-based Grid Management
Enhanced Island Management
Enhanced Disturbance Management

Online Security
SECONDS

GRID STABILITY ASSESSMENT
WAMS ONLY

Angle Difference Monitoring
Oscillatory Stability Monitoring & Control
Islanding, Resynchronization & Blackstart

Sub-Synchronous Resonance
System Disturbance Monitoring

Short Circuit Capacity

WAMS ONLY
SUB SECONDS

Transmission Roadmap

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28-Mar-19
WAMS Control: Fast Frequency Response

Problem to solve
- Contain frequency volatility when low system inertia with RES, and high load or generation tripping
- Mobilize rapid frequency response from right sources
- Avoid spinning reserve from large plants
- Avoid islanding and blackout

WAMS Fast Frequency Response
- Fast response localization
- Harness fast-acting resource in a reliable and safe manner
- Proportional to Power Imbalance
- Return control to normal AGC after event
- Central and distributed control system with PMUs
- Reduce high cost spinning reserve service
Advanced energy management system – EMS + DER + WAMS

Experience Situation Awareness and User Interface

Dynamic DTS

- WAMS Monitor, Analysis, Control
- Renewable and DER
- Network and Generation

Real-Time Data Across the Enterprise

- Network Model Manager
- Scada
- Intelligent Alarming
- Outage and Switching Management
- Cyber Security
- Data House
Advanced Grid Analytics Suite

Key Attributes

- Applications built to address specific customer outcomes
- AI/ML techniques deliver predictive and prescriptive analytics
- Pre-built analytic tools and pre-defined data models
- On-prem / cloud alignment
- Reduced ingestion and integration costs across data silos
- Abstraction of data ingestion and operationalization frees staff to focus on value-added activities

Analytic Applications
- Asset
  - Strategy
  - Reliability
  - Health
- Distribution
  - Network Model
  - Storm Response
- Transmission
  - Fault & Event Analysis
  - Inertia Prediction
- AMI
  - AMI Network Operations
  - Revenue Protection

Core Analytics Platform
- Analytic Library
  - Outage Prediction
  - Facility Damage
  - Connectivity
  - Anomaly Detection
  - Forecasts
  - Root Cause Analysis
  - AI-based Tag Mapping
  - Pattern Matching

Runtime & Orchestration
- Common Data Model / Data Fabric
  - Weather
  - Markets
  - GIS
  - OMS
  - ADMS
  - EMS

External Data Sources
- Operational Systems with Siloed Data

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  - Applications built to address specific customer outcomes
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**ADVANCED EMS - Inertia Management**

1. Wind/Solar Generation Forecast from DERMS
2. Traditional Generation/Load Forecast from EMS

- Inertia Estimation
- Inertia Prediction
- Machine Learning Model
- Inertia Management

EMS model

- Cheapest/Greenest mix of generation possible
- Max Security

WAMS and SCADA

Machine Learning

Transmission Roadmap
Inertia Forecasting by Machine Learning

Applying machine learning using predictors relates area inertia to know & predictable values

- Conventional rotating inertia
- Load
- Solar power
- Wind power

24h prediction trialed successfully

Sensitivity of inertia to system state yields insights into contributions of different factors
Advanced energy management system – The new EMS

Experience Situation Awareness and User Interface

Real-Time Data Across the Enterprise

Dynamic DTS

WAMS Monitor, Analysis, Control

Renewable and DER

Network and Generation

Analytics

Network Model Manager

Scada

Intelligent Alarming

Outage and Switching Management

Cyber Security

Data House

Analytics

Cloud - On prem
Brilliant Software Factory

Priorities
- Transition to Continuous Integration & Deployment on key products
- Common artifact repository
- Automated testing with customer specific models (FAT/SAT) for key products
- An agile/iterative development process for all new product development

Customer Partnership
- Test data: represents your system & regularly updated
- Commitment: involvement throughout development cycle

DevOps Model using Customer Environment
- Design, Develop, Validate with CI/CD
- Pre-FAT
- FAT
- SAT

‘Shift Left’
User Feedback, Test Data, and Training
Thank you