Smart technology and teamwork for smarter grids

Making smarter grids a reality

AREVA T&D
Presentation Agenda

- AREVA Smart Grid View
- Progression of Distribution Operations
  - Past
  - Present
  - Future
- Integrated Distribution Management System (IDMS) facilitates the Smart Grid
- Examples of AMI integration value
Recap of global industry drivers

- Increasing Pressure of Environmental and Resources Availability Constraints on Energy Supply Chain
- Environment conscience and Growing Penetration of Renewable & Distributed Energies
- Emergence of large Regional Transmission Systems Operator for enhanced reliability, effective reserve management, and overall operational efficiency
- T&D Companies forced to meet strict Service Level Agreements in line with their approved Grid Codes (rates & tariffs)

Changes pushed by public authorities, regulators and consumers
The grid will need to be “smarter”

The smarter grid will:

- Be self-healing (detect, analyze, respond, restore)
- Empower and incorporate the consumer
- Be tolerant of security attack
- Accommodate a variety of generation options
- Fully enable electricity markets
- Optimize asset use and minimize O&M costs while being safer to operate
- Be a significant contributor to preserving our environment
- Ensure the reliability and efficiency of electrical energy supply
A customer Definition: from DOE

**U.S. DEPARTMENT OF ENERGY**

- Be Self-Healing: Anticipate & respond effectively to system disturbances
- Enable active participation of Consumers
- Operate resiliently against attack and natural disaster
- Accommodate all generation & storage options
- Enable introduction of new Products, Services & Markets
- Optimize asset utilization and operate efficiently
- Provide Power Quality for the digital economy

**Aligned with US DOE definition**

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4YP Smarter Grid Vision

Smarter Grid = Efficient and reliable energy usage
Smart Grid from Vision to Product

Smart Grid

Smart Dispatch
- Generation Portfolio Management including renewable
- Full Integration of pricing and demand/supply principles to manage the grid
- Smart demand response management

Smart Transmission Grids
- On-line Asset Management
- On-Line Stability Analysis & Defense Plans
- Smart Power Electronic Controls (HVDC, FACTS, SVC...)

Smart Distribution Grids
- Automatic Meter Management System
- Integrated Distribution Management Systems
- Renewable and load management integration

Smart Substation
- Substation Protection & Control Architectures
- Self-adaptive Defense Plans
- Secondary Distribution Smart Grid Box

Visualization, Situation Awareness and Decision Support Tools

System Architecture including Common Information Model

Secure, deterministic and reliable data communication
Customer Issues

- Large number of resources to be dispatched
- More and more renewable generation to connect and manage
- Integration of Demand Response
- Emission constraints
- Deal with Inaccurate & incomplete data
- Larger volume of data and information to be processed in different time horizon
- Tighter level of integration required from wholesale market and T&D network operation

The Smarter Dispatch will bring all the necessary integration and decision tools in order to handle and anticipate increasingly complex situations on different time horizons
The smart dispatch offer is based on our current MMS (e-terra \textit{market} v2.4, e-terra \textit{commit}).

\begin{itemize}
  \item Accelerate the development of the new e-terra \textit{platform} (increased reliance on open standards, Service oriented architecture)
  \item Productize our Dispatch solutions
  \item Design a Generation Scheduling information platform
  \item Extend the renewable energies module to include energy storage/restitution devices
  \item Integrate more parameters impacting decisions (weather, system stability, market dynamics, Co2, etc.)
\end{itemize}
Customer Issues

- Very large regional interconnected grids
- Increasing energy demand
- Competitive market which leads operators to reduce their expenses
- Interconnection & dispatch of renewable energy resources (Wind, solar …)
- Very diverse interconnection of generation portfolios
- Optimize transfer capacity
- Mitigation & fast recovery from disturbances & blackouts
- New constraints: Demand Response, Emission reduction …

The online stability offer will allow to prevent black-outs and create system-wide defense plans to mitigate cascading
The Smart Grid offer is based on our current EMS, SCADA, PMU and PDC.

Our Approach

- Enhance speed of security analysis
- Build a security over-viewer
- Enable predictive security in EMS
- Integrate PMU (Phase Measurement Units) for online stability analysis
- Integrate Smart controlling devices for implementation of automated fast closed loop defense scheme
Customer Issues

- Ageing infrastructure
- Congested transmission highway
- Prioritization for investment
- Efficient management of field forces

The Smarter Asset Management tools will assess, prioritize and increase productivity of resources allocation.
The Smart Transmission offer will bring high value-added applications on top of a standard Asset Management package.

**Our Approach**

- Monitor equipment conditions with predictive algorithms
- Integrate Non-Operational Data and Condition Based monitoring in the maintenance planning
- Integrate CIM interface and network model representation of equipment (e-terrasource)
- Integrate health monitoring information in decisions
- Evaluate benefits of planned work sequences
Customer Issues

- Support & enable active participation of load and customer choice as well as monitor compliance
- Manage millions of smart meters and their data
- Manage the dynamic electrical network connectivity from transmission all the way to the millions of LV consumers and producers
- Distribution network visualization and situational awareness
- Rapid distribution network restoration and pro-active reconfiguration
- Manage Distributed Generation (DG) with many production patterns
- Enable bi-directional communication with smart meters in real-time and make information available to all stakeholders

The Smarter Distribution will support the modeling, aggregation, control and monitoring, forecasting and dispatching of a wide spectrum of renewable and load portfolios
The Smart Grid offer is based on e-terra distribution and MDM products.

**Our Approach**

- Define and Interface MDM components for Smart Demand Side Management
- Design and Develop components for commercial and market information platform
- Design and Develop a framework for operational and planning decisions
- Architect solutions for DG owners and operators
- Develop analysis and financial tools
A significant share of world electricity flows is managed by AREVA.

Source: AREVA
Strategic Technological Footprint across these operators

- National Grid
- Réseau de transport d’électricité (RTE)
- California ISO
- Midwest ISO
- PJM Interconnection
- Red Electrica de Espana
- Operador Nacional do Sistema
- China North and State Grid Corporation of China
- Terna
- Tokyo Electric Power (TEPCO)
- KPX Korea
- SO-CDO Russia
- Power Grid of India
- Russia

Dominant IT Player among Very Large Power Grid Operators

Strategic Technological Footprint across these operators
North China Grid (NCG) Project:

**Scope**

- **Customer Industry:**
  - Very Large Power Grid Operator (VLPGO)

- **Customer description:**
  - 1 of 6 Regional Grid Operators in China
  - 120 GW Installed Gen Capacity
  - 500KV: 17,000 KM
  - 220KV: 43,000 KM
  - Directly controls Beijing area (OLYMPICS)

- **Type of Solution provided:**
  - Visualization for secure grid operation
  - Decision Support for electricity reform

- **Contract Duration/ Completion:**
  - Phase 1: 2006-2007 (In Production)
  - Phase 2: 2007-2008 (In Acceptance Test)
Maintain GRID SECURITY in scheduling generation contracts

Visualization for PMU-based
Wide Area Security
Transmission Grid Today

AEP System

- Headquarters, Columbus, OH
- Over 5 million Customers
- Approximately 20,000 Employees
- Total Revenue (2006) = $12.6 billion
- Total Assets (2006) = $38 billion

US Transmission Ranking

<table>
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<tr>
<th>Ranking</th>
<th>Company</th>
<th>Transmission Mileage</th>
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<tr>
<td>1</td>
<td>AEP</td>
<td>38,900</td>
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<td>2</td>
<td>Southern Company</td>
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<td>Xcel Energy Inc.</td>
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<tr>
<td>7</td>
<td>Tennessee Valley Authority</td>
<td>17,000</td>
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On-line stability: A Smart Grid technology

- **e-terravision: Situation Aware Control Centers:**
  - Provides “interactive situation awareness” and problem solving to utility Control Centers, independently of EMS/SCADA technology
  - Monitors vital signs of network grids with capability to zoom into problem areas
  - Combines advanced visualization techniques with expert knowledge of power systems dynamics and behavior under stress

- **Next project phase will**
  - Provide What if scenario capability
  - Ability to view:
    - PMU/WAMS measurements & Stability Analysis
    - Interface Flow & Violations
    - Transformer loading
    - Ranked Constraint sensitivities & associated control

**Deployment at AEP**

- e-terravision: (control Room Wallboard)
- e-terravision (Analysts Workstations)
- e-terravision (Corporate Executive Office)
A Smart Grid Project today

- **Energinet.dk (ENDK)**
  - State owned company, merger between East TSO, West TSO and Gas TSO
  - Operates and natural gas storage facilities

- **Danish networks**
  - Elec 1,180 Km of HV lines / 400kV 150kV and 132kV networks / 186 S/s
  - Installed capacity: 14 GW / 8GW thermal / 3.8 GW Wind / 2,2GGW CHP
  - Gas Network 800Km of Pipelines 60 substations

- **Project target**: replacement of the 3 existing transmission control systems (3 different suppliers) by a single system
  - CC1, in Erritsoe: Primary EMS, Back up GMS
  - CC2, in Egtved: Primary GMS, Back up EMS

- **Contract signed**: 24/10/2006
- **Solution delivered**: May 2008
**Key Smart Grid Features**

**Distributed Generation Management**
- Estimates the production of non-measured distributed generation units: wind turbines and CHP. Used by several critical network analysis applications as well as by PB.

**Power Balance**
- Input: Power schedules from PBR, HVDC stations and Tie-lines
- Output: Delta between committed and measured production of each market player (PBR).

**Offline Simulation**
- Input: Power, load and outage schedules, DACF from neighboring TSOs
- Output: automatically produce a set of future network states (one-day horizon, 15mn steps)

**GAS Management System Integration**
- Integration of GMS (SIMONE) to e-terra platform
- Development of specific applications: pig tracking, gas retroactive historic reconstruction
PJM as Part of the Eastern Connection

KEY STATISTICS
- PJM member companies: 400+
- Millions of people served: 51
- Peak load in megawatts: 145,000
- MWs of generating capacity: 165,000
- Miles of transmission lines: 56,070
- GWh of annual energy: 700,000
- Generation sources: 1,271
- Square miles of territory: 164,260
- Area served: 13 states + DC

19% of U.S. GDP produced in PJM

26% of generation in Eastern Interconnection
23% of load in Eastern Interconnection
19% of transmission assets in Eastern Interconnection
Settlement

- 450 Participants, 1271 Generation Units, 164.9 GW
- More than $42 Billions of Annual billing

**AREVA e-terra settlement**

- Business Rules - Fully Configurable
- Output Results
- High Volume & Performance Calculation
- Input Processing
  - Multi-Threaded to meet AMI needs
- Run # 1
- Run # 2
- Run # 3

**PJM e-Suit Applications for Market Participant Interface**

- LSE (Load Serving Entity)
- EDC (Electric Distribution Company)

**Member Generation & Merchant Companies**

**AREVA - CSP (Curtailment Service Providers)**

**MDSP (Meter Data Service Providers)**

**HAN (Home Area Network)**

**Smart Meter/Gateway**

**High Volume of Data Processing**

- AREVA e-terra settlement offers scalable architecture to meet growing data volume needs driven by:
  - PJM market evolution
  - PJM Smart Grid / Demand Response initiative
  - Highly scalable
  - Support for Parallel executions

**Business Rules - Fully Configurable**

- No code development for new market settlement rules
- Load Response Run Group configured for PJM Smart Grid Demand Response initiative
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THANK YOU !