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Key ICT Solutions for Realizing Smart Grid

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1. Introduction

1-1. Expectations and Challenges of Smart Grid

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Challenges for large scale deployment of smart grid technologies

Smart Grid → **Next Gen. Energy Management System**

More renewable energy installation and optimized energy production and consumption.

A lot of field trial and pilot projects…

Various Smart Grid applications are proposed

Advanced T & D Network

Renewable Energy Expansion

Energy Corroborative control

Two-Way Communication

BEMS, FEMS, HEMS etc.

Smart Traffic

Most of them are based on effective information utilization

On the other hand, there are little information about such information related fundamental solutions considered actual large scale deployment.

Key Practical and Fundamental Solutions for Information Utilization

1-2. Roles of ICT for Smart Grid

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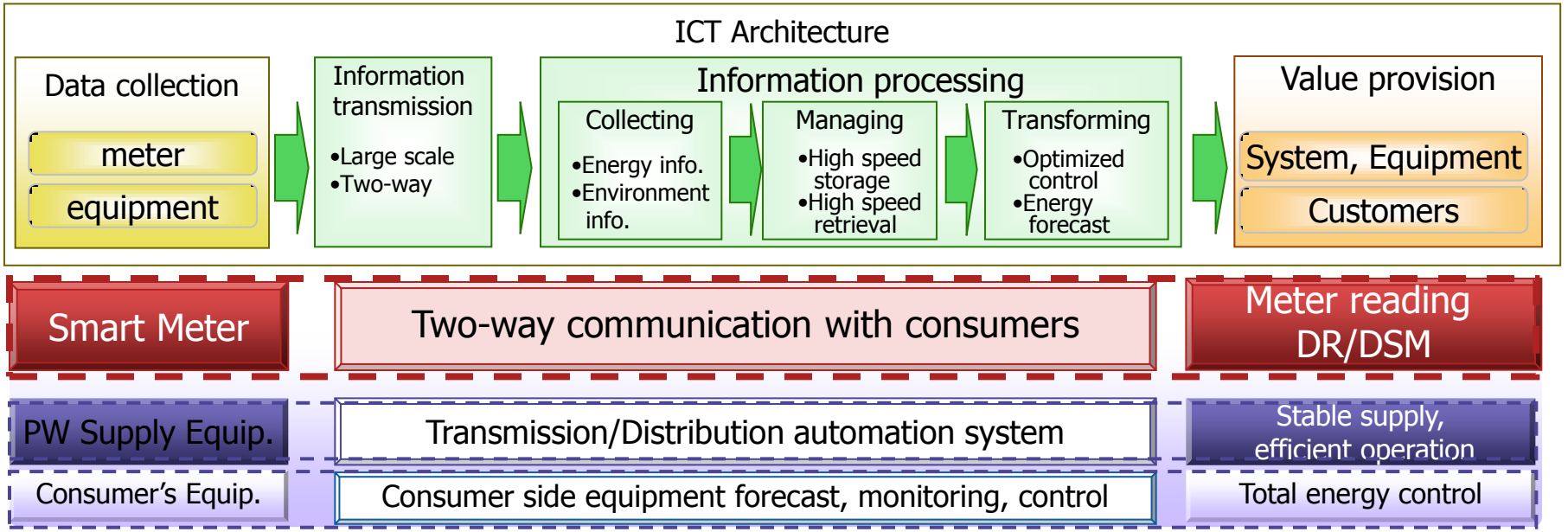
Smart Grid will be realized by solving challenges in each ICT element



Source: Fujitsu's Approach to Realization of Energy Management System

Access network (last mile network) connecting utilities and their customers and/or electricity supply /consumption equipment

AMI Solution

Fully S & D information utilized energy management system contributing to optimized energy production and consumption.

EMS Solution

AMI and EMS are Two Major Keys to Realize Smart Grid

1-3. ICT based Smart Grid Solutions Concept

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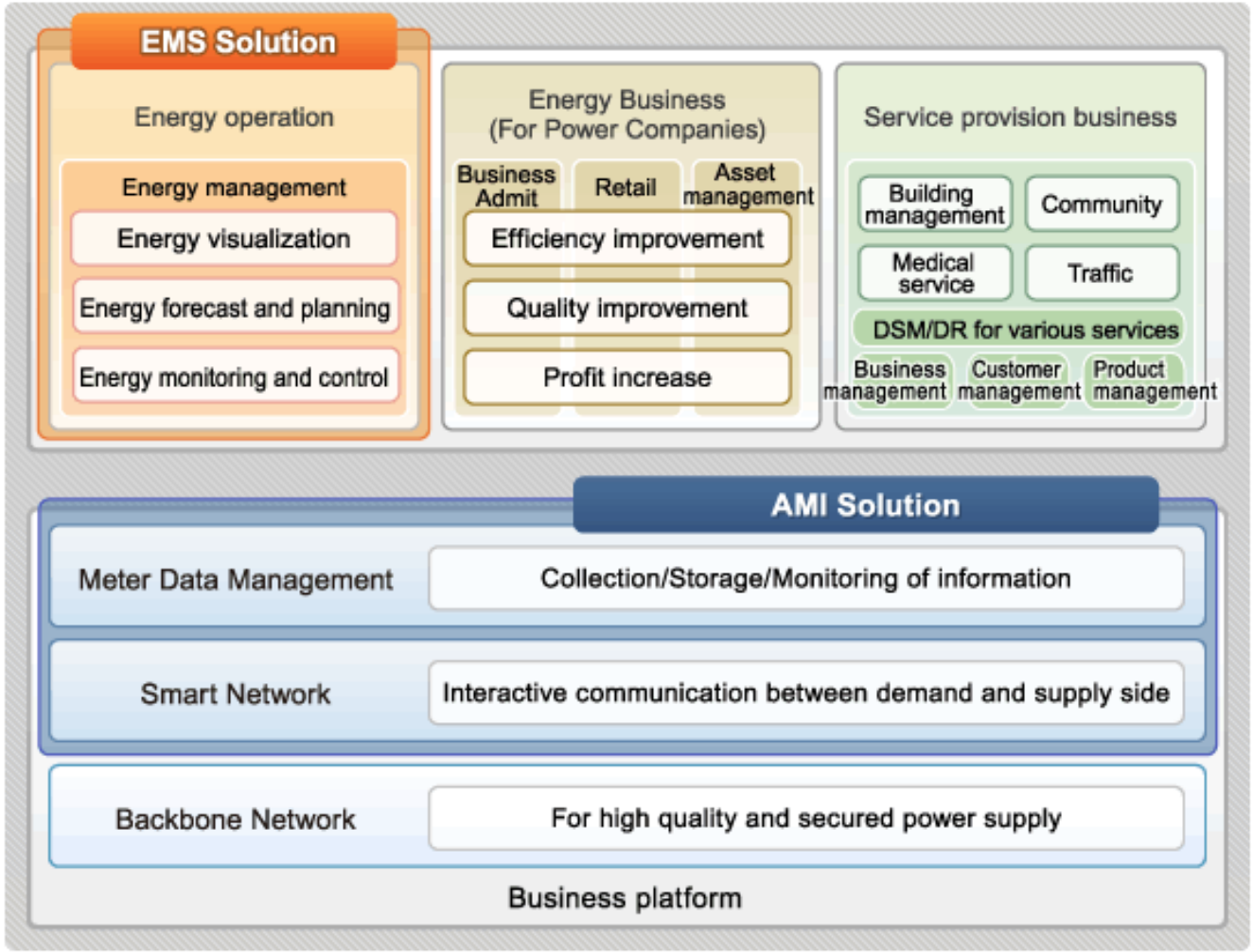
ICT gathers and process huge data rapidly and create new values



Fujitsu, Smart Grid Solution, http://www.fujitsu.com/smartgrid/

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2. AMI Solution as a Smart Grid Infrastructure

2-1. Power Comm. Network and Last Mile Network

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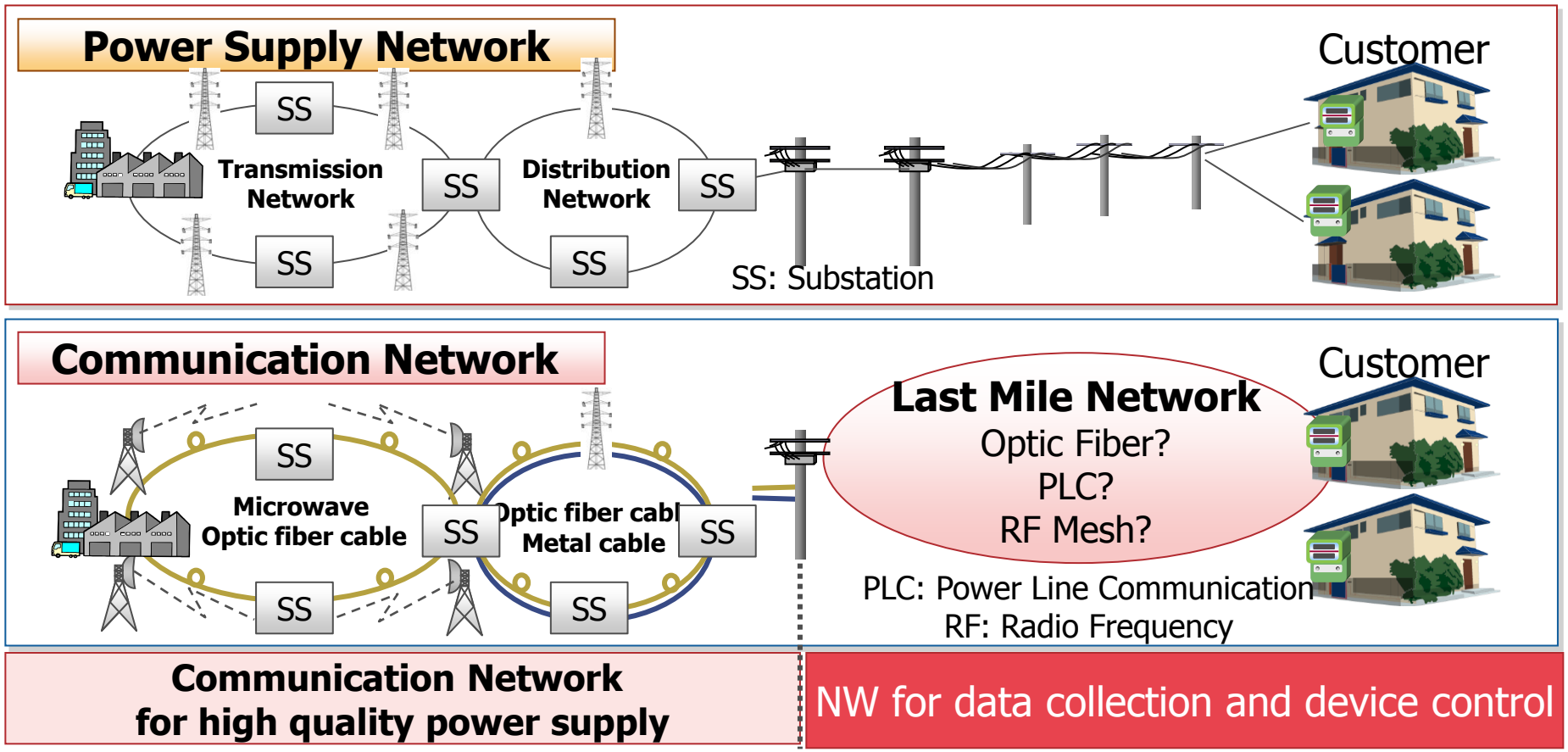
Last-One-Mile comm. network connecting utilities and customers



Communication Network for high quality power supply

NW for data collection and device control

A part of the Smart Grid Infrastructure

Select the Scalable Last Mile Network Technology

2-2. New Challenges and Requirements in AMI

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Many large scale and long term related issues exist in AMI

AMI Implementation

Many System configuration and registration

Enormous management works are generated in addition to current meter management items.

Related communication equipment (gateways, repeaters etc.,) management, interfaces to backend systems such as billing system etc.

Flexible Network Design

Long time (several to more than ten years) network installation term.

It is almost impossible to design suitable network considering several to more than ten years later environment.

AMI Operation

Environmental Change

Requirement of Network re-designing, Efficient re-designing.

Efficient and easy network re-design in later implementation stage is required.

Troubleshooting and Maintenance

Requirement of rapid failure discovery and recovery

At present, it is difficult to detect failures before customer's discovery.

Technology to Solve Large Scale/Long Term Related Challenges

2-3. Proposed AMI Solution Overview

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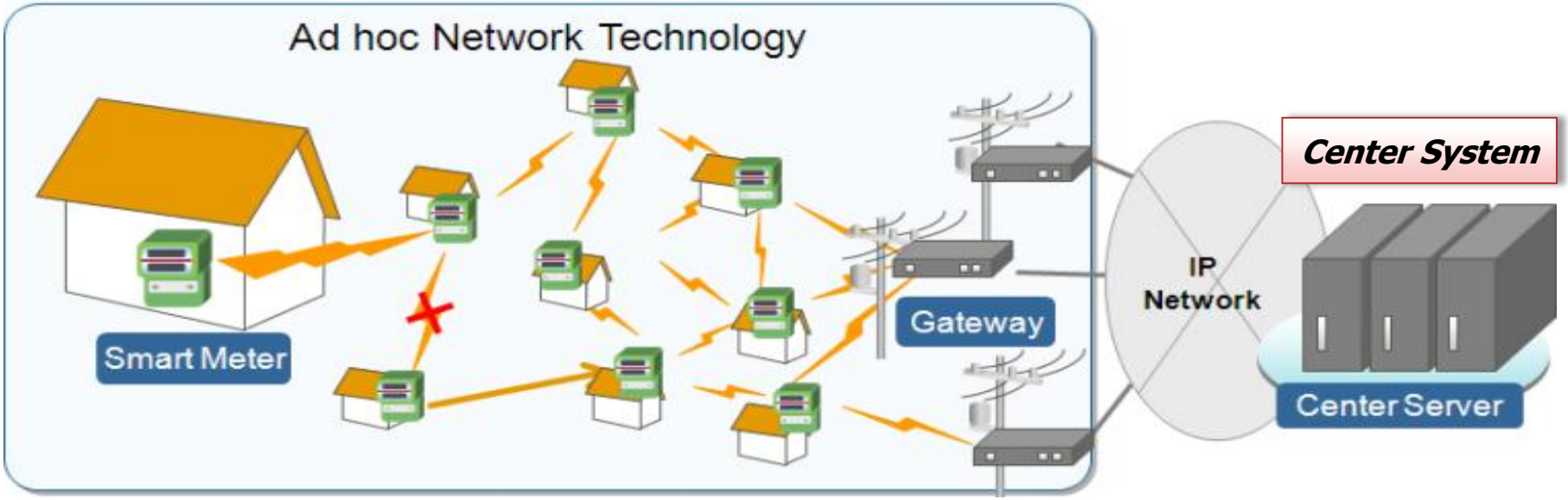
Key points of AMI Solution are last miles comm. & meter data mgt.

AMI Requirements

Last miles / Two-way comm. for huge data	**Long term and large scale network implementation**	**High secured and stable network**



RF Mesh Ad –hoc Network Technology + ***Center System*** → ***AMI Solution***

RF Mesh Ad-hoc NW & Cooperatively Binding Center System

2-4. RF Mesh Tech. Improvement for AMI

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RF Mesh Tech. improvement for a large scale networks

Current RF Mesh Routing Protocols

Routing Type	Reactive type (AODV)	Proactive type (OLSR)
Description	Route setting at every communication	Route setting prior to communication by sending periodical control packets.
Advantage	Real time re-routing corresponding to NW environment.	Equalizing traffic by sending control packets periodically
Disadvantage	Heavy traffic (packets) as the NW size get larger.	Inability of real time re-routing
Suitable Network	**Small Size Network**	**Medium Size Network**

Improved RF Mesh Technology for challenges in radio wave

Routing Type	Improved Proactive Type
Description	**Searching based on leaned routing information without sending unnecessary control packets**
Advantage	**Control packets reduction and real-time re-routing capability**
Suitable Network	**Large Scale Fixed Network**

2-4. RF Mesh Tech. Improvement for AMI (Cont'd)

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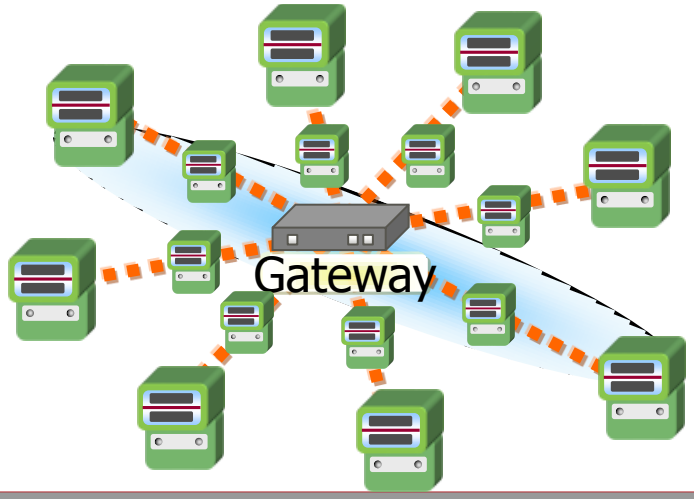
The New RF mesh technology solves new challenges in AMI

- "Adaptive Ad-hoc routing algorithm" enabling communication units to establish and change data transmission route automatically.
- Applicable for large scale, high secured and stable wireless network by the new algorithm

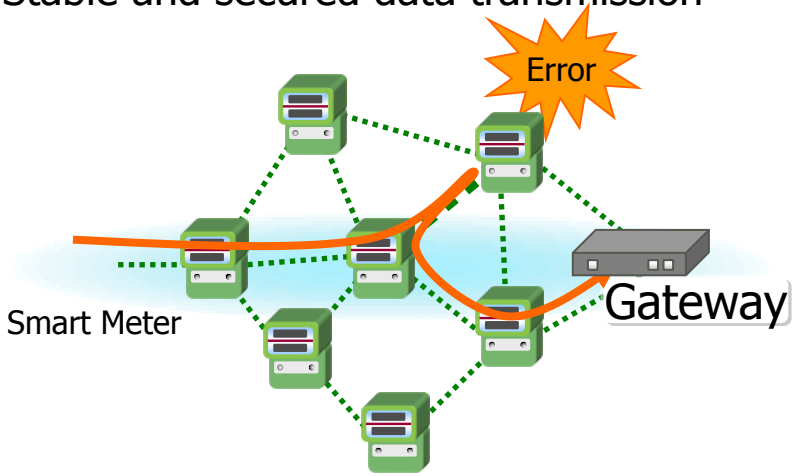
Auto Establishment of a Large Scale Network

- No complicated Network setting
- About 1,000 Smart Meters per Gateway



High Reliability - Automatic Rapid Re-routing -

- Automatic re-routing if failures/ congestions occurred
- Stable and secured data transmission



The New RF mesh ad-hoc is the best technology for AMI

2-5. AMI Utilization as a Smart Grid Infrastructure

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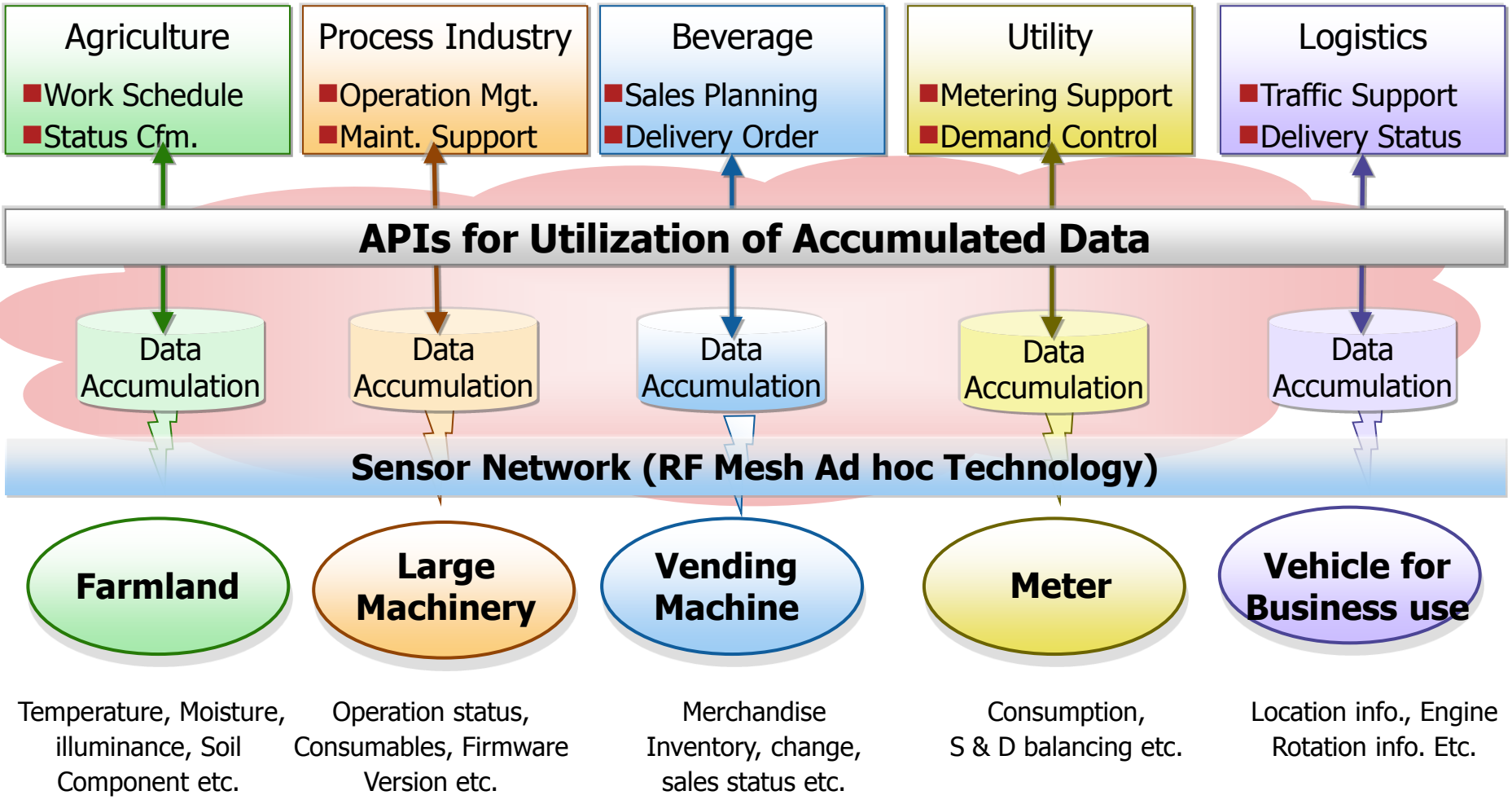
AMI and its tech. contribute to establish Smart Grid Infrastructure



Future Sensor Network would be the Smart Grid Infrastructure

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3. EMS Solution as a Smart Grid Key Component

3-1. EMS Requirement

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Optimized power production and consumption utilizing ICT

Current Situation

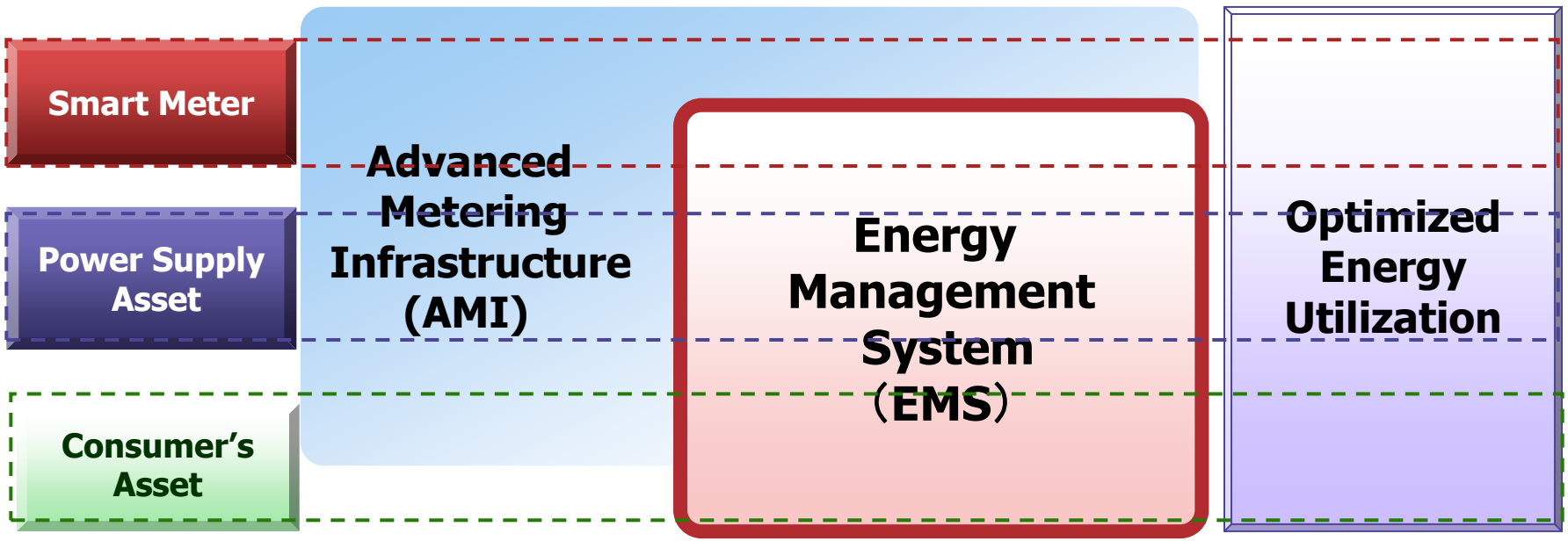
Electric power from large concentrated generations is supplied corresponding to successive fluctuating demand

One-way Model

Future Target

Demand side concerns with efficient power utilization for providing benefit for both supply and demand sides.

Cooperative Model



EMS: Detailed Power Supply and Demand Balancing System

3-3. Required Functions for Targeted EMS

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Optimized energy utilization with many unstable small DGs

Targeted EMS	Detailed Power Supply and Demand Balancing System in Distribution Area

Required Features

To realize the target, following steps and supporting functions are required.

- Forecast accurate amount of power supply and demand in each calculation time frame
- Develop an optimized targeted power supply and demand plan.
- Shift power demand targeting for the developed demand plan and dispatch power supply amount corresponding to the shifted power demand.

Also following monitoring and control features are required, once the optimized power supply and demand plan is determined.

- Monitor power supply and consumption equipment status
- Control power supply and demand equipment for achievement of the optimized targeted power supply and demand plan.

3-4. Summary of EMS Required Functions

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Forecasting & Planning and Monitoring & Control are key func. in EMS

Category	Function group	Functions
Forecasting and planning	**Supply and demand forecasting**	● Forecasting (Total generation, total demand, response rate (recommendation) ● Data Interface (Control center, Power eXchange, Weather info, other EMSs info etc.)
	Supply and demand balancing	● Demand Response (DR) and Demand Side Management (DSM) program development ● Generation dispatch ● Notification (PV(PCS) Battery, EV charge) ● Data Interface ● Power Flow Calculation
	Supply and demand scheduling	● DR and DSM Recommendation provision ● Generation dispatch ● Notification (PV(PCS) Battery, EV charge) ● Data Interface ● Power Flow Calculation
Monitoring and control	**Equipment Monitoring**	● Real-time system situation monitoring ● Real-time system status monitoring ● Backup generation monitoring
	Equipment Control	● Control message transformation ● Interface Existing process computers

3-5. Technologies Required for EMS Functions

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Forecasting & Planning and Monitoring & Control are key func. in EMS

Various advanced technologies are required to realize enormous data high speed processing because of dealing with a large amount of distribution assets and residential equipment data.

Required Functions				
Forecasting and planning			Monitoring and Control	
Supply and demand forecasting	Supply and demand balancing	Supply and demand scheduling	Equipment Monitoring	Equipment Control

Required Technologies		
Advanced technical calculation	**Enormous information collection and delivery**	**Data visualization and quantitative evaluation**
High speed data processing		

3-5. Technologies Required for EMS Functions

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Various technologies are utilized to realize targeted EMS

Enormous information collection and delivery

	Advanced technical calculation	Data visualization and quantitative evaluation

Power status data (Distribution Asset)

RE status data (PV, Wind etc.)

AMI data

SCADA data

DMS data

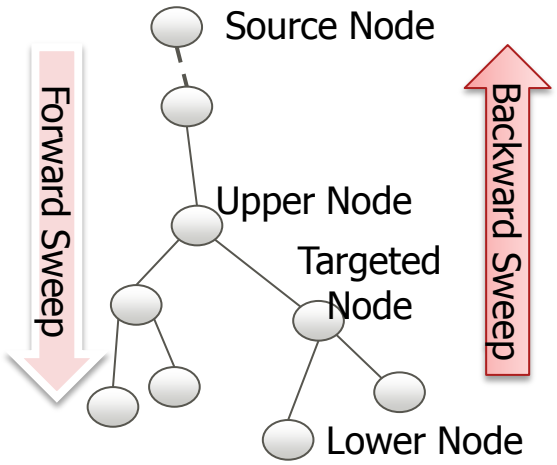
Others

Interface

High Speed Power Flow Calculation

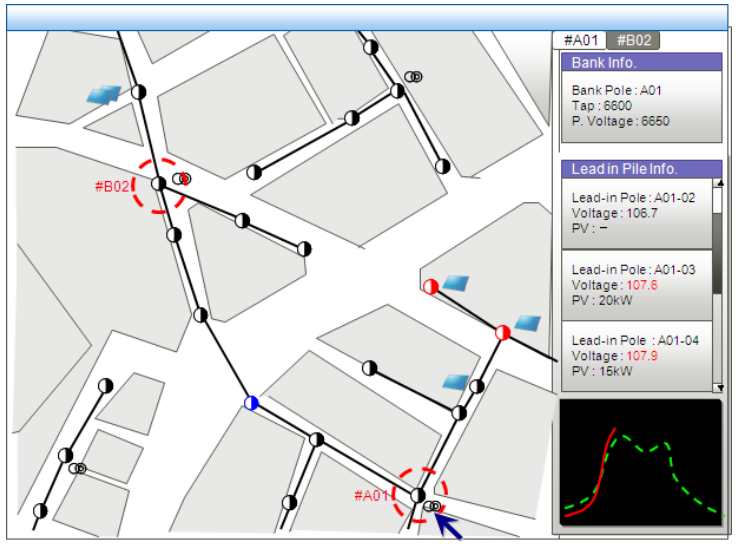
High Speed Power flow calculation and optimization to forecast power supply and demand amount and to create optimized supply and demand plan.

Backward and Forward Method



Data integration with GIS

This is one of effective methods for T & D operation because it is required for operators to know holistic picture of broad power line network quickly.



Combination of Existing and Advanced Technologies

3-6. Fundamental ICT Technologies for EMS

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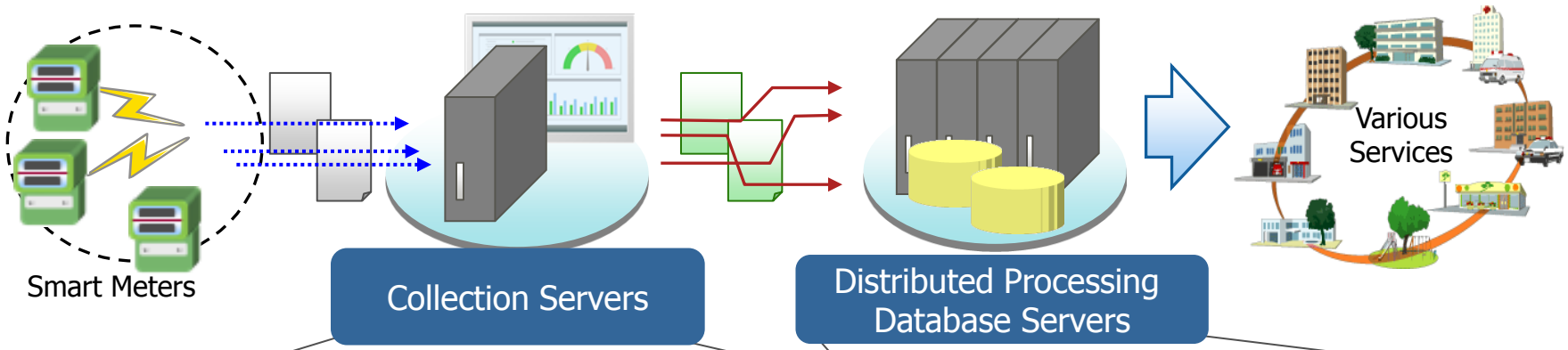
High Speed Data Processing Technologies are essential for the EMS



Requirement	Rapid Processing of Continuously Generated Data	Enormous data Distributed Processing
Adopted technology	CEP （Complex Event Processing）	KVS （Key Value Store）
Features	•High speed on-memory event processing compared with current interactive processing. •Defined rule based processing with judgment of event context	•High speed summary/storage than existing DWH technologies. •Easy scale-out and high availability in case of hardware troubles.

Every Fundamental ICT Technology is Considered Scalability

3-7. EMS Basic Architecture and utilizing Data

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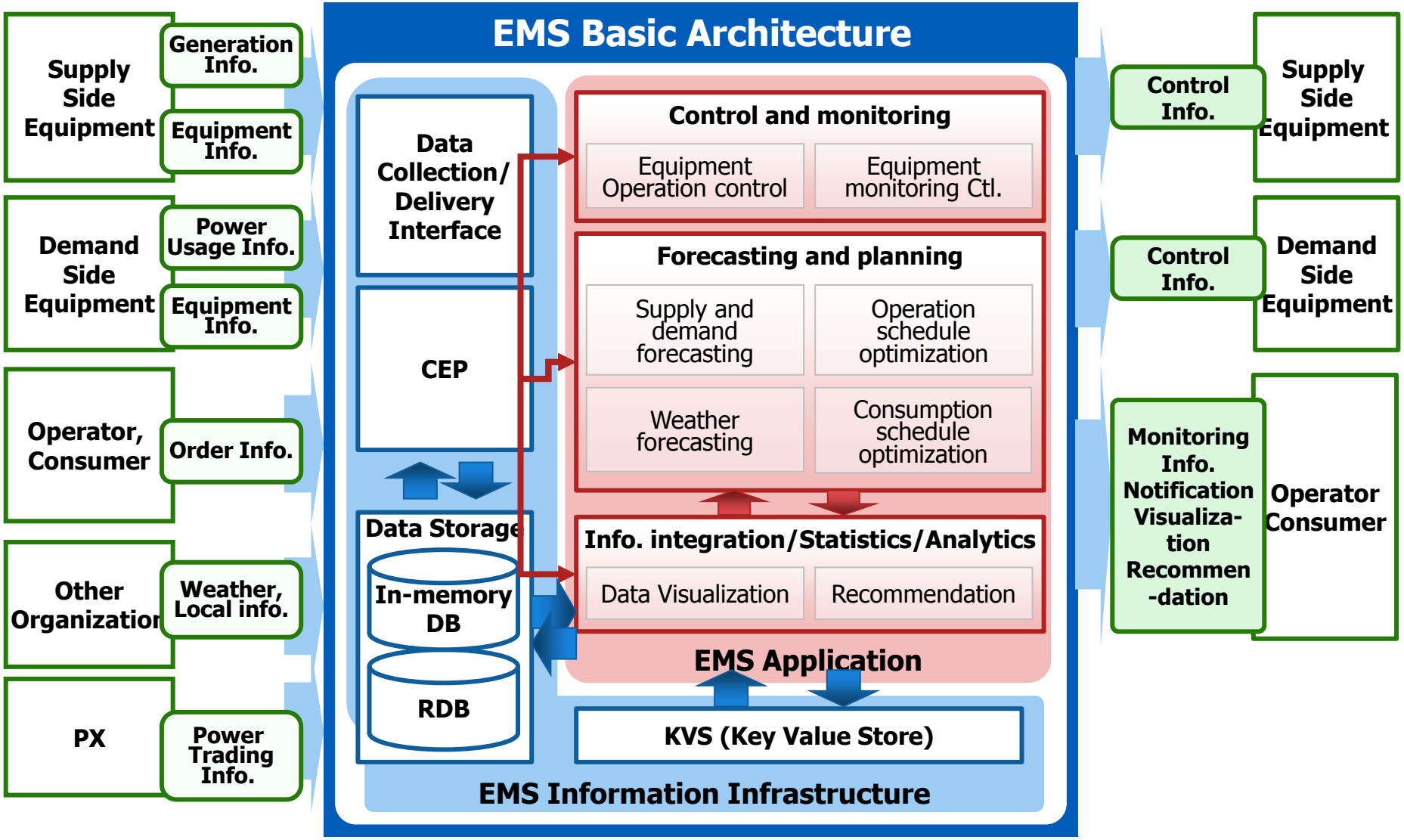
Various data are gathered and processed rapidly to provide values



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4. Conclusion

4. Conclusion

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Smart Grid would be a future social infrastructure

- **There are many challenges and requirements for ICT fundamental solution areas to realize Smart Grid**
- **Two key solutions were showed with possible technologies and/or development concepts for solving them.**

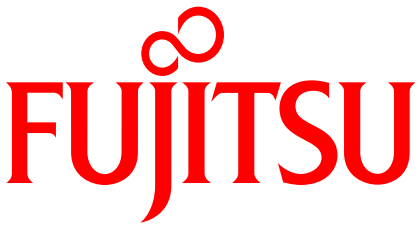
The 2011 East Japan Earthquake Disaster revealed Japanese energy policy issues in the aspects of security, while it has caused a heavy damage to energy infrastructure in east Japan.

In such circumstance, Smart Grid has been expected as the resilient next generation energy management system in Japan to realize optimized electricity production and consumption for both supply and demand sides' benefits.

Targeting to realize that…

We will Continue Developing of Advanced Solutions

Thank you for your attention



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