Using AMI to Realize the Smart Grid

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What is AMI?
Advanced Meter Infrastructure (AMI)

- Smart meters with two way communications
- Self configuring
- Self healing
- Offer new functionality such as:
  - Interval data
  - TOU data
  - Home automation
  - Service connect/disconnect
AMI Network

Steps
1. Collector looks for unregistered nodes
2. Collector registers level 1 nodes

A3 Meter with WAN interface is the Collector

A3 Meter or REX Meter acts as a node in the Mesh Network

Each path is qualified!
AMI Network

Steps
1. Collector looks for unregistered nodes
2. Collector registers level 1 nodes
3. Collector interrogates level 1 nodes to find level 2 nodes
Steps
1. Collector looks for unregistered nodes
2. Collector registers level 1 nodes
3. Collector interrogates level 1 nodes to find level 2 nodes
4. Collector interrogates level 2 nodes to find level 3 nodes
5. Collector builds out entire network
AMI Network
Meter Functionality

Meter calculates:

- kWh-delivered
- kWh-received
- kWh-delivered+received
- kWh-delivered-received (not available as a demand source)
- Alternate energy sources (VARh and VAh available Q4 '08). Firmware will be upgradeable remotely
- Interval data
- Demand data

![15 Minute Load Profile Data (kWh)](chart)

### Meter Data

<table>
<thead>
<tr>
<th>Tier</th>
<th>kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier A</td>
<td>1949</td>
</tr>
<tr>
<td>Tier B</td>
<td>748</td>
</tr>
<tr>
<td>Tier C</td>
<td>7319</td>
</tr>
<tr>
<td>Tier D</td>
<td>718</td>
</tr>
<tr>
<td>Tier E</td>
<td>767</td>
</tr>
</tbody>
</table>

| Total Received kWh | 0 |
| Total kWh          | 11501 |
| Max Demand 1       | 2.37 |
| Max Demand 2       | 2.37 |
| Voltage            | 242.43 |
AMI - Architecture Overview

MAS (Meter Automation Server)
- Main MAS Server: HP DL580
- Backup MAS Server: HP DL580

Shared Storage Interconnect: HP StorageWorks MSA1000

Optional Tape Library

LAN / WAN

Outgoing WAN Connections

Corporate Firewall

DMZ

Remote Comm Server 1: HP DL380
Remote Comm Server 4: HP DL380

Load Enterprise Systems

Asset Mgmt
WMS
CIS Billing
OMS

Fibre Channel / SCSI

Outgoing WAN Connections

LAN

Elster Gas Modules
With 900 MHz LAN

REX Meter
with 900 MHz LAN

A3 ALPHA
Meter/Collector

Level 1
Level 2
Level 3
Level 8

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What is the Smart Grid?
Elster is a member of EPRI’s IntelliGrid Program
Supporting the Power Delivery System of the Future

Uses open standards-based architecture

Integrates data communications networks and intelligent equipment

Provides the methods, tools, best practices and recommendations for specifying “intelligent” systems to promote:

- Interoperability
- Flexibility
- Expandability
- Effective security for data and system management
Vision of Smart Grid

- Self healing distribution power grid
- Grid free of disturbances such as sags, swells, interruptions
- Secure operation
- Accommodates a wide variety of generation options
- Optimizes Asset Utilization and O&M expenses
How does AMI help realize the smart grid?
Elster’s View of the AMI and the Smart Grid

• There is no single definition of Smart Grid
  • Many define Smart Grid from 50,000 feet

• AMI is a key part of the Smart Grid but not the only part
  • Start by leveraging AMI infrastructure

• AMI vendors need to partner with utilities and key technology partners to realize components of the smart grid

Smart Grid $\cap$ AMI = AGI
AMI Allows for more economical remote sensing

AMI Meters and AGI Nodes
AGI nodes allow measurements across the grid
Power Grid Today

Power Goes In

Substation

DMS

Power Goes Out

AMI Residential

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Smart Grid Tomorrow

DMS  Billing  O&M  Planning  Customer  Service
• We should not think of AMI endpoints as traditional revenue meters but as Advanced Grid Infrastructure (AGI) nodes.

Today an AMI device or endpoint looks like:

Tomorrow AMI endpoints will also look like:
AGI Endpoints

- LV Distribution Transformer Node
- Thermostat
- MV Overhead Line Sensor Node
- SensorLink®
- FieldMetrics®
- MV Underground Line Node
- LINDSEY
- ABB
- MV Recloser Node
### AGI – the Benefits

<table>
<thead>
<tr>
<th>Customer Service</th>
<th>Operations</th>
<th>Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>Outage Management System</strong> – use smart meters to report outages</td>
<td>• <strong>Efficiency</strong> – central Volt/Var control</td>
<td>• <strong>Loading</strong> – use historical data to obtain better information on transformer/feeder loading</td>
</tr>
<tr>
<td>• <strong>Power Quality</strong> – use smart meter voltage reporting to better understand voltage profile across system</td>
<td>• <strong>Maintenance</strong> – Use outage indices to target areas needing maintenance</td>
<td></td>
</tr>
<tr>
<td>• <strong>Customer Usage</strong> – use smart controls to level loads and inform customer of usage (IHD)</td>
<td>• <strong>Reduce Losses</strong> – Tamper detection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• <strong>Reduce Losses</strong> – Non-technical loss detection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• <strong>Load Flow</strong> – improved data for load modeling for renewables or switch reconfiguration</td>
<td></td>
</tr>
</tbody>
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Some Examples
Pilot for Loss Detection

- Joint utility/Elster/ABB pilot to demonstrate loss detection
- ABB FeederAll allows user to model electrical network
- Head and load meters are modeled in the network
- Elster meter data is imported from files
- User initiated trace shows the loads and circuit covered by a head meter
- Dynamic trace detects head meters downstream from an upstream head meter
- Downstream head meter reading is subtracted
- Difference indicates losses
Thermostats with Load Control

- Deployed in the field
- Expands the basic Energate thermostat to provide:
  - event status information
  - energy use information

<table>
<thead>
<tr>
<th>LOAD CONTROL DEVICES</th>
<th>EVENT</th>
<th>START</th>
<th>END</th>
</tr>
</thead>
<tbody>
<tr>
<td>THERMOSTAT</td>
<td>NONE</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>POOL PUMP</td>
<td>12:04</td>
<td>2:34</td>
<td></td>
</tr>
<tr>
<td>WATER HEAT</td>
<td>2:00</td>
<td>4:00</td>
<td></td>
</tr>
<tr>
<td>SWITCH 4</td>
<td>4:00</td>
<td>10:00</td>
<td></td>
</tr>
<tr>
<td>ANY EVENT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENERGY USE</th>
<th>TOU RATE</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOW: 3.725 KW</td>
<td></td>
<td>88</td>
<td>89</td>
<td>383</td>
</tr>
<tr>
<td>TOTAL ENERGY</td>
<td></td>
<td>560 KWH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESTIMATED COST</td>
<td></td>
<td>$ 39.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

• AMI will become a key part of the smart grid
• AMI has the potential to provide significant missing measurements in distribution power system applications, providing solutions matching real-time conditions throughout the distribution network
• AMI provides the capability to:
  • verify and improve real-time per phase unbalanced load flow
  • outage and restoration notification
  • Understand load flows on the distribution grid
  • Improve planning
  • Improve maintenance
  • Inform customers of usage
  • Initiate load conservation
• If you believe the future requires more energy generation, better control and conservation are also required
Thank You !