Session 4: How to follow up on demonstration projects?

EMS Development and Commercialization

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KOREA ELECTROTECHNOLOGY RESEARCH INSTITUTE
Project Overview

• Project: Development of EMS Generation Applications in the Control Center
  • Phase I: EMS R&D for Power System Operation
  • Phase II: EMS Commercialization for Real Power System Operation

• Project Period:
  • Phase I: November 2005 ~ October 2010 [60months]
  • Phase II: April 2012 ~ December 2014 [33months]

• Project Budget:
  • 7.2 Million USD (Phase I)
  • 1.8 Million USD (Phase II)

• Man-Years:
  • Phase I: 8 Researchers (20.5 MY)
  • Phase II: 6 Researchers (13.3 MY)
Project Background

- Project was launched to find the future growth engine in the area of electric power industry.
- Innovation Approach was needed to share the human resources and co-work for EMS development among KERI, LSIS and KEPCO KDN.
  - KERI : Research Institute has enough power system engineers and expertise
  - LSIS and KEPCO KDN : Business entities do not have power system technology, but they are good at software engineering and ICT systems.
- Test-bed was implemented to interface large-scale real power system to test the development output.
Greatest Engineering Achievements of the 20th century

1. Electrification
2. Automobile
3. Airplane
4. Water Supply and Distribution
5. Electronics
6. Radio and Television
7. Agricultural Mechanization
8. Computers
9. Telephone
10. Air Conditioning and Refrigeration
11. Highways
12. Spacecraft
13. Internet
14. Imaging
15. Household Appliances
16. Health Technologies
17. Petroleum and Petrochemical Technologies
18. Laser and Fiber Optics
19. Nuclear Technologies
20. High-performance Materials

Electric Power Supply Chain

Conversion from Resources to Electric Energy

Power System Operation using EMS

Economic and secure real-time power balancing between supply and demand is very important for high quality of electricity
Korean Power System Status

90,000 MW Generations
(400 Units dispatched by EMS in real-time(2~4 sec))

High Voltage Transmission over 154kV in 2019 (900 substations)
What is EMS?

- EMS capabilities have evolved over the past five decades (since the 1965 blackout)
- EMS manage the flow of electricity in the grid.
  - Operate the electric grid within safe limits
  - Operate the system reliably – “Prevent Blackouts”
  - *Keep the Lights On!!*
  - Automatically adjust generation to follow Instantaneous customer load changes (Remember, Electricity Cannot be Stored.....)
  - Identify potential risks and take preventive action
  - Expedite restoration of customers after an emergency
Major EMS Functions

- Provides system operators with real-time information for reliable and economic power grid operation
- Achieves objectives by providing decision support and control means for generation and transmission systems
- Monitors power system states through real-time data acquisition
- Balances generation and load by real-time generation control (LFC & ED/SCED)
- Performs network analysis for normal and contingency case operation to maintain secure power system

KRX EMS installed since 2014
EMS Development (Phase I)

1st year [12 months]
- Baseline EMS (30 months)
- Development (24 months)
  - Site test (6 months)

2nd year [24 months]
- Prototype EMS (44 months)
  - Development (40 months)
  - Site test (4 months)

3rd year [36 months]
- Development (54 months)
- Site test (6 months)

4th year [48 months]
- Full-scale EMS (60 months)
  - Advanced SCADA
  - Optimal Power Flow
  - SCED
  - Voltage Control
  - NA Functions
  - Simulator Development

5th year [60 months]
- Dispatch Schedule
- Security Enhancement
- Unit Commitment
- Market Interface
- Advanced NA Functions
- Simulator site test
- Final Site test (6 months)

Development (Phase I)
- Site test (6 months)
- Site test (4 months)
- Site test (6 months)
 EMS Site Test for Real-time Generation Applications (2010)

<table>
<thead>
<tr>
<th>1st step</th>
<th>2nd step</th>
<th>3rd step</th>
<th>4th step</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/3 of gen. units switching (Hydro+Pumped, 79 units)</td>
<td>2/3 of gen. units switching (1st step +Combined, 142 units)</td>
<td>2/3 of gen. units switching (1st step +Combined, 142 units)</td>
<td>Total units switching (Total gen. units, 211 units)</td>
</tr>
<tr>
<td>A part of units are tested for monitoring</td>
<td>A part of units are tested for monitoring</td>
<td>Frequency regulation is tested</td>
<td>Economic Dispatch &amp; AGC functions are tested</td>
</tr>
</tbody>
</table>
EMS Development (Phase II)

- 2011.11 Project Launched (2012.4 KERI Joined)
- 2013.10 FAT (Factory Acceptance Test) Completed
- 2014.8 SAT (Site Acceptance Test) Completed
- 2014.9 5 time Real Power System Test Completed
- 2014.9 France RTE Consulting Completed
- 2014.10 1,500hour (62.5 days) 99.9% Availability Test (AVT) Completed
- 2014.10 KPX Naju Main Control Center Operation Started
  (Switching from Existing NEMS to Developed EMS)
- 2014.11 KPX Cheonan Backup Control Center Operation Started,
  Seoul Control Center Operation Started
EMS Development (Phase II)

• Future EMS at 3 sites (Naju, Cheonan, Seoul)

- Seoul Control Center
  - EMS for Monitoring Power System

- Backup Control Center (Cheonan)
  - Full-scale EMS for Backup Control Center

- Main Control Center (Naju)
  - Full-scale EMS for Main Control Center

• Conventional EMS is developed for power system operation
• Advanced EMS functions are being developed to deal with future grid change (HVDC, FACTS, EV, Renewables)
### EMS Gen. Application Site Test (2014) – Phase II

- **Real power system tests**

<table>
<thead>
<tr>
<th>Step</th>
<th>Date</th>
<th>Period (hour)</th>
<th>Test purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st step</td>
<td>5.27 15:00 ∼ 5.27 15:30</td>
<td>0.5</td>
<td>Data acquisition and Generator control</td>
</tr>
<tr>
<td></td>
<td>5.28 15:00 ∼ 5.28 15:30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.29 15:00 ∼ 5.29 15:30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.30 14:00 ∼ 5.30 16:00</td>
<td>2</td>
<td>Frequency regulation</td>
</tr>
<tr>
<td>2nd step</td>
<td>6.10 09:30 ∼ 6.10 10:00</td>
<td>0.5</td>
<td>Data Acquisition and Generator control</td>
</tr>
<tr>
<td></td>
<td>6.11 12:00 ∼ 6.11 12:30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.11 17:00 ∼ 6.11 17:30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.12 12:00 ∼ 6.12 14:00</td>
<td>2</td>
<td>Frequency regulation</td>
</tr>
<tr>
<td>3rd step</td>
<td>6.24 14:00 ∼ 6.26 02:00</td>
<td>36</td>
<td>EMS control</td>
</tr>
<tr>
<td>4th step</td>
<td>8.29 10:00 ∼ 9.03 20:00</td>
<td>106</td>
<td>EMS data acquisition and control reliability</td>
</tr>
<tr>
<td>Final test</td>
<td>9.12 10:00 ∼ 9.19 10:00</td>
<td>168</td>
<td>EMS reliability</td>
</tr>
</tbody>
</table>

- EMS switching on Oct. 6 2014, 15:00

![Table and chart showing test purposes and dates]
Future Growth for Electric Power Industry

- To change the paradigm from the hardware-oriented electric power R&D to the software-oriented R&D
- To expand the portfolio in the business area of electric power industry and enable the system business
- To open possibility to contribute to the growth of Korean economy
- To contribute to the advanced operation of national power grid and enable the applicability of new technology and the acceptance of new facility