

EMS Development and Commercialization

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Lee, Jeong Ho (leejh@keri.re.kr)

Smart Power Grid Research Center



**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 :
 - 7.2Million USD (Phase I)
 - 1.8Million USD (Phase II)
- Man-Years :
 - Phase I : 8 Researchers (20.5 MY)
 - Phase II : 6 Researchers (13.3 MY)

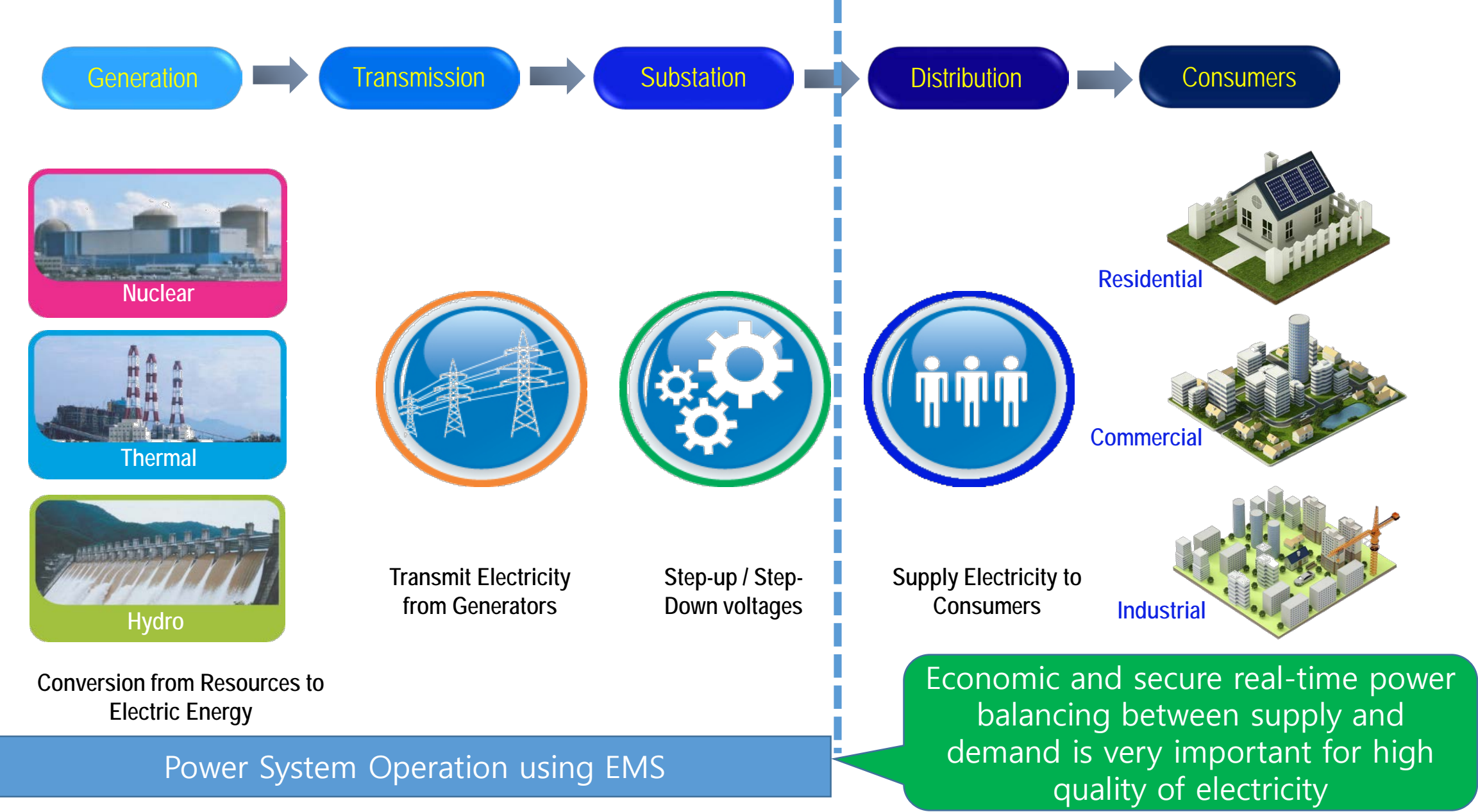
Project Background

- 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

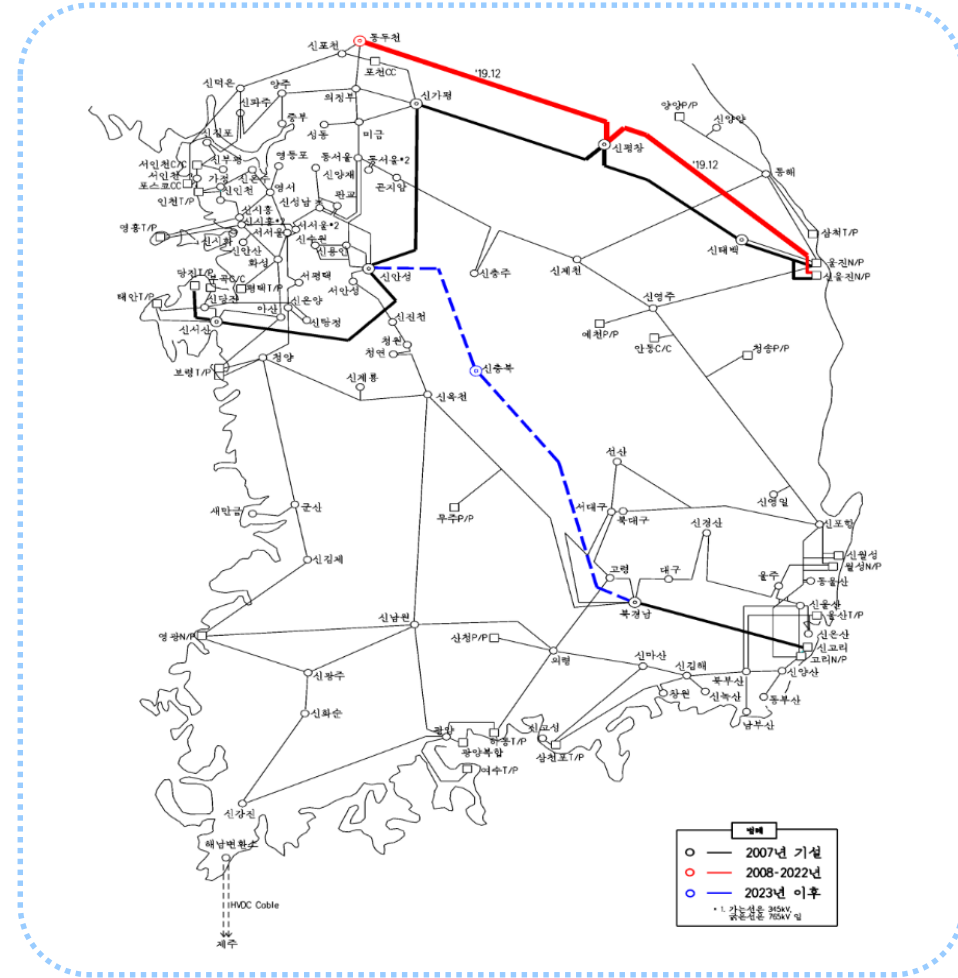
Electric Power Supply Chain



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

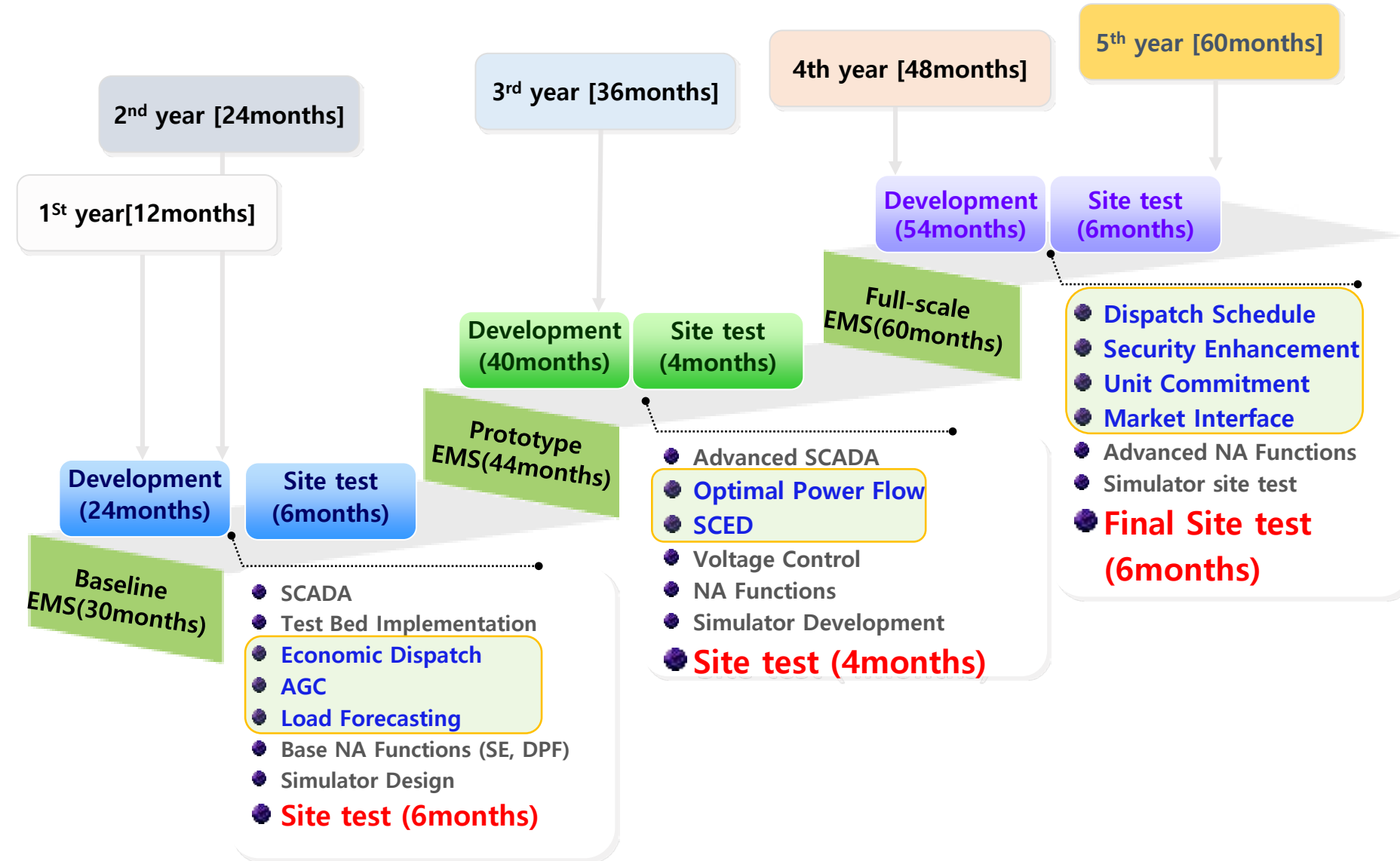
Major EMS Functions



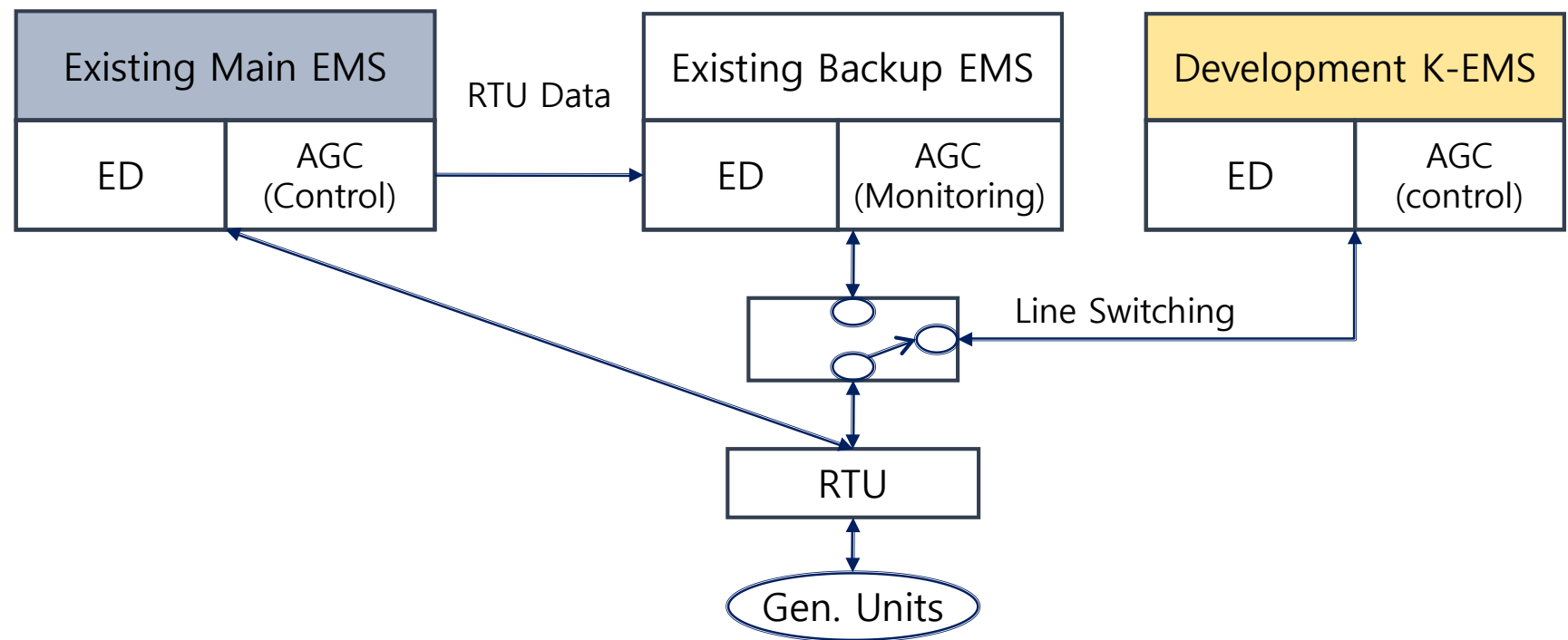
KPX EMS installed since 2014

- 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

EMS Development (Phase I)



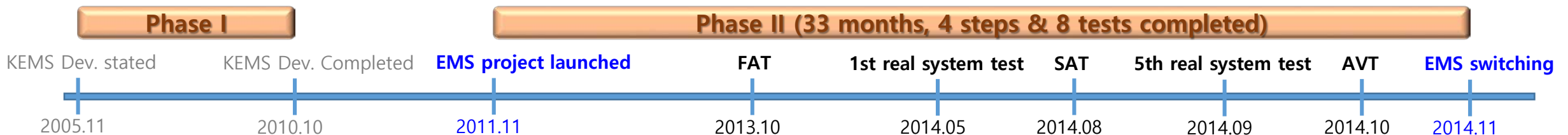
EMS Site Test for Real-time Generation Applications (2010)



1 st step	2 nd step	3 rd step	4 th step
1/3 of gen. units switching (Hydro+Pumped , 79 units)	2/3 of gen. units switching (1 st step +Combined, 142 units)	2/3 of gen. units switching (1 st step +Combined, 142 units)	Total units switching (Total gen. units, 211units)
A part of units are tested for monitoring	A part of units are tested for monitoring	Frequency regulation is tested	Economic Dispatch & AGC functions are tested

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(62.5days) 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



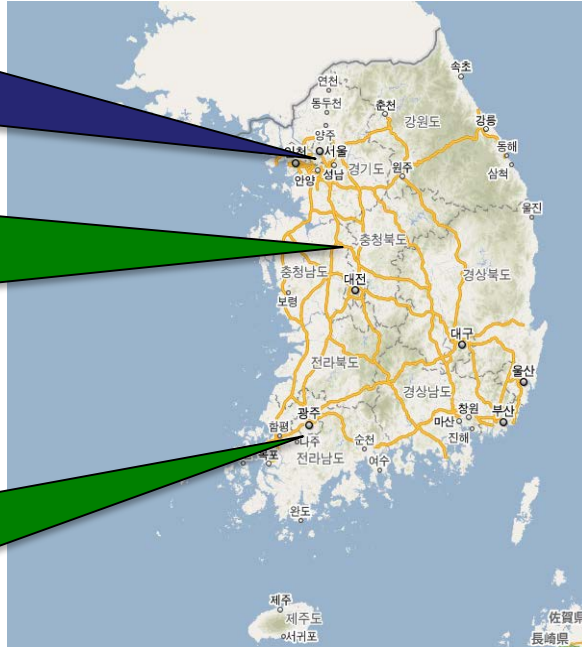
EMS Development (Phase II)

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

Seoul Control Center-
EMS for Monitoring
Power System

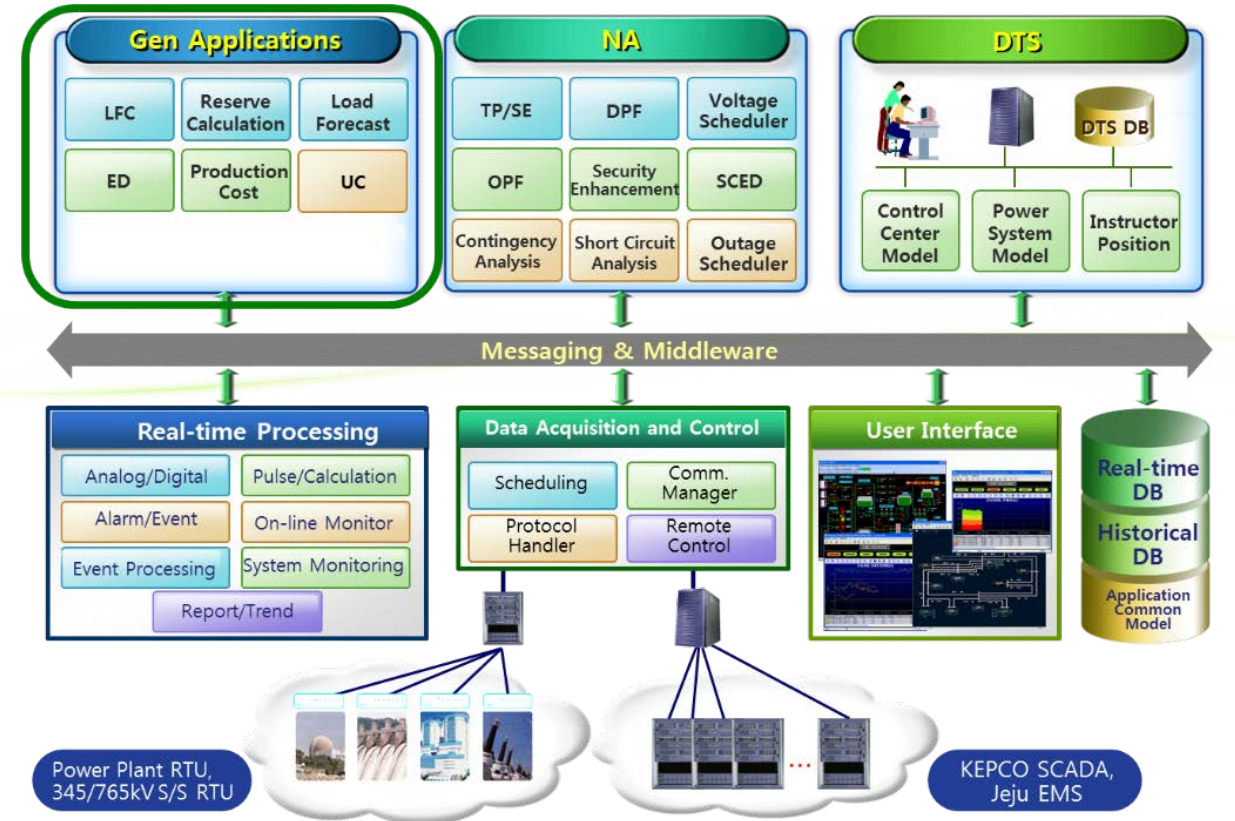
Backup Control Center
(Cheonan)
-Full-scale EMS for
Backup Control Center

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)

- Future EMS



LFC: Load Frequency Control
ED: Economic Dispatch
LF: Load Forecasting
SCED: Security Constrained Economic Dispatch
OPF: Optimal Power Flow
UC: Unit Commitment
SEN: Security Enhancement

NA: Network Analysis
SE: State Estimator
TP: Topology Processor
DPF: Dispatcher Power Flow
VS: Voltage Scheduler
OS: Outage Scheduler
CA: Contingency Analysis
SCA: Short Circuit Analysis

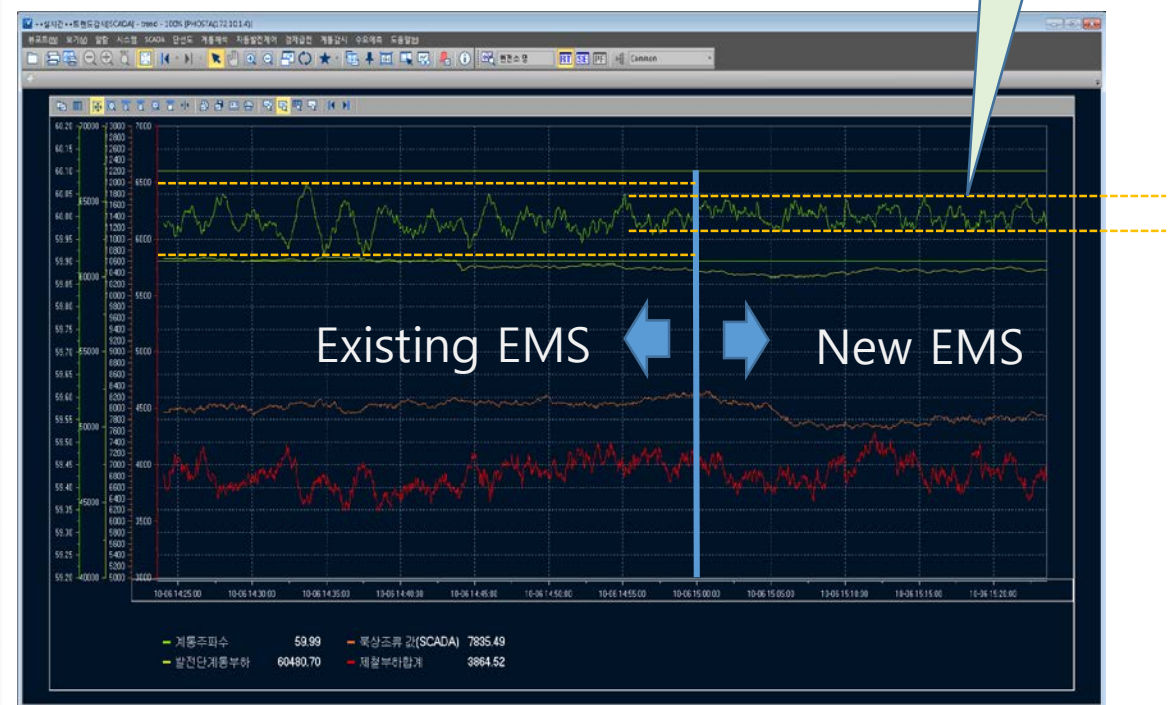
DTS: Dispatcher Training Simulator
DB: Database
SCADA: Supervisory Control and Data Acquisition

EMS Gen. Application Site Test (2014) – Phase II

- Real power system tests

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

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



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



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