Wind Turbine Monitoring and Control

Optimal & Desired Long Term Performance

- Real Time Monitoring & Data Analysis
- Smart Turbine & Plant Level Controls
- Service & Maintenance Strategies

Advanced Energy Conference 2010
New York, New York
November 9th, 2010

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Wind Plant SCADA Functionality Highlights

**Data Acquisition**
- Collect data from Turbines
- Send Turbine data to Reporting Servers
- Send Turbine data to Customer
- Collect Meter data from Substation

**Supervisory Control**
- Start/Stop Turbines & Wind Plant
- Reset Turbine & Power Plant Controller Alarms – 24/7
- Active/Reactive Power Set points from utility/customer
- Use Meter data from Substation to maintain Active/Reactive Power Set Point
## Wind Plant SCADA Evolution Trends

<table>
<thead>
<tr>
<th></th>
<th>1st generation</th>
<th>2nd generation</th>
<th>3rd generation</th>
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<tbody>
<tr>
<td><strong>Data sampling method</strong></td>
<td>Signal scanning by SCADA on-site</td>
<td>Signal processing by turbine controller</td>
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<tr>
<td><strong>Plant network topology</strong></td>
<td>Serial based</td>
<td>Serial/Ethernet</td>
<td>Ethernet</td>
</tr>
<tr>
<td><strong>Turbine buffer size</strong></td>
<td>Very limited capacity</td>
<td>Medium capacity</td>
<td>Large capacity</td>
</tr>
<tr>
<td><strong>Plant connection topology</strong></td>
<td>Modem</td>
<td>Modem, GPRS, Internet</td>
<td>Broadband internet, Satellite</td>
</tr>
<tr>
<td><strong>Bandwidth</strong></td>
<td>Small</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td><strong>SCADA Server location</strong></td>
<td>On-site</td>
<td>On-site (more complex on SW &amp; HW)</td>
<td>Off-site with optional embedded solutions on-site</td>
</tr>
<tr>
<td><strong>Third party access to online data</strong></td>
<td>Very difficult</td>
<td>Possible</td>
<td>As standard</td>
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Flexible platforms enabled through increased bandwidth high speed connections

Multiple project single point access as well as increased data viewing possibilities
Wind Turbine & Plant Controls
Smart Controls with Data Repository

- Advancing turbine controller technology
- Developing Power Plant control applications
- High capacity data storage on controllers
  - Statistical counters
  - Ave, Min, Max, Std Deviation capture
  - Multi-channel detailed data for alarm and user action cycles
- Windows based protocols applied to PLC functions enables ease and flexibility of data transfer
- Linked controllers for enhanced control and data availability
Wind Power Plant Controls
Increasing Levels of Sophistication

- Active Power Regulation
  - Start / Stop / Curtailment for full range control
  - Bandwidth around set point or max value set point with offset
  - Ramp rate capabilities
- Reactive / Voltage / Frequency regulation
  - Based in principal on turbine functions
  - Cooperative controls with substation capabilities for extended demands
- Dynamic responses of network varies with wind, shutdowns, user demand
- PID Loops can be tuned to specific needs
- Turbine and System models used to study and plan for effects including transient
Monitoring Center
Increasing Operational Efficiency

Turbine & Power Plant Real Time Monitoring

Environmental Coordination

Alarm Review & Response
Data and Reporting
Driving Reliability Through Analysis

Reporting features include:

- Access to all raw turbine processed data
- Transparent warranty availability reporting
- Enterprise reporting capabilities
- User defined reports
  - Powerful statistical reports
  - Power curve analysis
  - Selected levels of condition monitoring
  - Correlation with condition measurements, corrective maintenance, preventative maintenance records
  - Ability to incorporate add-on auxiliary systems to collect and process additional details