



Service Suite in a Smart Grid World

**The Role of Enterprise Workforce Management in
Supporting an Intelligent Electric Network**

Steven A. Radice, Ventyx, VP, Utility T&D Solutions

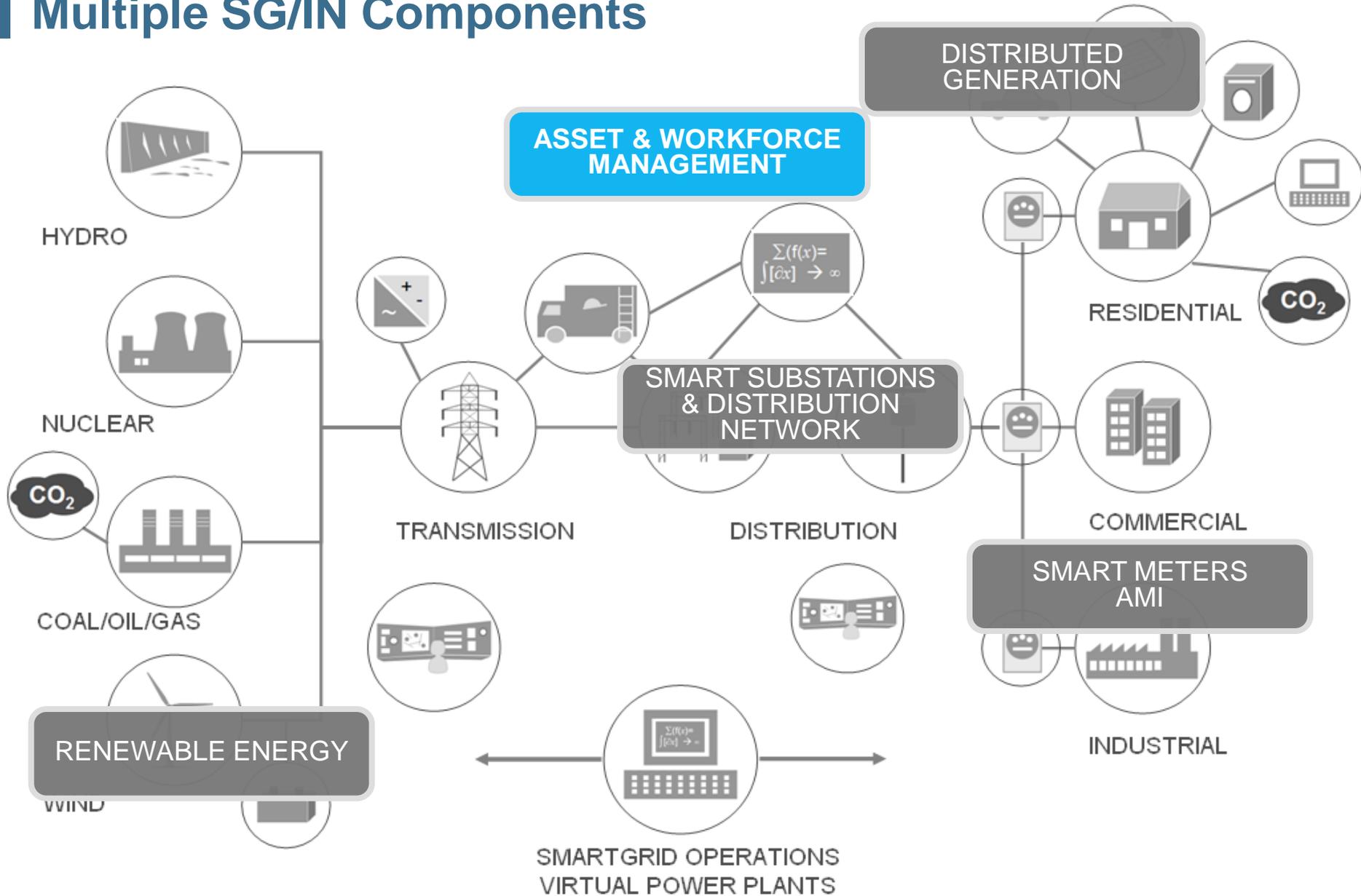
April, 2011

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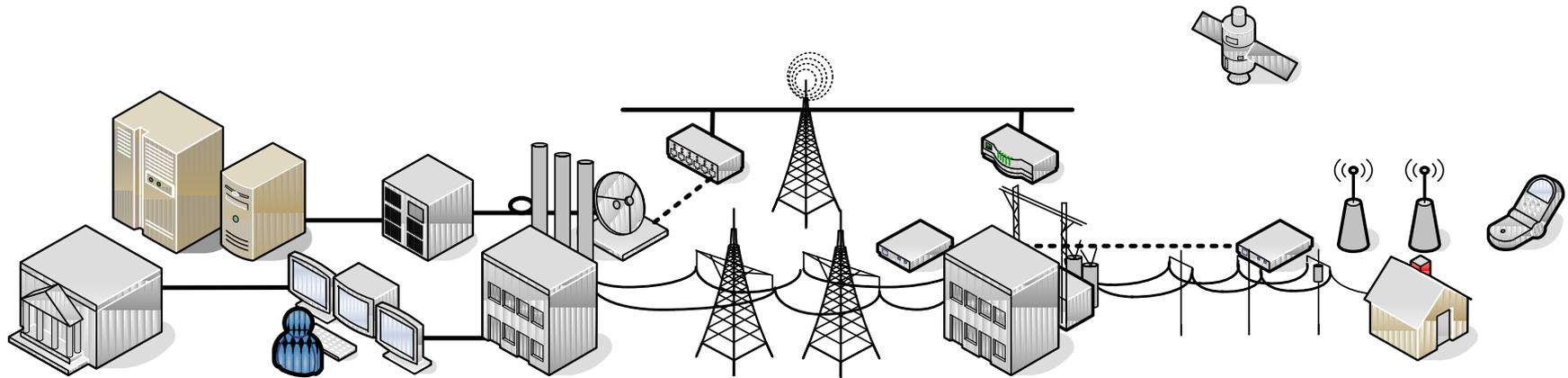
Presentation Topics

- **Overview of Smart Grid/Intelligent Network Components**
- **The Challenges of SG/IN for Workforce Management**
- **CMMI Stages**
- **SG/IN – Service Suite Solution Topography and Workflow**
- **Use Case Example**
- **Requirements and Value of SG/IN – Service Suite Systems Together**
- **Questions**

Multiple SG/IN Components



The Role of Workforce Management in SG/IN



Real-time Simulation and Contingency Analysis

Distributed Generation and Alternate Energy Sources

Self-Healing Wide-Area Protection and Islanding

**Asset and Workforce Management; On-Line Equipment
Monitoring Response**

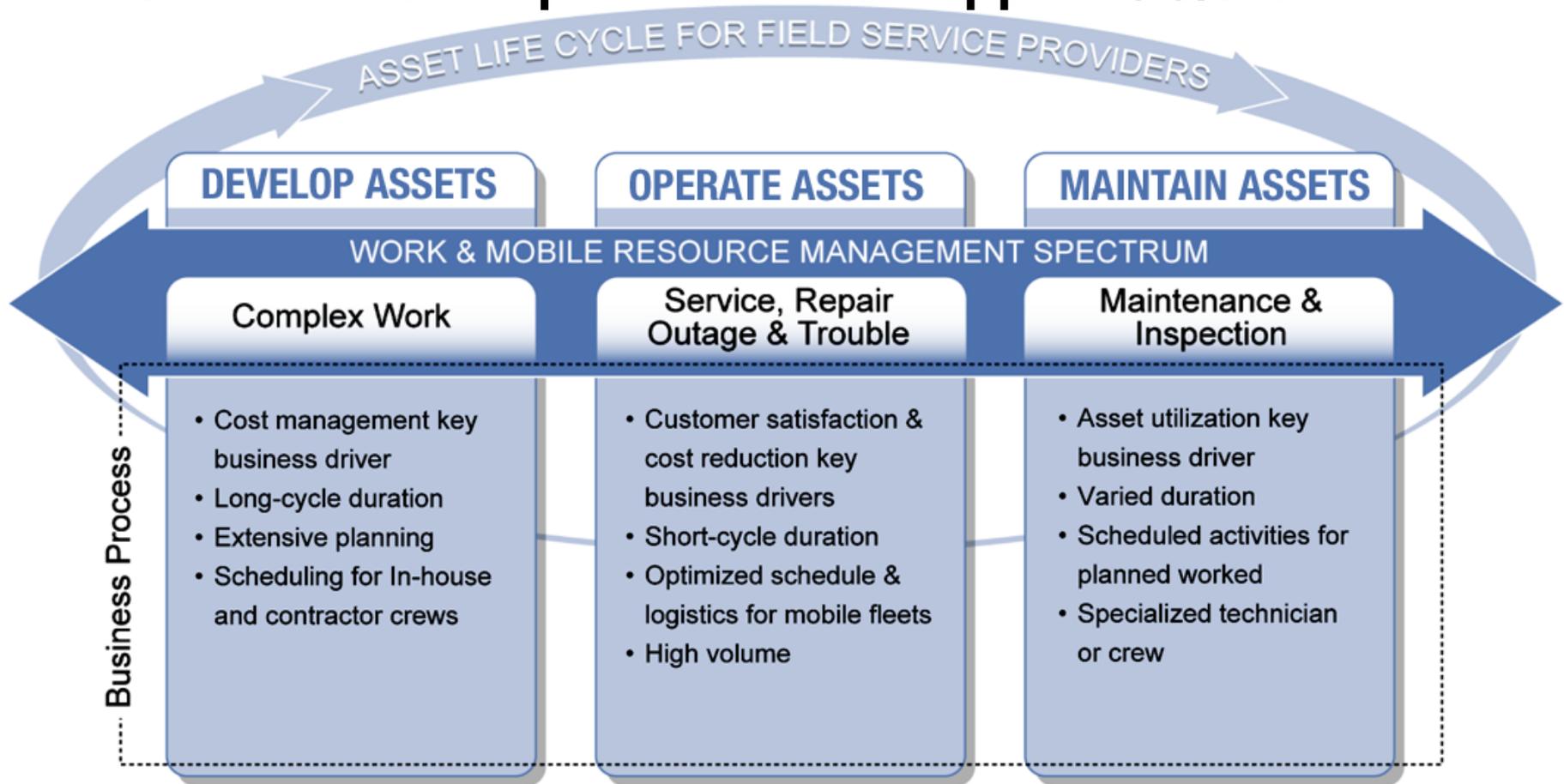
Demand Response and Dynamic Pricing

Participation in Energy Markets

**Shared Information – Continuously Optimizing –
Intelligent Responses**

Managing Assets, Work and Mobile Resources

Utilities address a spectrum of Enterprise Work and Mobile Resource requirements to support SG/IN.



The Asset Challenges of a Smart Grid Network

▶ Data Flow

- ▶ How to determine what asset data is important
 - ▶ Xcel Energy experiences 30,000 distribution data points a day

▶ Distribution Assets Become More Critical

- ▶ Smaller Distribution assets now can better avoid outages
 - ▶ Current NA environment provide 99.7%
- ▶ Distribution systems provide real-time analysis of grid health
 - ▶ They become lifelines of the network



▶ More Assets to Manage

- ▶ Demand Response (DR) devices require installation, maintenance, replacement
 - ▶ NV Energy plans to roll out 600,000 DR devices at its customers

▶ Modifies the Business Organization

- ▶ Changes how you manage outages, distribution networks, faults, work crew decisions and asset management

▶ Existing Utility Challenges Outside of Smart Grid

- ▶ Still must face replacement, management of existing “non-smart” infrastructure
 - ▶ Average age of a sub station transformer is 42 years old (2 years beyond life span)

Value of AM/EWFM in Smart Grid

- **Asset EOL Extension changes procurement strategies**
 - Extending life of assets could reduce distribution asset acquisition up to 10% per year
 - On-hand inventory needs could drop 20-30%
- **Outage Responses lead to action and dollars**
 - Many utilities must pay fines for excessive power outages
 - One utility refunded \$27 million for excessive outages
 - Work crew productivity could rise by 10%-15%
- **Real Systems to manage Real Assets**
 - Complex system that can track customer related intelligent assets
 - Utilities need systems to meet the needs of smart asset tracking



The 5-level SG/IN CMMI

- **Capability Maturity Model Index History**
 - **Carnegie Mellon produces maturity model for many different operational areas**
 - Utility IT is familiar with the Software Development standards (CMMI-SW)
 - **Maturity is usually rated from 0-5, with 5 the highest**
- **Smart Grid CMMI**
 - **Global Intelligent Utility Network Coalition**
 - **July 2009 53 large utilities assessed their maturity across a range of topics**
 - **One component was Work & Asset Management**
 - Most respondents from July 2009 rated 1 out of 5
 - **Utilities can perform their own assessment and compare to other utilities**
 - Documents are free to download and provide detail tools to complete assessments
- **Leveraging Smart Grid CMMI**
 - **Standard Language**
 - Provides consistent language that the market is adopting for terms
 - **AM/WM/EWFM can help move a utility from a lower maturity to a higher one**

5-Level CMMI Model

	GO Grid Operations Advanced grid observability, control, quality, and reliability	WAM Work and Asset Management Optimized assets and resources (i.e., people and equipment)	CME Customer Management and Experience Detailed customer care, pricing options and control, advanced services, visibility into utilization, quality, and performance	VCI Value Chain Integration Enabling demand and supply management, distributed generation and load management, and leveraging market opportunities
5 Innovating	<ul style="list-style-type: none"> Grid employs self-healing capabilities System-wide automated grid decision making Optimized rate design/regulatory policy Ubiquitous system-wide dynamic control Universal dynamic protection New opportunities as a result of the integrated view of customers, assets, and operations 	<ul style="list-style-type: none"> Optimizing the use of assets between and across supply chain participants Just-in-time retirement of assets Enterprise-wide abstract representation of assets for investment decisions 	<ul style="list-style-type: none"> Capability for customer management of end-to-end energy supply and usage level Automatic usage detection at residential level or device Play-and-play customer-based generation supported Near real-time data on customer usage Innovative customer products possible Consumption level by device available 	<ul style="list-style-type: none"> Dispatchable resources are available for increasingly granular market options (e.g., Locational Marginal Pricing) Coordinated energy management and generation throughout the supply chain Optimization of entire energy assets
4 Optimizing	<ul style="list-style-type: none"> Integration into enterprise processes Dynamic grid management Tactical forecasts based on real data Information available across enterprise through end-to-end observability Automated decision making within protection schemes (i.e., leveraging increased analytics capabilities and context) 	<ul style="list-style-type: none"> Enterprise view of assets: location, status, interrelationships, connectivity, and proximity Asset models based on real data Optimization across fleet of assets Condition-based and predictive management on key components Efficient inventory management utilizing real asset status and modeling 	<ul style="list-style-type: none"> Analysis of usage within pricing programs Automatic outage detection and proactive notification at circuit level Automated response to pricing signals Nudging programs in the home Recent customer usage data (e.g., daily) Common customer experience integrated across all channels 	<ul style="list-style-type: none"> New and existing energy resources can be dispatched and traded Portfolio optimization modeling expanded for new resources and real-time markets Ability to communicate with Home Area Network (HAN) Visibility and control of customer large-demand appliances Uses distributed generation and load management to sell extra power off network
3 Integrating	<ul style="list-style-type: none"> Sharing data across functions and systems Implementing control analytics to support manual decision making Move from estimation to fact-based planning Customer meter becomes an essential grid management sensor New process being defined due to increased automation and observability 	<ul style="list-style-type: none"> Performance and trend analysis available for components Developing Condition Based Management (CBM) on key components Integrating RAM to asset management Integrating RAM to mobile work force and work orders Integrated view of Geospatial Information Systems Tracking inventory from source to utilization Modeling asset investments for key components based on smart grid data 	<ul style="list-style-type: none"> High degree of actionable customer segmentation Two-way meter communication Remote disconnect and connect Remote load control available Automatic outage detection at substation Common customer experience Customer participation in demand/response New interactive products and services 	<ul style="list-style-type: none"> Integrated resource plan includes new targeted resources (e.g., DR, DG, volt/VAR) Enabling market and usage information for use by customer energy management solutions New resources available as substitute for market products to meet reliability objectives Programs to support value chain partners for load management and distributed generation
2 Investing	<ul style="list-style-type: none"> Initial distribution to substation automation projects Implementing advanced outage restoration schemes Piloting remote asset monitoring (RAM) on key assets for manual decision making Expanding and investing in extended communications networks Emphasis on communications with respect to automation and observability 	<ul style="list-style-type: none"> Developing mobile workforce strategy Approach for tracking, inventory, and event history of assets under development Developing an integrated view of GIS and RAM with location, status, and nodal interconnectivity Pilots for enhancements to crew scheduling Developing track history of assets 	<ul style="list-style-type: none"> Piloting remote AMI/AMR More frequent knowledge of customer usage Modeling of reliability issues to drive investments for improvements Piloted remote disconnect and connect Assessing impact of new services and delivery processes (e.g., HAN) 	<ul style="list-style-type: none"> Introducing support for home energy management systems Pilot grid investments to utilize a diverse resource portfolio Redefining the value chain into a new ecosystem Programs to promote customer distributed generation Support for distributed generation systems Contract vehicles to accommodate distributed generation to mid and small based customers
1 Initiating	<ul style="list-style-type: none"> Exploring new sensors, switches, and communication devices Exploring outage and distribution management linked to substation automation Building business case at functional level Proof of concept and component testing Safety and physical security Evaluating communications technologies 	<ul style="list-style-type: none"> Building a business case at the functional level Conducting value analysis for new equipment and systems Exploring Remote Access Monitoring (RAM) beyond SCADA Evaluating mobile workforce and crew communication system Exploring proactive and predictive asset maintenance Exploring using spatial view of assets 	<ul style="list-style-type: none"> Research on how to reshape the customer experience through smart grid Deploy/walk by Automated Meter Reading Broad customer segmentation Limited remote load control, load management for C&I Relative to customer experience 	<ul style="list-style-type: none"> Assets and programs that facilitate load management programs are identified Distributed generation sources and existing capabilities to support them are identified Developing a strategy for diverse resource portfolio AMR or one-way AMI infrastructure Education for curtailing peak usage available to customers

Black text = Required characteristics

Blue text = Descriptive characteristics

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Smart Grid Maturity Model 3- Integrating

	GO Grid Operations Advanced grid observability, control, quality, and reliability	WAM Work and Asset Management Optimized assets and resources (i.e., people and equipment)	CMF Customer Management and Experience Retail, customer care, pricing options and control, advanced services, visibility into utilization, quality, and performance	VCI Value Chain Integration Enabling demand and supply management, distributed generation and load management, and leveraging market opportunities	
5 Innovating	<ul style="list-style-type: none"> Grid employs self-healing capabilities System-wide automated grid decision making Optimized rate design/regulatory policy Ubiquitous system-wide dynamic control Universal dynamic protection New opportunities as a result of the integrated view of customers, assets, and operations 	<ul style="list-style-type: none"> Optimizing the use of assets between and across supply chain participants Just-in-time retirement of assets Enterprise-wide abstract representation of assets for investment decisions 	<ul style="list-style-type: none"> Ability for customer management of end-to-end energy supply and usage level Automatic usage detection at residential level or device Plug-and-play customer-based generation supported Near real-time data on customer usage Innovative customer products possible Consumption level by device available 	<ul style="list-style-type: none"> Dispatchable resources are available for increasingly granular market options (e.g., Locational Marginal Pricing) Coordinated energy management and generation throughout the supply chain Optimization of entire energy assets 	
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3 Integrating	<ul style="list-style-type: none"> Share Imple makl Move Custo senso New and c 				<ul style="list-style-type: none"> Includes new targeted resources Information for use by management solutions Substitute for market products as Chain partners for load managed generation
2 Investing	<ul style="list-style-type: none"> Initial Imple Pilotti man Expar netw Empl and c 				<ul style="list-style-type: none"> Energy management Utilize a diverse resource portfolio into a new ecosystem Other distributed generation generation systems Integrate distributed generation customers
1 Initiating	<ul style="list-style-type: none"> Expli devl Exploring outage and distribution management linked to substation automation Building business case at functional level Proof of concept and component testing Safety and physical security Evaluating communications technologies 	<ul style="list-style-type: none"> Exploring Remote Access Monitoring (RAM) beyond SCADA Evaluating mobile workforce and crew communication system Exploring proactive and predictive asset maintenance Exploring using spatial view of assets 	<ul style="list-style-type: none"> Drive by/walk by Automated Meter Reading Broad customer segmentation Limited remote load control, load management for C&I Reactive to customer experience 	<ul style="list-style-type: none"> Distributed generation sources and existing capabilities to support them are identified Developing a strategy for diverse resource portfolio AMR or one-way AMI infrastructure Education for curtailing peak usage available to customers 	

Smart Grid Maturity Model 4- Optimizing

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5 Innovating	<ul style="list-style-type: none"> Grid employs self-healing capabilities System-wide automated grid decision making Optimized rate design Ubiquitous system Universal dynamic New opportunities for customers, assets, and services 	<ul style="list-style-type: none"> Optimizing the use of assets between and across supply chain participants 	<ul style="list-style-type: none"> Ability for customer management of end-to-end energy supply and usage level 	<ul style="list-style-type: none"> Dispatchable resources are available for increasingly granular market options (e.g., Locational Marginal Pricing) and generation
4 Optimizing	<ul style="list-style-type: none"> Integration into enterprise Dynamic grid management Tactical forecasts based on real-time data Information available for observability Automated decision making (i.e., leveraging incremental intelligence) 	<ul style="list-style-type: none"> Enterprise view of assets: location, status, interrelationships, connectivity, and proximity Asset models based on real data Optimization across fleet of assets Condition-based and predictive management on key components Efficient inventory management utilizing real asset status and modeling 	<ul style="list-style-type: none"> More frequent knowledge of customer usage Modeling of reliability issues to drive investments for improvements Isolated remote disconnect and connect Assessing impact of new services and delivery processes (e.g., HAN) 	<ul style="list-style-type: none"> Dispatchable resources can be dispatched Market options expanded for new services Home Area Network (HAN) for large-demand appliances and load management to sell
3 Integrating	<ul style="list-style-type: none"> Sharing data across systems Implementing control making Move from estimated to real-time Customer meter base sensor New process being and observability 	<ul style="list-style-type: none"> Approach for tracking, inventory, and event history of assets under development Developing an integrated view of GIS and RAM with location, status, and nodal interconnectivity Pilots for enhancements to crew scheduling Developing track history of assets 	<ul style="list-style-type: none"> Research on how to reshape the customer experience through smart grid Drive by/walk by Automated Meter Reading Broad customer segmentation Limited remote load control, load management for C&I Responsive to customer experience 	<ul style="list-style-type: none"> Identifies new targeted resources Information for use by distributed solutions Institute for market products Partners for load generation
2 Investing	<ul style="list-style-type: none"> Initial distribution to substations Implementing advanced outage restoration schemes Piloting remote asset monitoring (RAM) on key assets for manual decision making Expanding and investing in extended communications networks Emphasis on communications with respect to automation and observability 	<ul style="list-style-type: none"> Building a business case at the functional level Conducting value analysis for new equipment and systems Exploring Remote Access Monitoring (RAM) beyond SCADA Evaluating mobile workforce and crew communication system Exploring proactive and predictive asset maintenance Exploring using spatial view of assets 	<ul style="list-style-type: none"> Systems Pilot grid investments to utilize a diverse resource portfolio Redefining the value chain into a new ecosystem Programs to promote customer distributed generation Support for distributed generation systems Contract vehicles to accommodate distributed generation to mid and small based customers 	
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Smart Grid Maturity Model 5- Innovating

GO Grid Operations
Advanced grid observability
reliability

- ◆ Optimizing the use of assets between and across supply chain participants
- ◆ Just-in-time retirement of assets
- ◆ Enterprise-wide abstract representation of assets for investment decisions

Innovating

- Grid employs self-healing capabilities
- System-wide automated grid decisions
- Optimized rate design/regulatory products
- Ubiquitous system-wide dynamic control
- Universal dynamic protection
- New opportunities as a result of the customers, assets, and operations

Optimizing

- Integration into enterprise processes
- Dynamic grid management
- Tactical forecasts based on real data
- Information available across enterprise observability
- Automated decision making within protection schemes (i.e., leveraging increased analytics capabilities and context)

- Condition-based and predictive management of key components
- Efficient inventory management utilizing real asset status and modeling

- Net billing programs in the home
- Recent customer usage data (e.g., daily)
- Common customer experience integrated across all channels

- Ability to communicate with remote area network (RAN)
- Visibility and control of customer large-demand appliances
- Uses distributed generation and load management to sell extra power off network

Integrating

- Sharing data across functions and systems
- Implementing control analytics to support manual decision making
- Move from estimation to fact-based planning
- Customer meter becomes an essential grid management sensor
- New process being defined due to increased automation and observability

- Performance and trend analysis available for components
- Developing Condition Based Management (CBM) on key components
- Integrating RAM to asset management
- Integrating RAM to mobile work force and work orders
- Integrated view of Geospatial Information Systems
- Tracking inventory from source to utilization
- Modeling asset investments for key components based on smart grid data

- High degree of actionable customer segmentation
- Two-way meter communication
- Remote disconnect and connect
- Remote load control available
- Automatic outage detection at substation
- Common customer experience
- Customer participation in demand/response
- New interactive products and services

- Integrated resource plan includes new targeted resources (e.g., DR, DG, volt/VAR)
- Enabling market and usage information for use by customer energy management solutions
- New resources available as substitute for market products to meet reliability objectives
- Programs to support value chain partners for load management and distributed generation

Investing

- Initial distribution to substation automation projects
- Implementing advanced outage restoration schemes
- Piloting remote asset monitoring (RAM) on key assets for manual decision making
- Expanding and Investing in extended communications networks
- Emphasis on communications with respect to automation and observability

- Developing mobile workforce strategy
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- Piloting remote AMI/AMR
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- Introducing support for home energy management systems
- Pilot grid investments to utilize a diverse resource portfolio
- Redefining the value chain into a new ecosystem
- Programs to promote customer distributed generation
- Support for distributed generation systems
- Contract vehicles to accommodate distributed generation to mid and small based customers

Initiating

- Exploring new sensors, switches, and communication devices
- Exploring outage and distribution management linked to substation automation
- Building business case at functional level
- Proof of concept and component testing
- Safety and physical security
- Evaluating communications technologies

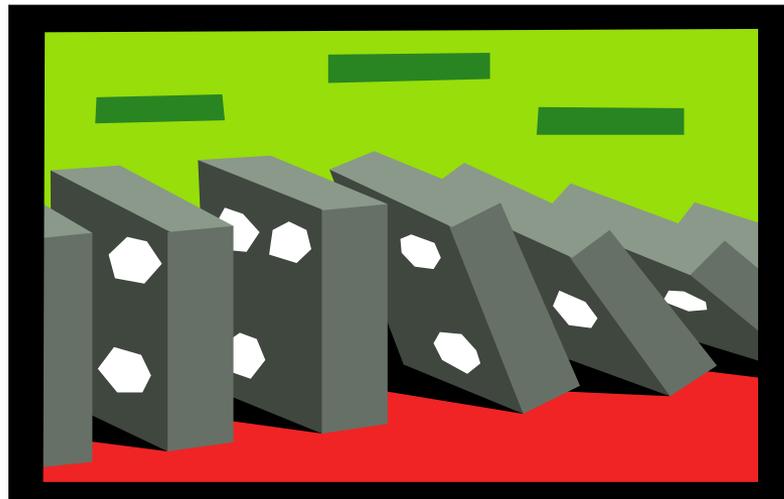
- Building a business case at the functional level
- Conducting value analysis for new equipment and systems
- Exploring Remote Access Monitoring (RAM) beyond SCADA
- Evaluating mobile workforce and crew communication system
- Exploring proactive and predictive asset maintenance
- Exploring using spatial view of assets

- Research on how to reshape the customer experience through smart grid
- Drive by/walk by Automated Meter Reading
- Broad customer segmentation
- Limited remote load control, load management for C&I
- Reactive to customer experience

- Assets and programs that facilitate load management programs are identified
- Distributed generation sources and existing capabilities to support them are identified
- Developing a strategy for diverse resource portfolio
- AMR or one-way AMI infrastructure
- Education for curtailing peak usage available to customers

Impacts of SG/IN on AM/EWFM

- **At least 3 Main Impact Areas**
 - **CIS:** the utility's end-customer relationship (and the information the customer will receive, need and demand)
 - **AM:** the asset management programme at that utility (and the new classes of assets to be maintained and tracked)
 - **EWFM:** the mobile workforce need for and access to information in the field concerning the customer and these new assets

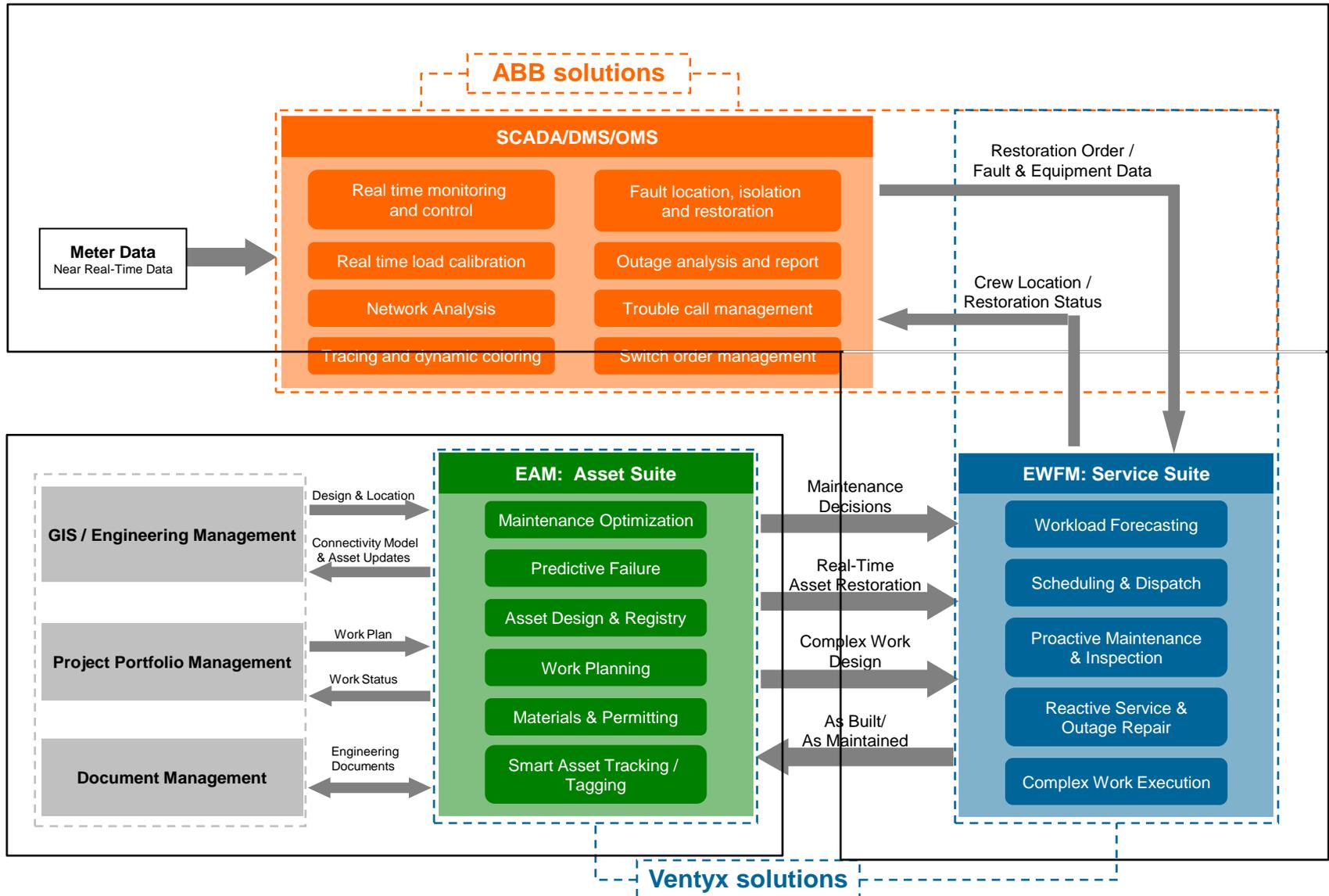


More Demanding Customer Relationships

- **Customers expect more**
 - **Intelligent devices in their homes**
 - **Explanations of new technology and/or products**
 - **Shorter appointment windows**
 - **More control**
 - **The “Smart Customer”**
- **CIS Requirements**
 - **Optimized Net billing for residential customers (Level 4)**
 - **Optimized Common customer experience for all channels (Level 4)**
 - **Innovative customer products (Level 5)**



Solution Topography

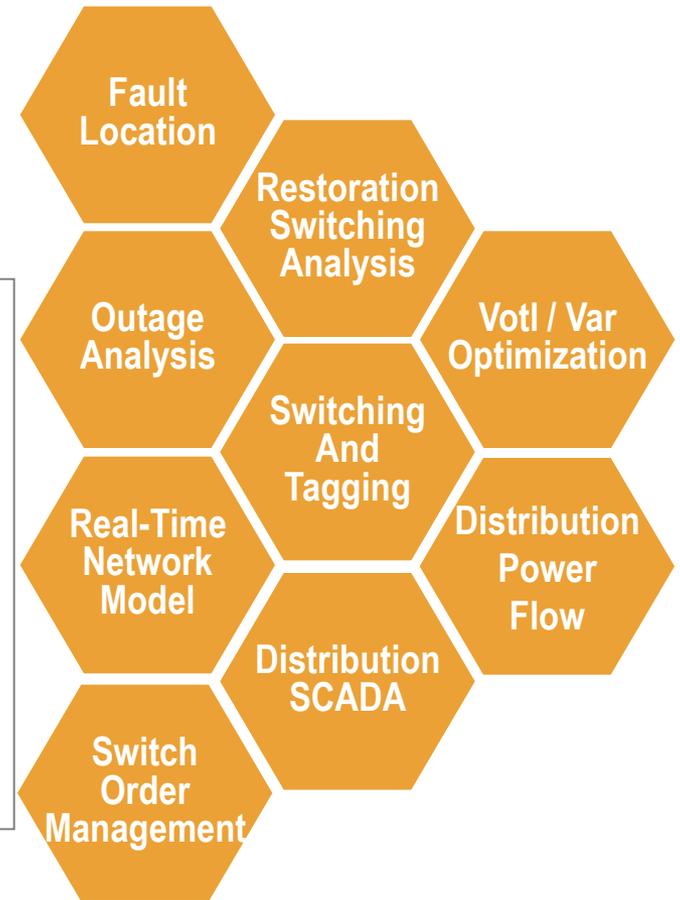


Workflow Between Control Center and the Field

Field Operations



- Dispatch best crew for the job
- Communicate accurate and timely information
- Forecast workforce requirements accurately
- Manage switch orders effectively

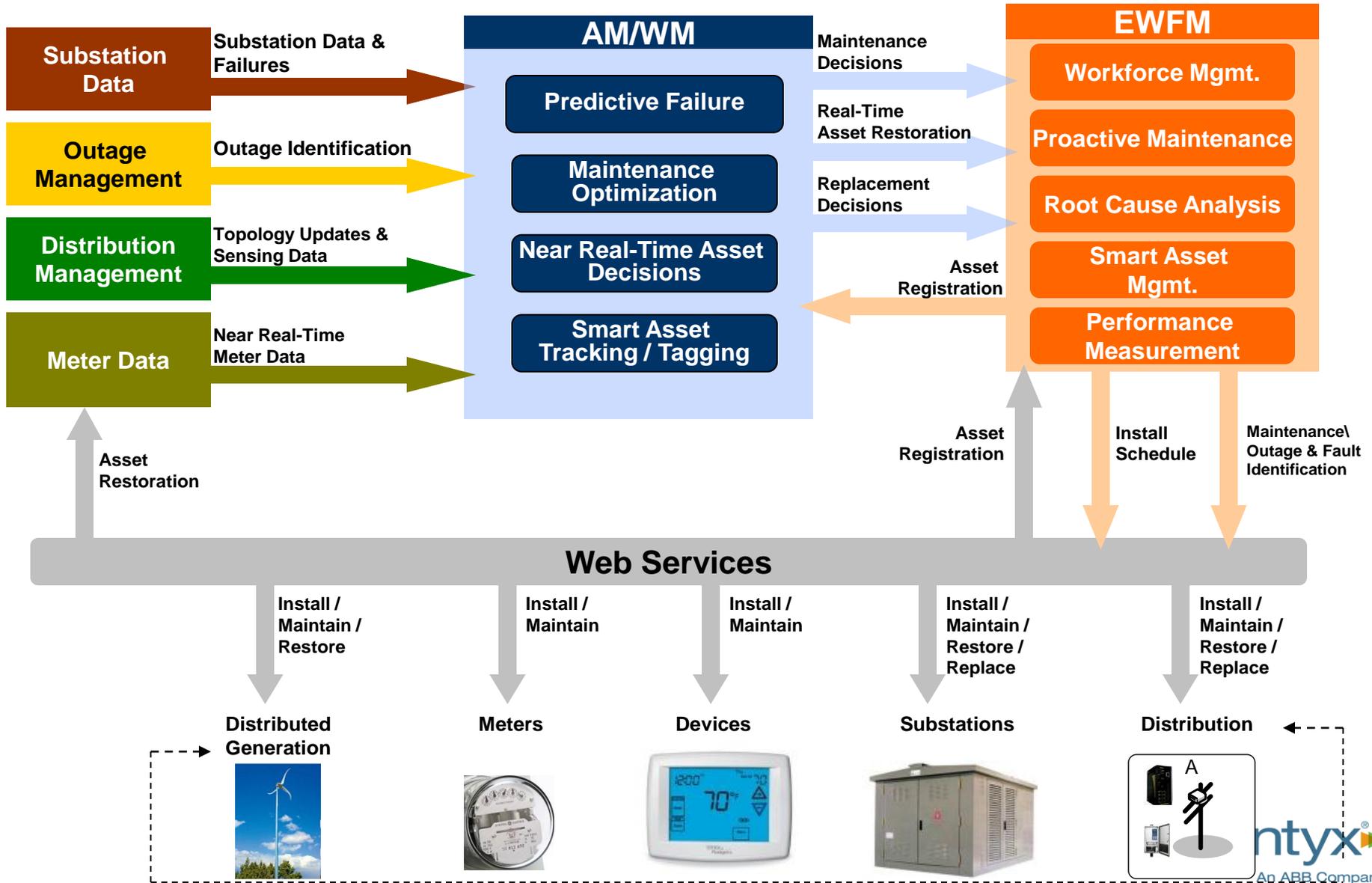


Control Center

Field Operations



SG/IN and AM/EWFM Flow



SG/IN – Service Suite Use Case

- **Intelligent Network – Motor Operated Switch**
 - **Intelligent devices in Substation**
 - **SCADA detects possible problems**
 - **Motor-Operated Switch (MOS) or Communications device**
 - **Different crew skill sets required to diagnose**
 - **DMS/OMS creates investigation orders and sends to Service Suite**
 - **Service Suite assigns unified crew with both skill sets, schedules and dispatches the work order (s)**
 - **Crew arrives, investigates, performs work, fixes one device**
 - **Results returned to DMS/OMS**
 - **Smart Grid cured itself before non-crew intervention required**



Asset Management Requirements

- **Predict Failure based on measurements (Level 4)**
 - Utilize smart distribution data to get the last gasp out of assets
 - Just in time retirement of assets (Level 5)
- **Maintenance Optimization**
 - Distribution data used to determine priority for maintenance (Level 3)
 - Integrate with EWFM to schedule maintenance crews appropriately
- **Near Real-Time Asset Decisions**
 - Asset models/investments based on real data (Level 4)
- **Smart Asset Tagging / Tracking**
 - Utilize AM to manage rollout of new assets (Level 2)
 - Integrate with other Asset components to gain better predictive failure and maintenance plans for new smart assets (DR Devices, meters)



Asset Management Requirements

- **Customers and regulators expect more from Assets**

- **Greater reliability**

- Fewer and less severe unplanned outages
- Shorter restoration times
- Lower costs



- **AM Uses**

- Detailed asset tracking: source, installation/event history (Level 2)
- Distribution data used to determine maintenance priorities (Level 3)
- Predictive maintenance from remote monitoring (Level 4)
- Asset models and investment based on real data (Level 4)
- Just in time retirement of assets (Level 5)

EWFM Requirements

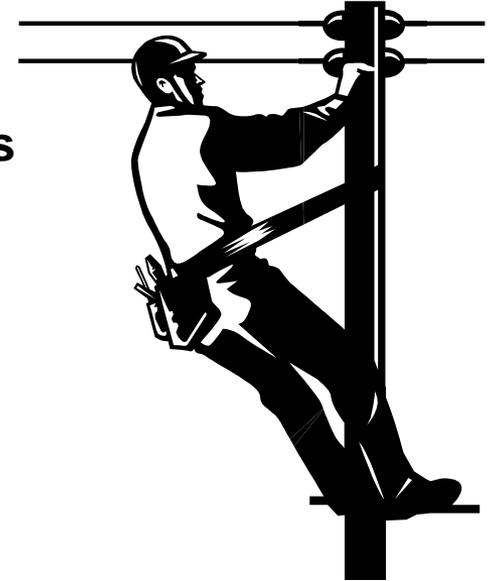
- **Workforce Management (Levels 2 and 3)**
 - Improved information increases productivity
 - Crews no longer searching for outage within an area (Level 4)
- **Proactive Maintenance (Levels 3 and 4)**
 - Integrated with Asset Management to determine which assets, when & who repairs or replaces
- **Root Cause Analysis**
 - Pinpoint and diagnose network issues with integration to OMS/DMS (Level 3)
 - Validate resolution of outage / fault on-site
- **Smart Asset Management**
 - Provide appointment bookings, self-service web portal
 - Integrate with Asset Management to register devices immediately
- **Performance Measurement**
 - Provide better crew assessments and metrics



EWFM Requirements

- **Customers expect more**
 - **Field Techs with needed information at hand**
 - **Explanations of new technology and/or products**
 - **Usage guidance**
 - **Short appointment windows**

- **EWFM Uses**
 - **Appointment booking; self-service web portal**
 - **Alerts & graphical warnings to dispatchers**
 - **Continuous optimization**
 - **Install addressable devices from the field**
 - **Activate back office connection immediately**



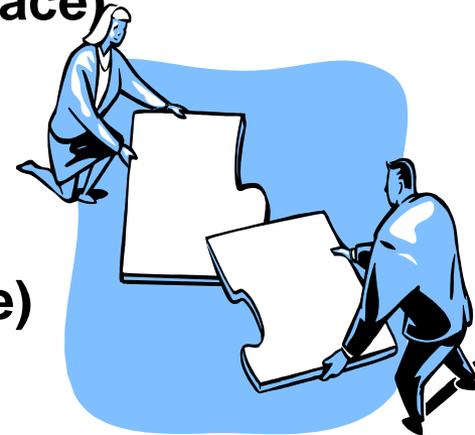
Systems Working Together

- **Directly from EWFM in the field**

- Pinpoint and diagnose network issues (OMS interface)
- Determine current network state (DMS interface)
- Examine asset health from the inside (smart asset AM interface)
- Program, test and activate new meters (MDM interface)

- **To and from AM in the back office**

- Supply chain & financial control (ERP interface)
- Asset connection status & topology (DMS interface)
- Failure notification (OMS interface)
- Remote access monitoring (SCADA / smart asset interface)





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**The Role of Enterprise Workforce Management in
Supporting an Intelligent Electric Network**

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April, 2011

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