



The Global Specialist in Power ICT, KEPCO-KDN

Introduction of Energy Management System

2017. 4.19





Contents

➔ I. KEPCO-KDN & Power Sector of Korea

➔ II. EMS in Korea

➔ III. EMS Features



I. KEPCO-KDN & Power Sector of Korea

- KDN & KEPCO Group
- The Business Coverage of KDN in Power Sector
- The Power Facilities of Korea
- The Power Grid of Korea



MINISTRY OF POWER & ENERGY



6 GENERATION COMPANIES

Nuclear & Hydro/Pumped Storage Plants



Thermal & Combined Cycle Plants



BUSINESS AREA OF KEPCO

Transmission

Distribution

Sales

KEPCO GROUP

SUBSIDIARIES

ICT Services for Energy



Engineering & Construction Service



Maintenance & repairs of Plants

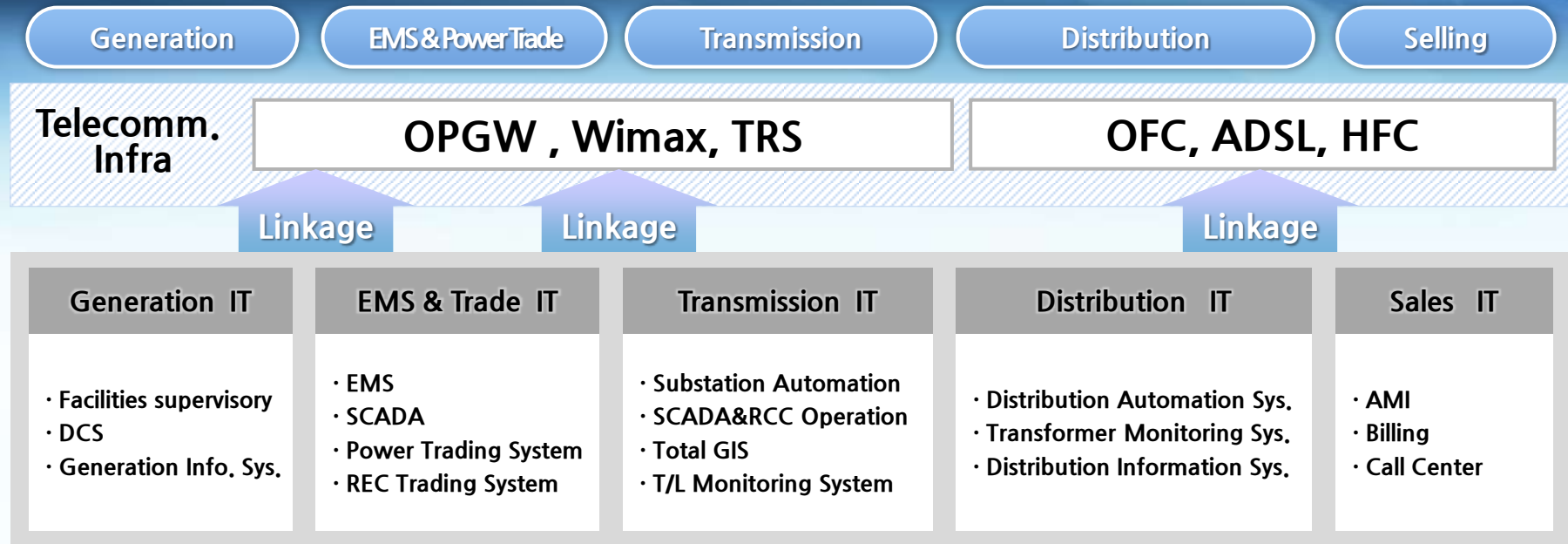


Nuclear Fuel Manufacturing

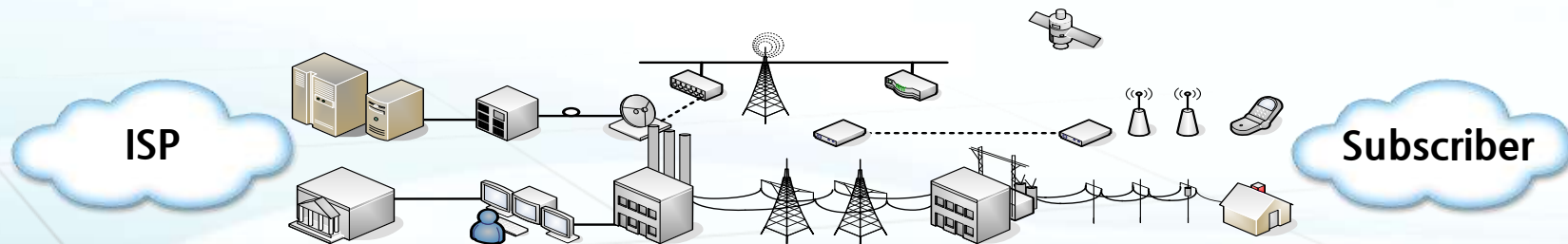




The Business Coverage of KDN in Power Sector

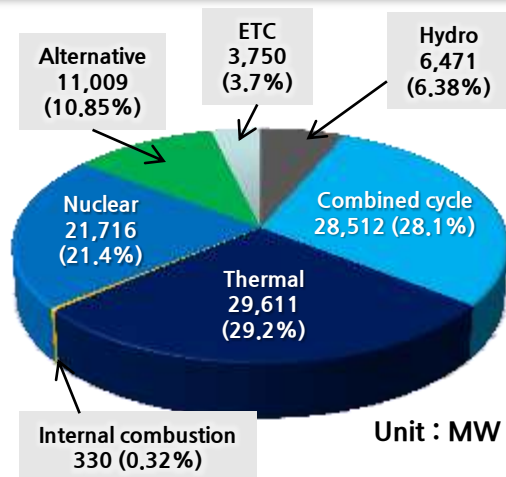


Telecommunication **+** Power Grid **=** **SMART GRID**



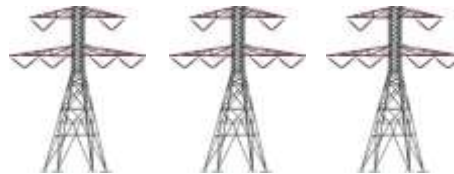
Telecommunication is essential element that realizes intelligent Power Grid
It is like a human neuro-system

Generation



- Total Capacity : 101.4GW (100%)
- 400 Generators (180 Plants)

Transmission

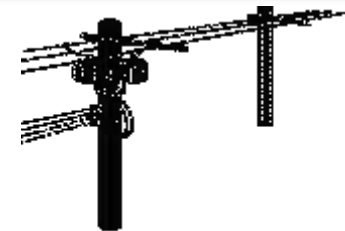


- 765 kV, 345 kV, 154 kV
- Length: 33,316 c-km



- 822 Substations
- Substation Capacity : 298,294 MVA

Distribution



- 22.9 kV, 380V, 220V
- Length : 465,278 c-km



- 22.0 million Customers

Power Sales

- Quantity of sales : 46.4 billion kWh/Month*
 - Amount of sales : 3.8 billion US\$/Month
- * As of January, 2017

Customers

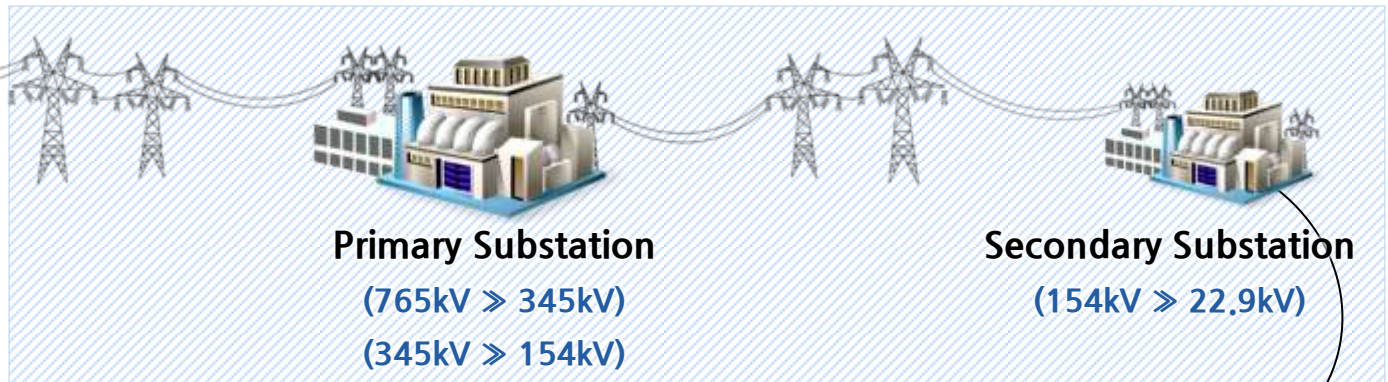


GENERATION

Nuclear, Thermal,
Hydro, Renewable



TRANSMISSION 3-Phase 4-wire, Star connection



CUSTOMERS

High-voltage
Customer

Low-voltage
Customer



22.9kV

380V

220V

Distribution line

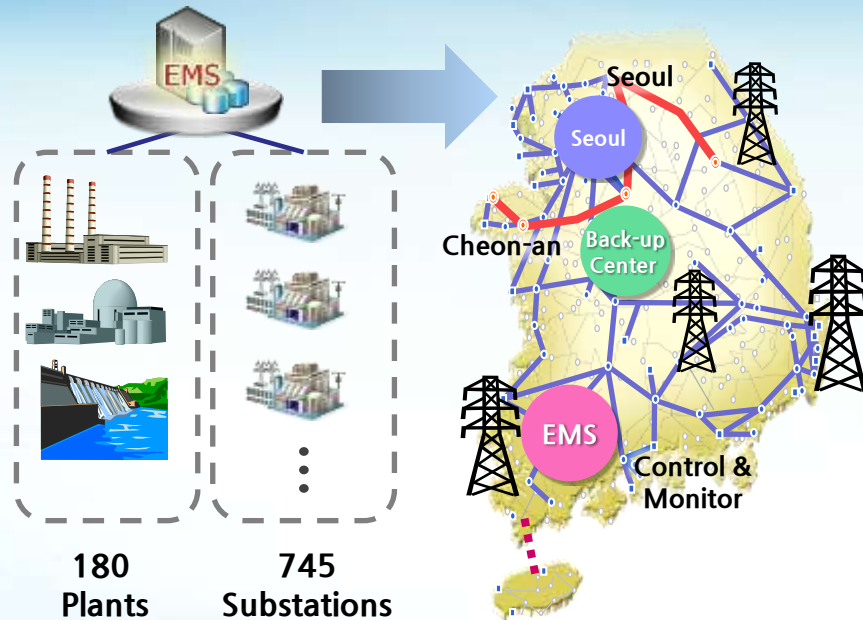
Line Switch &
Transformer

DISTRIBUTION 22.9kV

II . Energy Management System in Korea

- What is EMS
- History of EMS in Korea
- Background of EMS Development
- Main Control Center
- Location of Control Center

Configuration



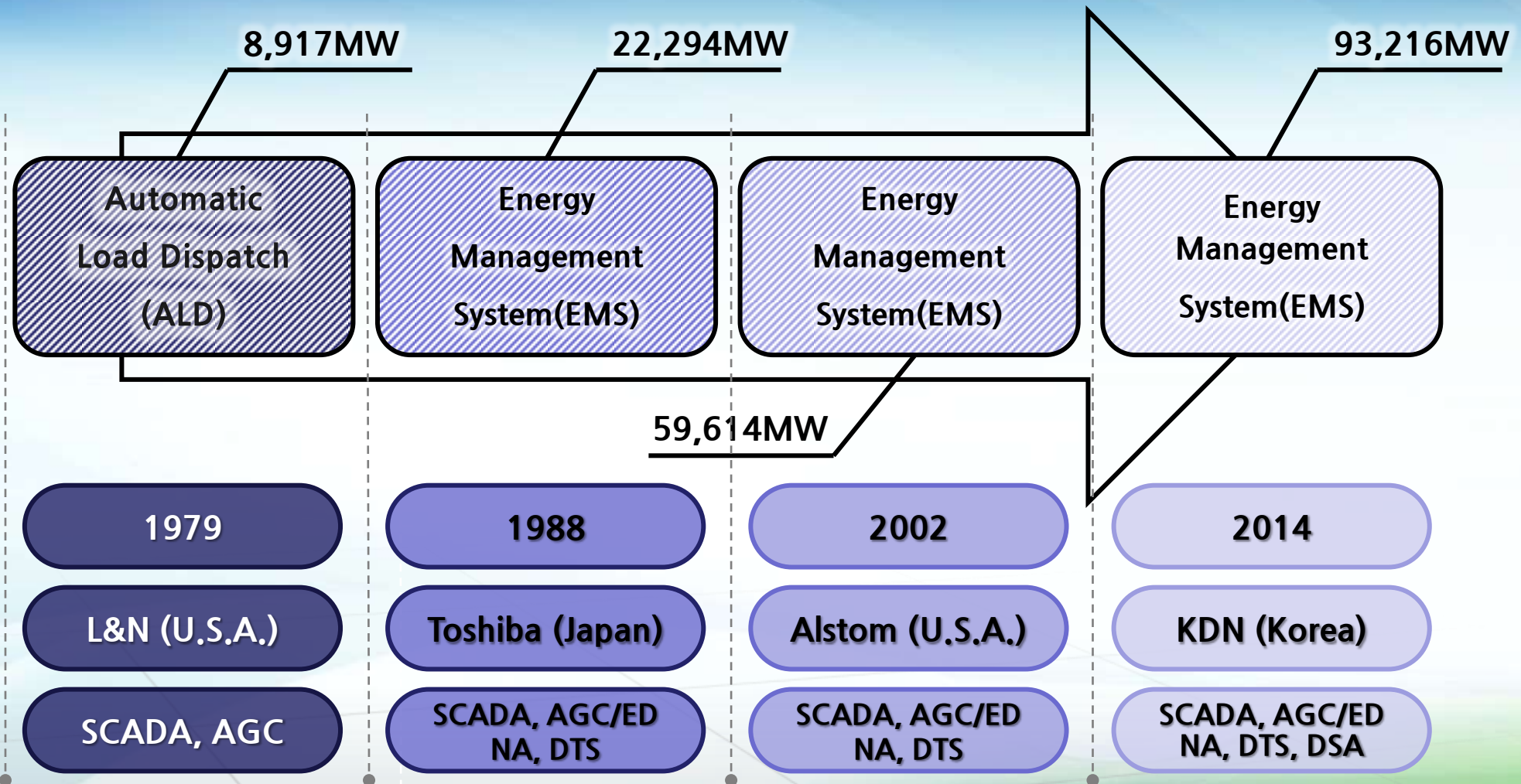
Features

- ❖ International Standard Protocol (DNP3.0, IEC 60870 etc.)
- ❖ High reliability and security on electric power grid
- ❖ Secure power flow on national and regional grids
- ❖ Enhanced operation efficiency
- ❖ Optimum utilization of transmission network



Experiences

- ❖ EMS R&D for application development (2005~2010)
- ❖ EMS Main Center Implementation in Naju, Korea
- ❖ EMS Back-up System Implementation in Cheon-an
- ❖ EMS implementation in Uiwang to monitor Seoul area





Over 30 years,

- ✓ Experiences on Large Power System Operation
- ✓ Operation and Maintenance Skills on EMS
- ✓ Support from advanced IT Technologies in Korea

**Construction & Operation of
Next Generation EMS**
(Nov. 2011 ~ Oct. 2014)

Development of EMS by Korean Technology

Period	Nov. 2005 ~ Oct. 2010 (5 years)
Company	KEPCO-KDN



Main Control Center

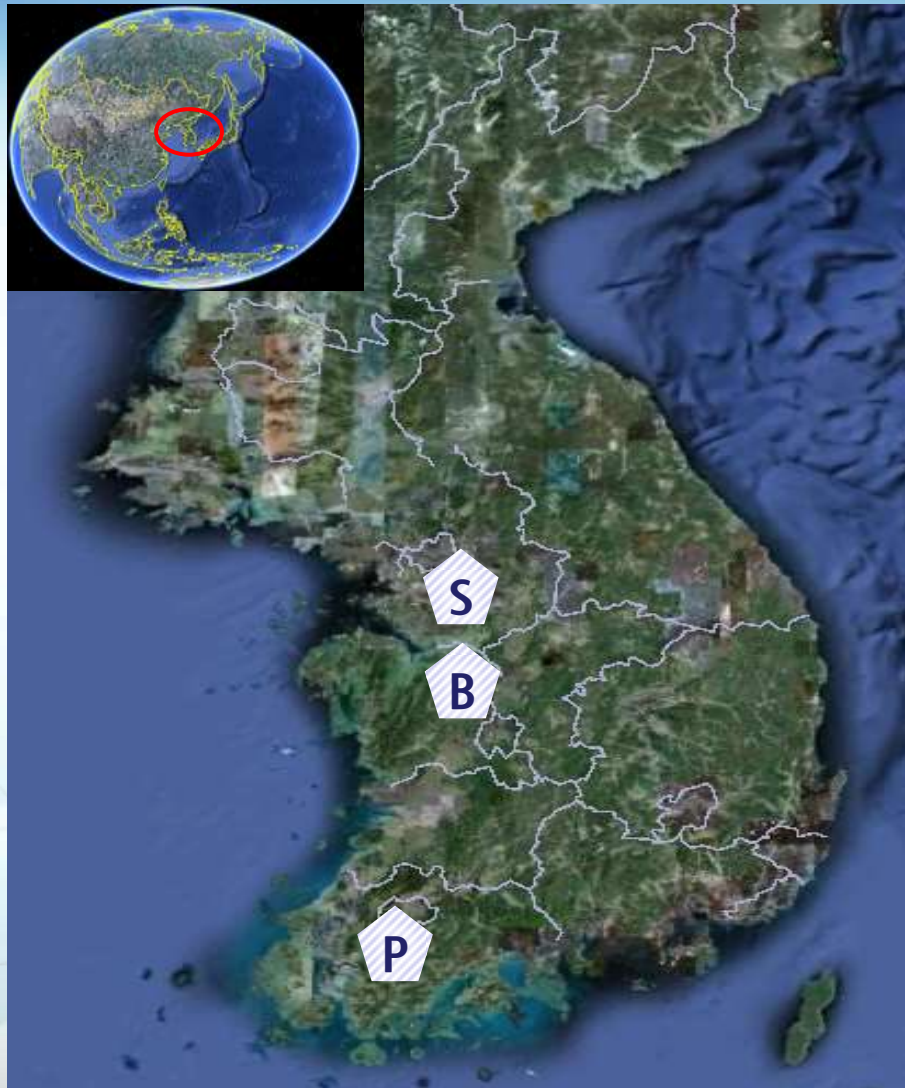
❖ **KEPCO-KDN developed EMS is in operation from October 18, 2014**

- Nationwide credible Power System Operation is guaranteed
- Frequency is maintained at $60\text{Hz} \pm 0.2\text{Hz}$ by AGC





Location of Control Centers



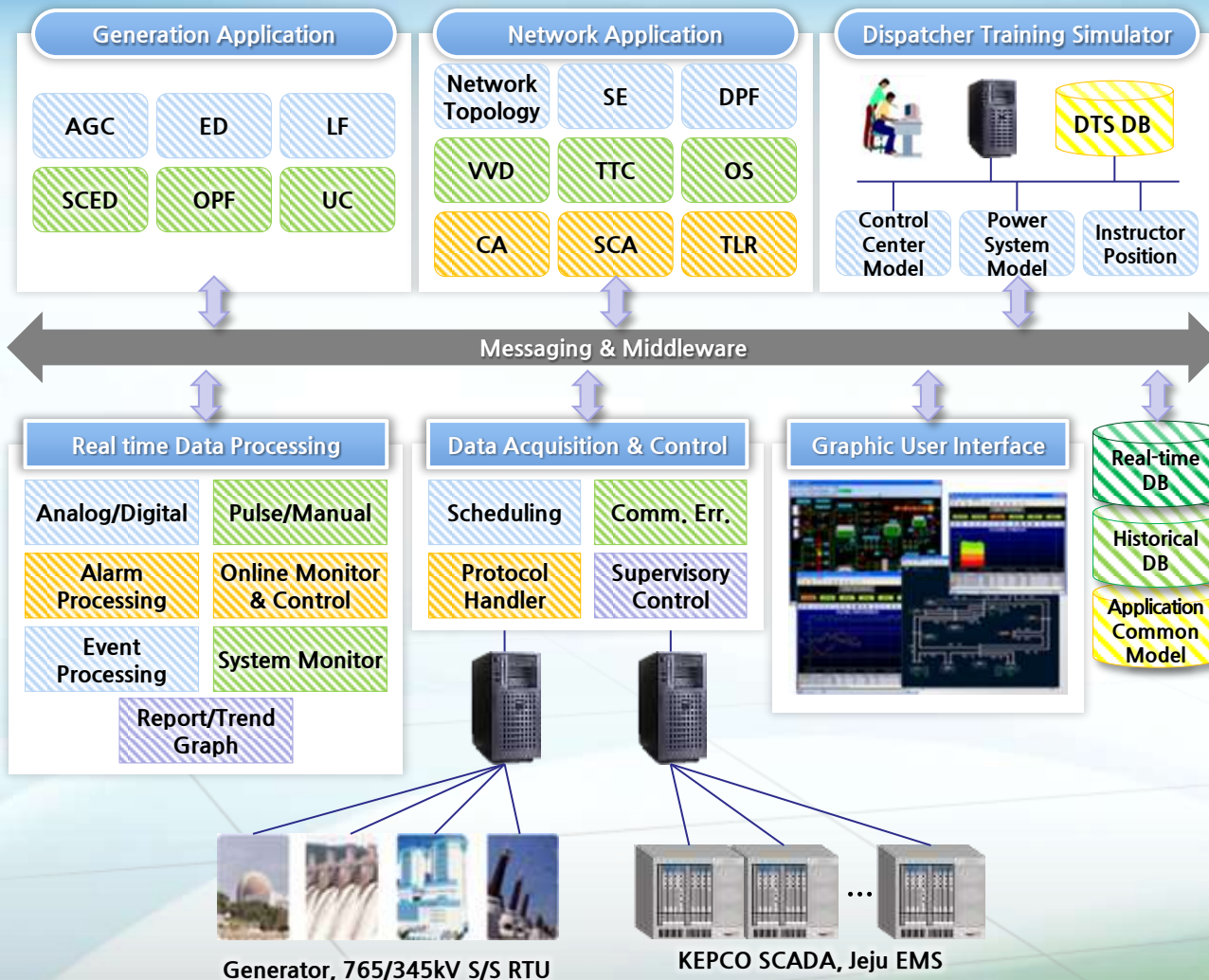
- **Primary Control Center : Naju**
- **Backup Control Center : Cheonan**
- **Seoul Control Center : Uiwang**
- 290 RTUs with DNP
- 13 RCC Data Links with ICCP
- 6,000 Buses
- 45,000 Analog points
- 72,500 Status points

III . EMS Features

- Functions of EMS
- EMS Software Architecture
- SCADA (Supervisory Control and Data Acquisition)
- AGC/ED (Automatic Generation Control / Economic Dispatch)
- NA (Network Analysis)
- DTS (Dispatcher Training Simulator)
- Benefits with KDN



Functions of EMS



Major functions

- SCADA
- Generation Applications
- Network Analysis Applications
- Dispatcher Training Simulator

Database Modeling Tool

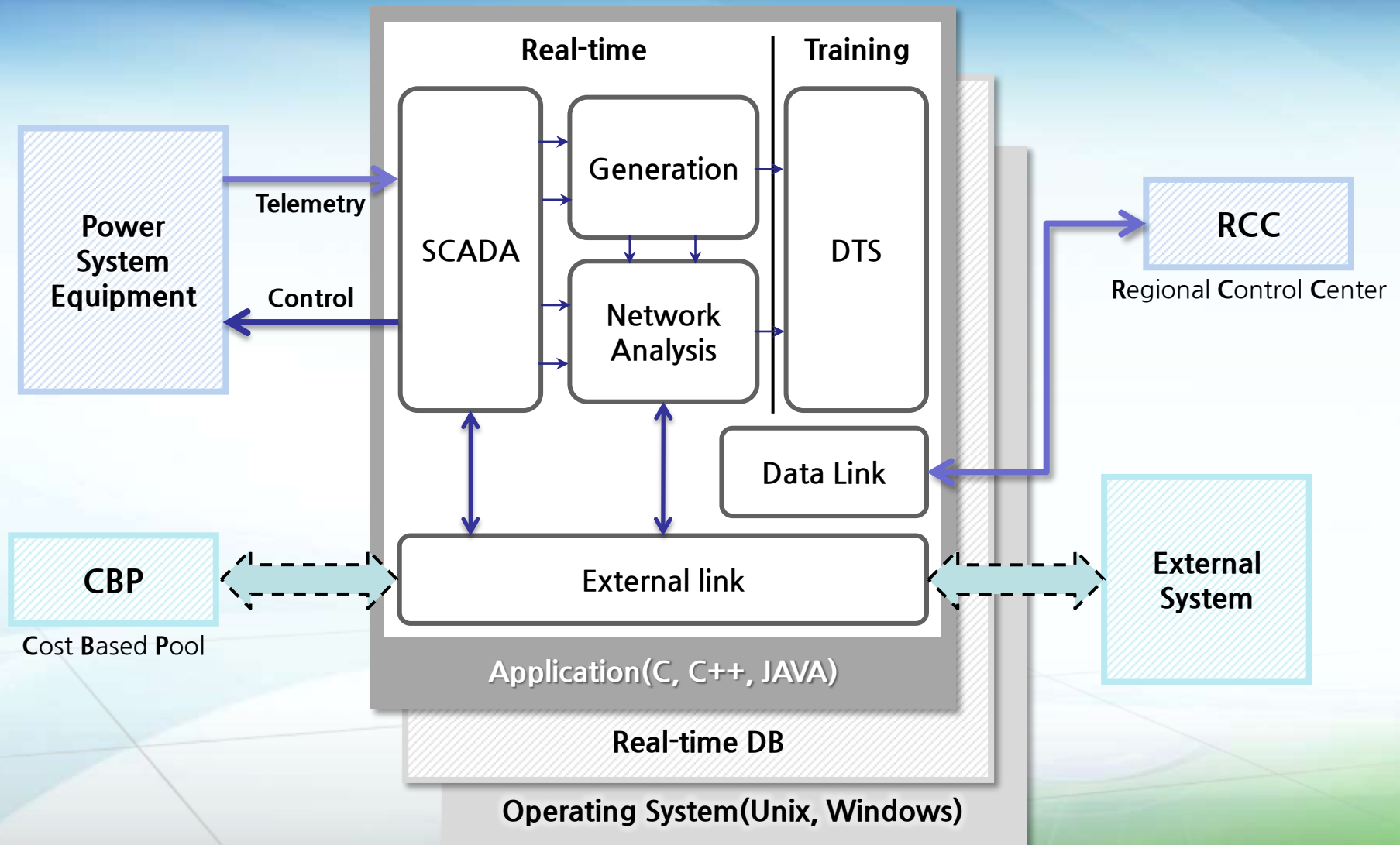
Web-based User Interface

Renewable Energy Control

Dynamic Stability Assessment

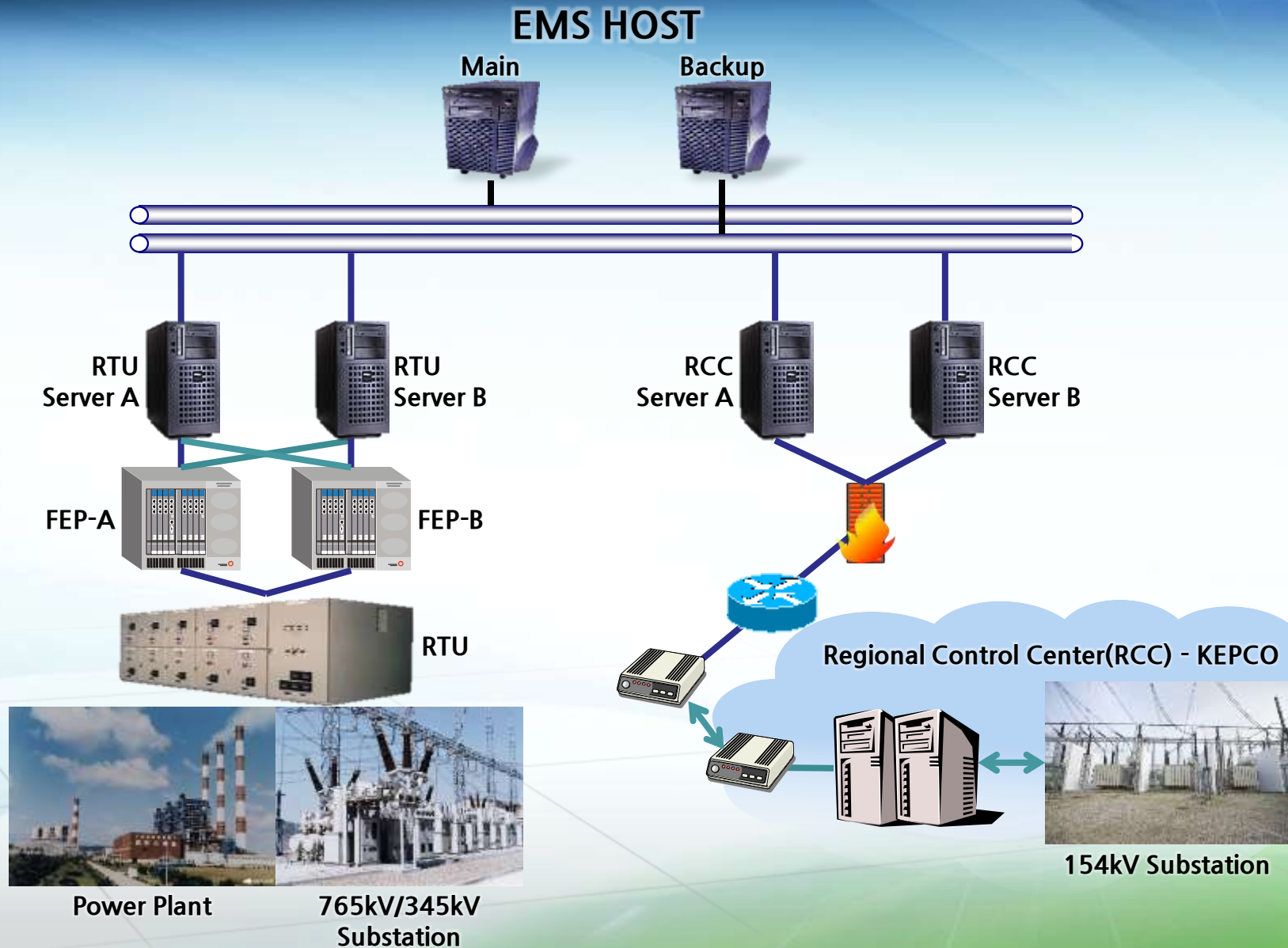


EMS Software Architecture





SCADA Configuration



❖ Data acquisition scale

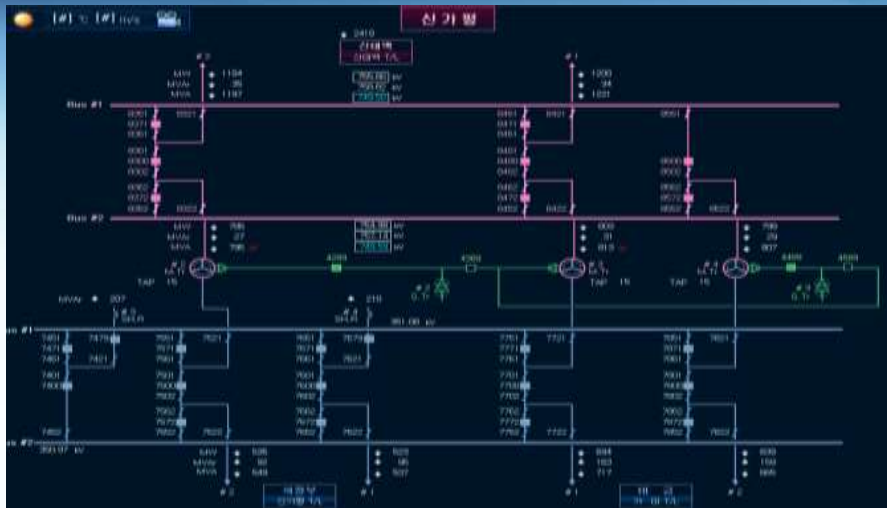
As of Mar 20, 2017

Location	Power Plant	Substation			Total
		765kV	345kV	154kV	
Number	108	5	73	667	853
Scan rate	2 sec	2 sec	2 sec	4 sec	

Data In/Out	Input (points)		Output (points)	Total
	Analog	Status		
From RTU (Direct scan)	7,597	14,878	177	22,652
From RCC (Data exchange)	13,941	24,146	-	38,087
Total	21,538	39,024	177	60,739

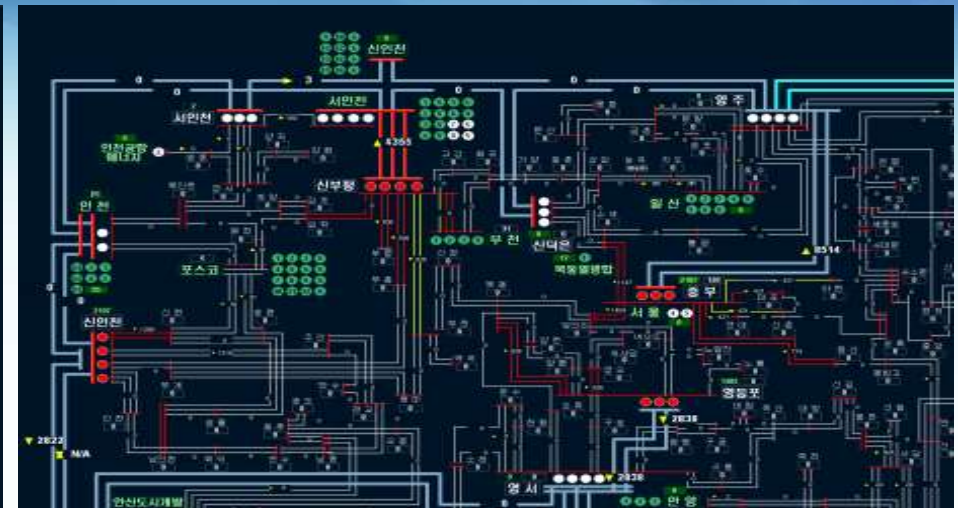


SCADA Single-line diagram



Substation diagram

- Layered by voltage level for each substation
- Displays value and direction of flow, bus voltage, circuit breaker status, etc.
- Changes color for limit violated analog values and displays alarm
- Pop-up control display to change analog or digital point, transformer tap, etc.
- Link to adjacent substation display

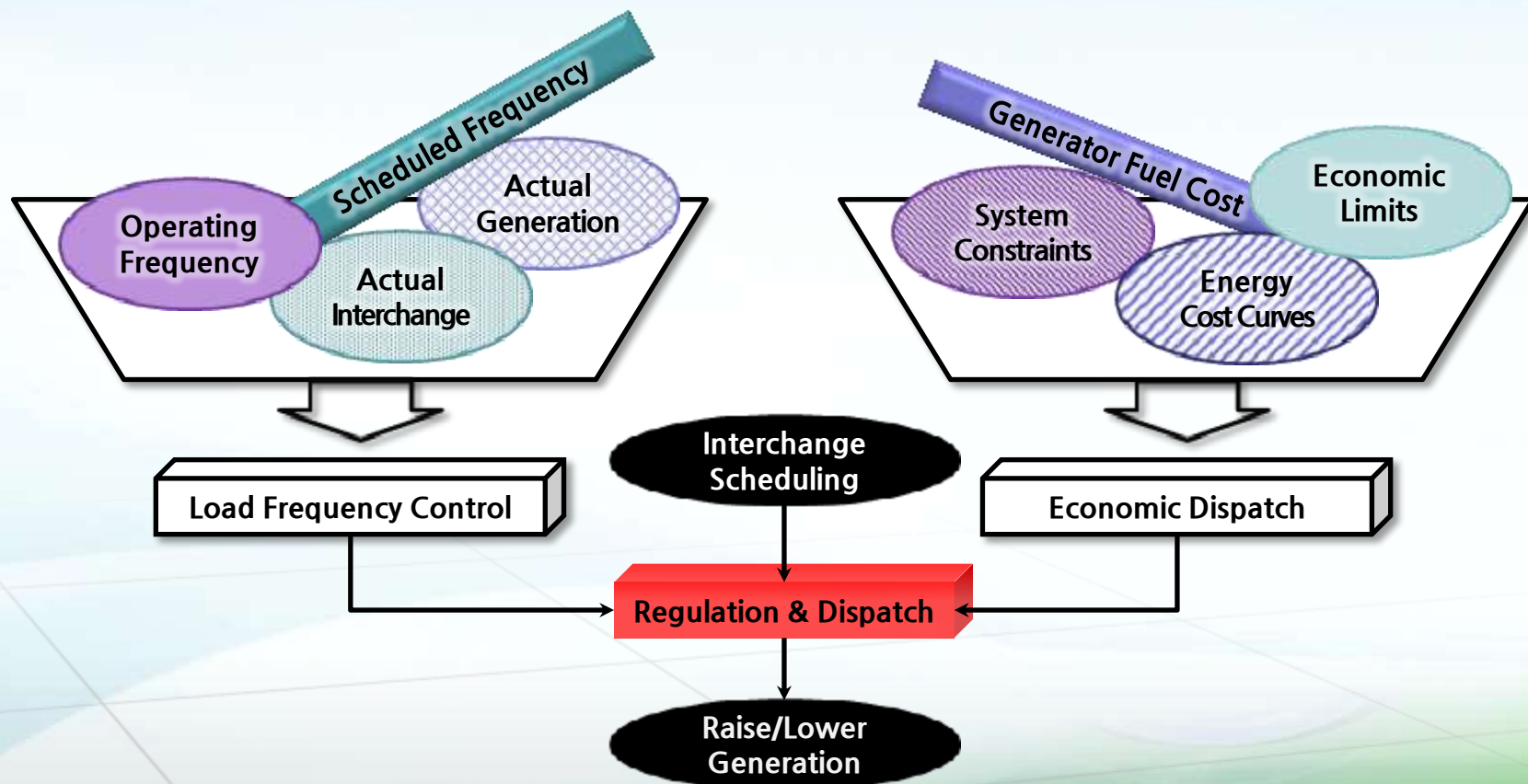


Power System Overview diagram

- Full diagram of Power System Network
- Different color for each voltage level
- Displays value and direction of flow, bus status and line status
- Decluttering by zoom level
- Link to adjacent substation display

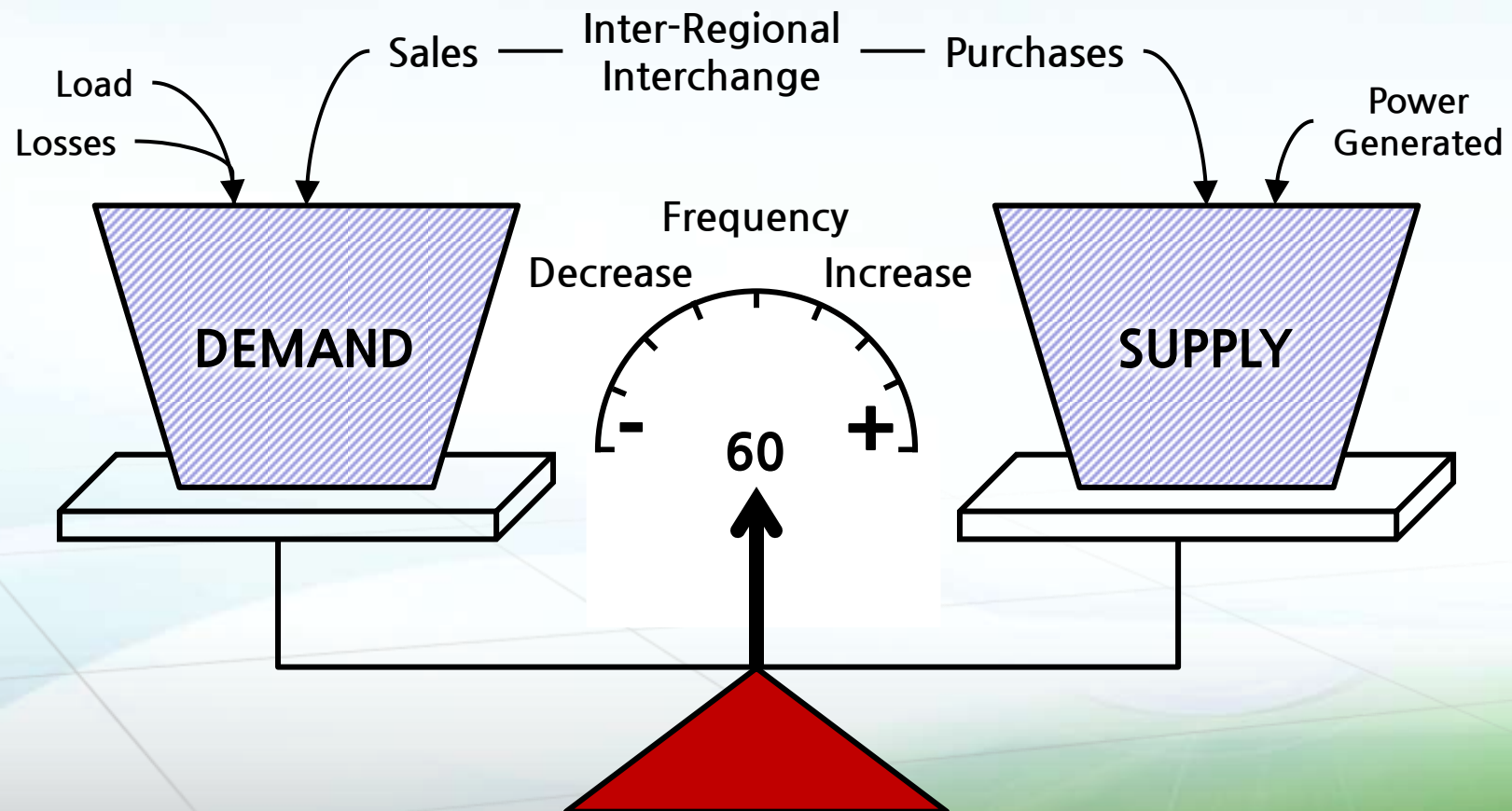
❖ AGC controls generators to maintain the frequency at 60Hz

Economic Dispatch calculates targeted output of all generators based on fuel cost (i.e. ascending order from cheap to expensive)



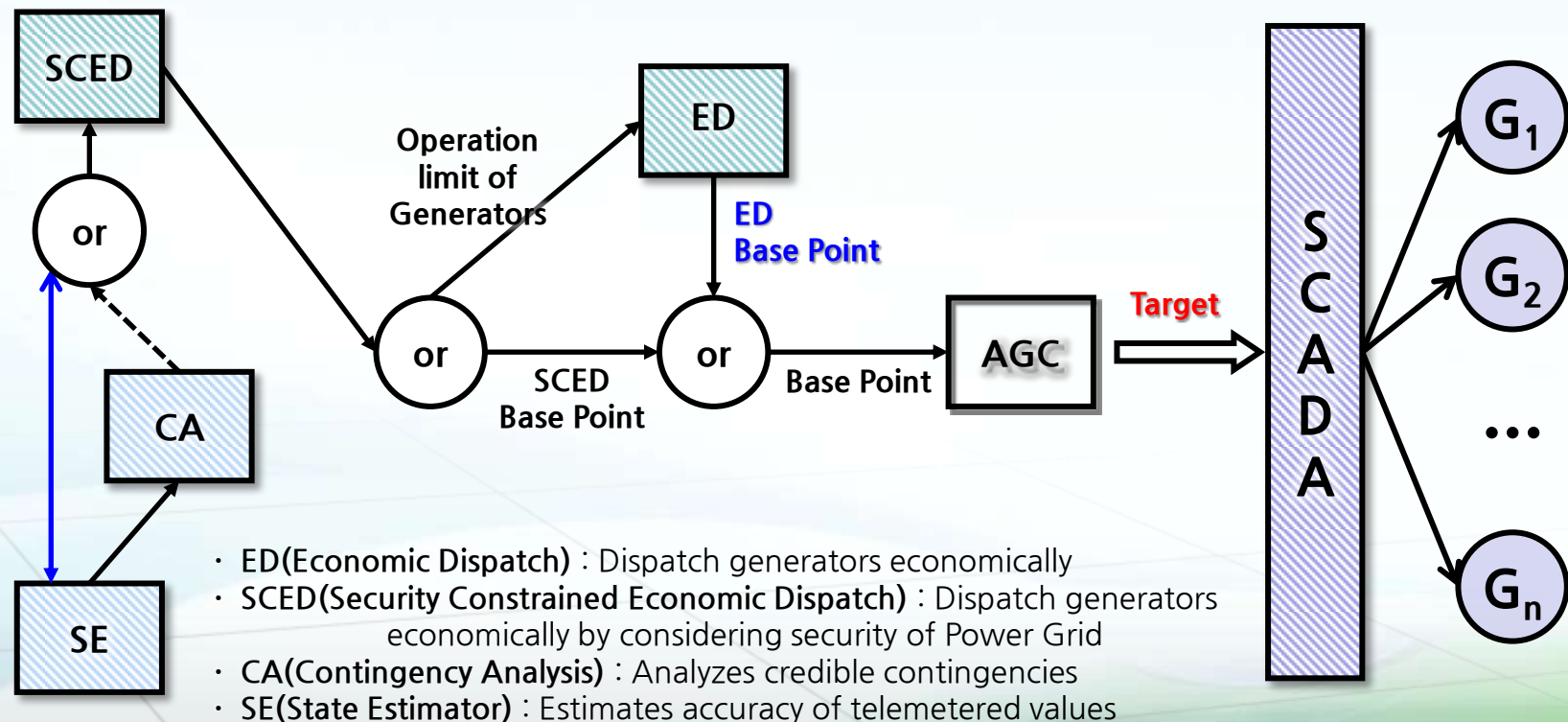
❖ **Power demand and supply should be equal at any moment in time**

- Frequency decreases if generation is smaller than the demand
- AGC controls generators to increase their output and keep the balance



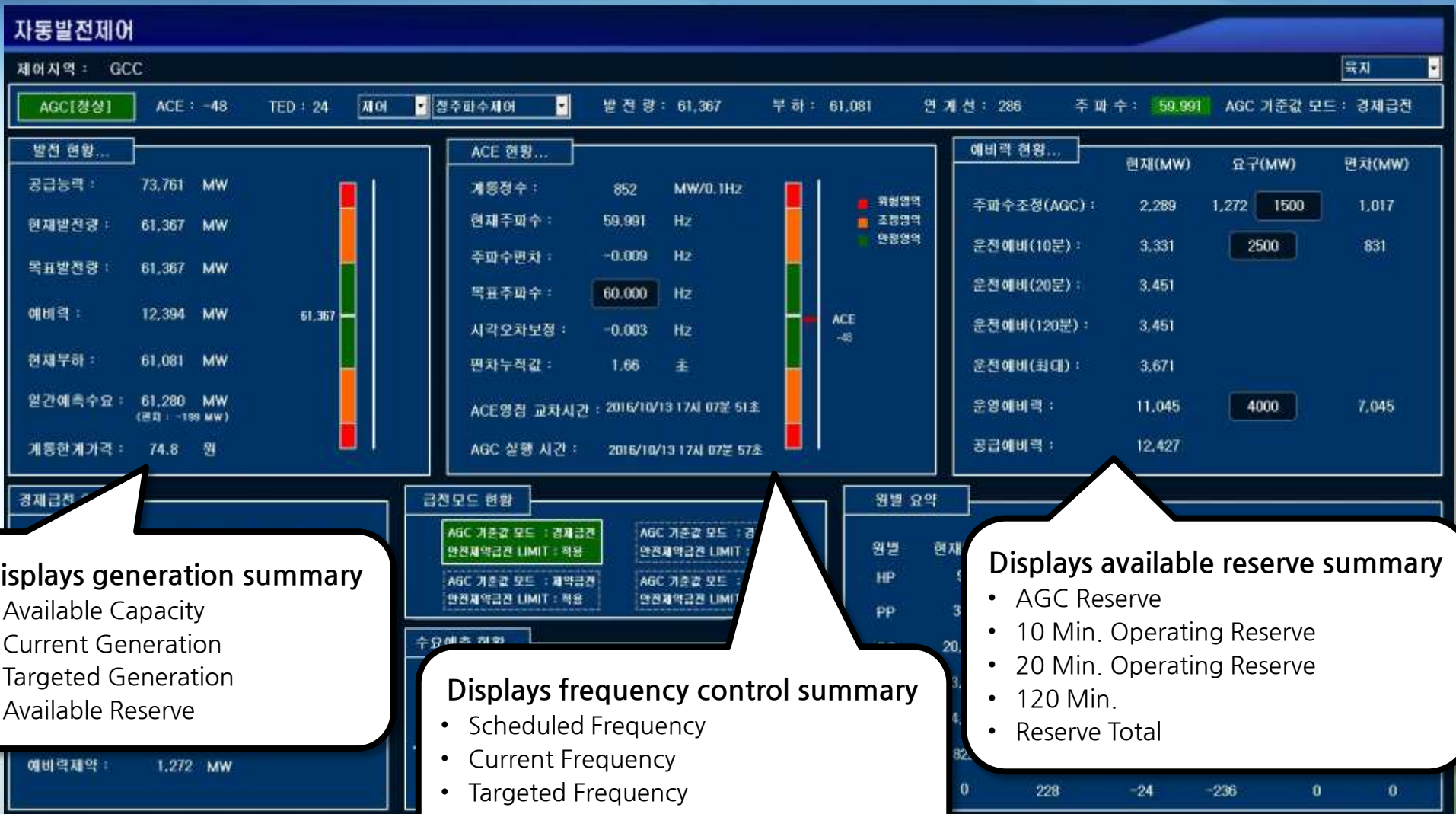
❖ AGC signals to control generators are sent every 4 sec. interval

- Targeted AGC set-point is calculated based on current output and ED
- Economic base point is decided by ED within operating limit





AGC/ED Sample display



Displays generation summary

- Available Capacity
- Current Generation
- Targeted Generation
- Available Reserve

Displays frequency control summary

- Scheduled Frequency
- Current Frequency
- Targeted Frequency
- Frequency Deviation

Displays available reserve summary

- AGC Reserve
- 10 Min. Operating Reserve
- 20 Min. Operating Reserve
- 120 Min.
- Reserve Total

- ❖ Information on Generator output and Governor Free status is displayed
 - Generators are grouped by fuel type and sorted by unit

발전기 출력현황 (송전단)

발전단

AGC

송발전단

조속기
온전상태

계통주파수 | 59.982Hz

공급능력 | 80,170MW

계통부하 | 61,050 MW

공급에비력 | 19,120MW

운영에비력 | 14,762MW

운영에비율 | 24.2 %

고리	1	576	2	495	군산	0	울진	C1	500	울진	4	357	대청	0
	2	644	3	493	분당	0		C2	763		5	353	섬진강	0
	3	1,013	4	495		0	오성	551			6	353	소양강	0
	4	1,007	5	0	C2	200	포천	782			8	326	안동	0
합계		3,240	6	509	보령	0		C2	793		1	330	용담	0
			7	516		0					2	327	의암	17
신고리	1	1,003	8	2,994	C3	455	포스코	C3	-7		3	327	임하	0
	2	990		519	부산	184		C4	0		4	327	주암	58
합계		1,992	1	520		19		C5	472	노원열병합		19	춘천	0
			2	0	C2	192		C6	470	논현열병합		0	충주	0
별성	1	666	3	491	C3	407		C7	408	대전열병합		-2	필당	10
	2	0	4	494	C4	316		C8	401	대구열병합		10	함천	32
	3	613		2,551	세종열병합	254		C9	397	대전서남부		0	화천	0
	4	627	1	743	서인천	0	광교열병합		49	대산북한		0		
합계		1,907	2	749	B2	0	대구그린	399		북동열병합		0		
			3	0	B2	0	별내에너지	0		수원열병합		-2		
신월성	1	998	4	838	C1	199	송도열병합	0		오산열병합		0		
	2	1,007		833	C2	200	수원에너지	0		경주열병합		21		
합계		2,005	5	827	C3	390				제주		391		
			6	3,993		0	안산북한	741						
한빛	1	987	1	498	영월	0	안산도시	0		양수계	-1		신재생계	1,213
	2	979	2	491	안동	0	양주열병합	543					연료전지	126
	3	991	3	0	울산	0	인천공항	0		무주	1	0	소각장	50
	4	0	4	485	C1	87	파주열병합	479			2	0	부생가스	864
	5	971	5	486	C2	0	관교열병합	139		산청	1	0	바이오	66
	6	969	6	421	C3	0	화성열병합	478			2	0	태안IGCC	0
합계		4,899	7	500	C4	828	동두천	C1	880	삼랑진	1	0		
			8	0	C2	-13		C2	800		2	0		
안울	1	963	9	494		0	아산열병합	0		양양	1	0	지연에너지	109
	2	967	10	492	서울	4	하남열병합	0			2	0	태양광	48
	3	989		493		5	신오산열병합	0			3	0	풍력	19
	4	994		495	광양	C1	545				4	0	소수력	42
	5	1,000		491	C2	533					5	0	조력	0
	6	0		486	GS당진	C1	433				6	0	기타계	573
합계		4,913		487										
				3,438										
유연탄계		20,153		0										
				0										
당진	1	493		495										
	2	496		491										
	3	410		486										
	4	408		487										
	5	400		0										
	6	0		0										
	7	0		0										
	8	0		0										
	9	0		0										
	10	0		0										
	11	0		0										
	12	0		0										
	13	0		0										
	14	0		0										
	15	0		0										
	16	0		0										
	17	0		0										
	18	0		0										
	19	0		0										
	20	0		0										
	21	0		0										
	22	0		0										
	23	0		0										
	24	0		0										
	25	0		0										
	26	0		0										
	27	0		0										
	28	0		0										
	29	0		0										
	30	0		0										
	31	0		0										
	32	0		0										
	33	0		0										
	34	0		0										
	35	0		0										
	36	0		0										
	37	0		0										
	38	0		0										
	39	0		0										
	40	0		0										
	41	0		0										
	42	0		0										
	43	0		0										
	44	0		0										
	45	0		0										
	46	0		0										
	47	0		0										
	48	0		0										
	49	0		0										
	50	0		0										
	51	0		0										
	52	0		0										
	53	0		0										
	54	0		0										
	55	0		0										
	56	0		0										
	57	0		0										
	58	0		0										
	59	0		0										
	60	0		0										
	61	0		0										
	62	0		0										
	63	0		0										
	64	0		0										
	65	0		0										
	66	0		0										
	67	0		0										
	68	0		0										
	69	0		0										
	70	0		0										
	71	0		0										
	72	0		0										
	73	0		0										
	74	0		0										
	75	0		0										
	76	0		0										
	77	0		0										
	78	0		0										
	79	0		0										
	80	0		0										
	81	0		0										
	82	0		0										
	83	0		0										
	84	0		0										
	85	0		0										
	86	0		0										
	87	0		0										
	88	0		0										
	89	0		0										
	90	0		0										
	91	0		0										
	92	0		0										
	93	0		0										
	94	0		0										
	95	0		0										
	96	0		0										
	97	0		0										
	98	0		0										
	99	0		0										
	100	0		0										

- And they should run in a pre-defined sequence of application

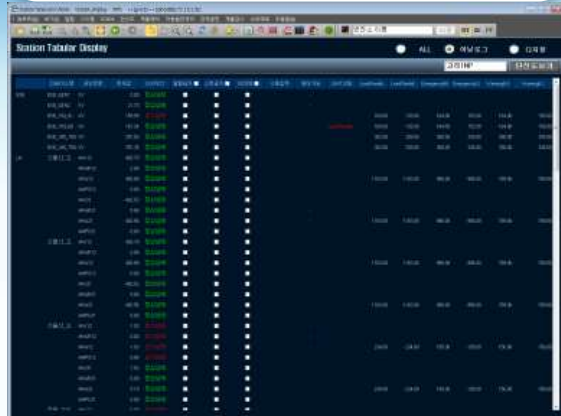


❖ First, TP and next SE should be executed orderly to check correctness of the electrical network

- After that other applications can be executed by using the SE data



Station Tabular Display



Major Transmission Flow



Bus Voltage in Substation



Displayed Information

- Displays details on Network Operation
- Generator outputs, information on transmission group flow in metropolitan area are displayed

Display Details

- Power System operating status is displayed on head
- Detailed analog and digital information of generation/substation are displayed
- Information on bus voltage of each substation are displayed in detail
- Information on major transmission group is displayed
 - Displays North-Bounded branch flow
 - Visualize value and direction of branch flow

❖ Branch MW/Mvar flow and Bus voltage information is displayed for each logical buses

- Users can compare tele-metered values and SE estimated values



송전선로

정상

→

451.4 MW

450.2 MW

-12.5 MVar

-9.3 MVar

신안성_신가평

→

신안성PO

모선

5100

0

Goto

변압기

정상

→

MTR2_P

284.9 MW

273.8 MW

87.1 MVar

112.1 MVar

신가평PO

모선

4577

Goto

변압기

정상

→

MTR3_P

285.3 MW

274.6 MW

87.2 MVar

111.8 MVar

신가평PO

모선

4576

Goto

변압기

정상

→

MTR4_P

283.3 MW

277.7 MW

86.5 MVar

105.5 MVar

신가평PO

모선

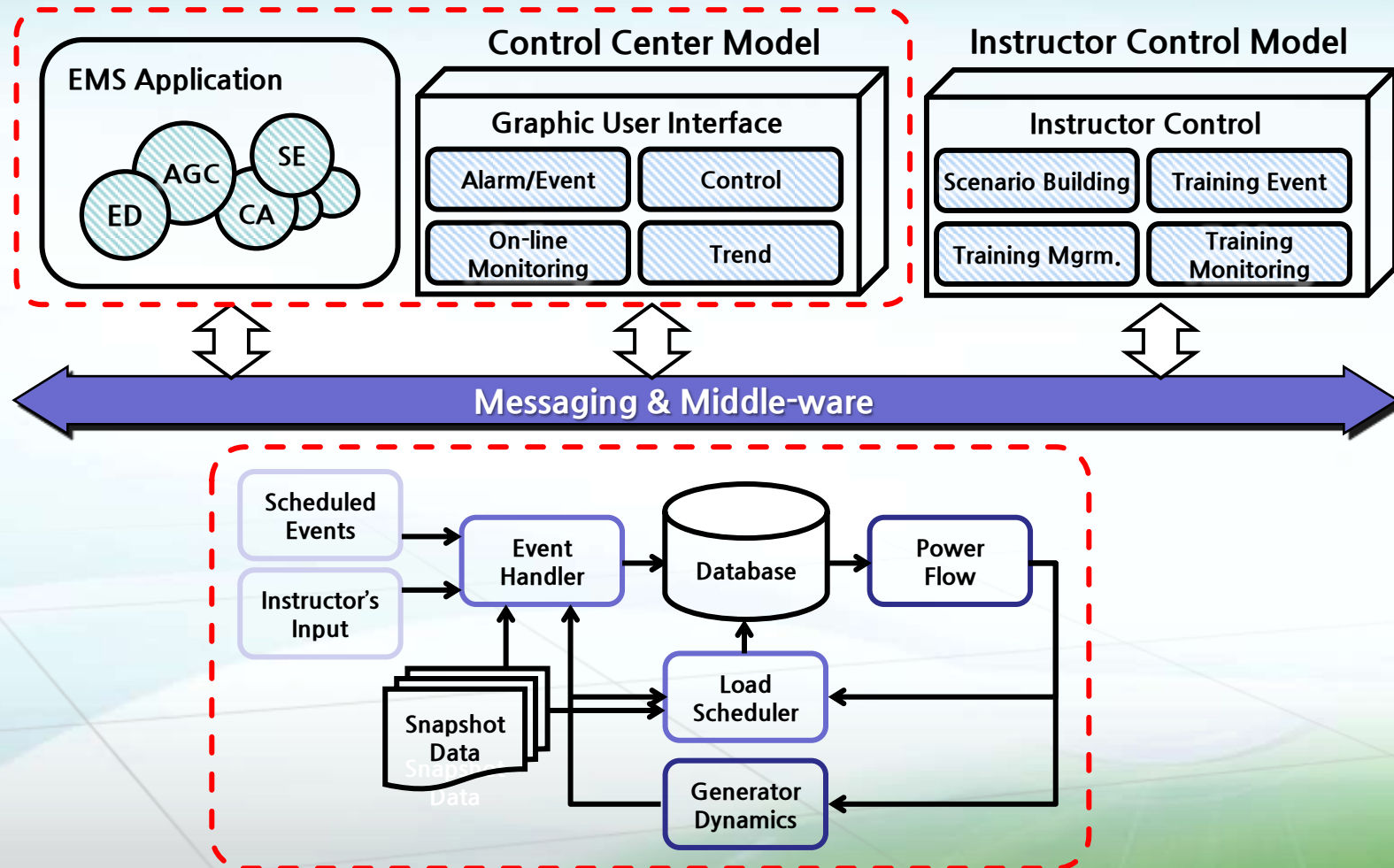
4576

Goto



DTS (Dispatcher Training Simulator)

- ❖ **SCADA, Generation and NA Applications are integrated to simulate operation**
 - Provide training function for Normal operation, Contingency case, Fault, Power System Restoration, etc.





Make your people happy
by reliable power supply

Save your cost
by economic operation of generators

Improve national competitiveness

- Contribute to improvement of national competitiveness
- Provide better service for the people



Your True Partner
KEPCO KDN

THANK YOU

