CIGRE SC D2 Colloquium
October 2015
Lima – PERU

D2-01_01

Development of Next-generation Power Supply Information Transmission System (i.QPA Network)

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Background and Purpose of Development

- The current power supply information transmission system has been stably operating since its launch in February 2005 and will be 10 years and 8 months old in October this year.

- Although an ATM exchange network is used as the dedicated network accommodating this system, the maintenance period of the ATM exchange system will expire soon.

- For this reason, the network accommodating the power supply information transmission system needs to be changed.

Background and Purpose of Development

The following factors were taken into consideration when changing the network:

- The new network system must satisfy the requirements of high reliability and low delay.
- Network construction costs need to be held down.

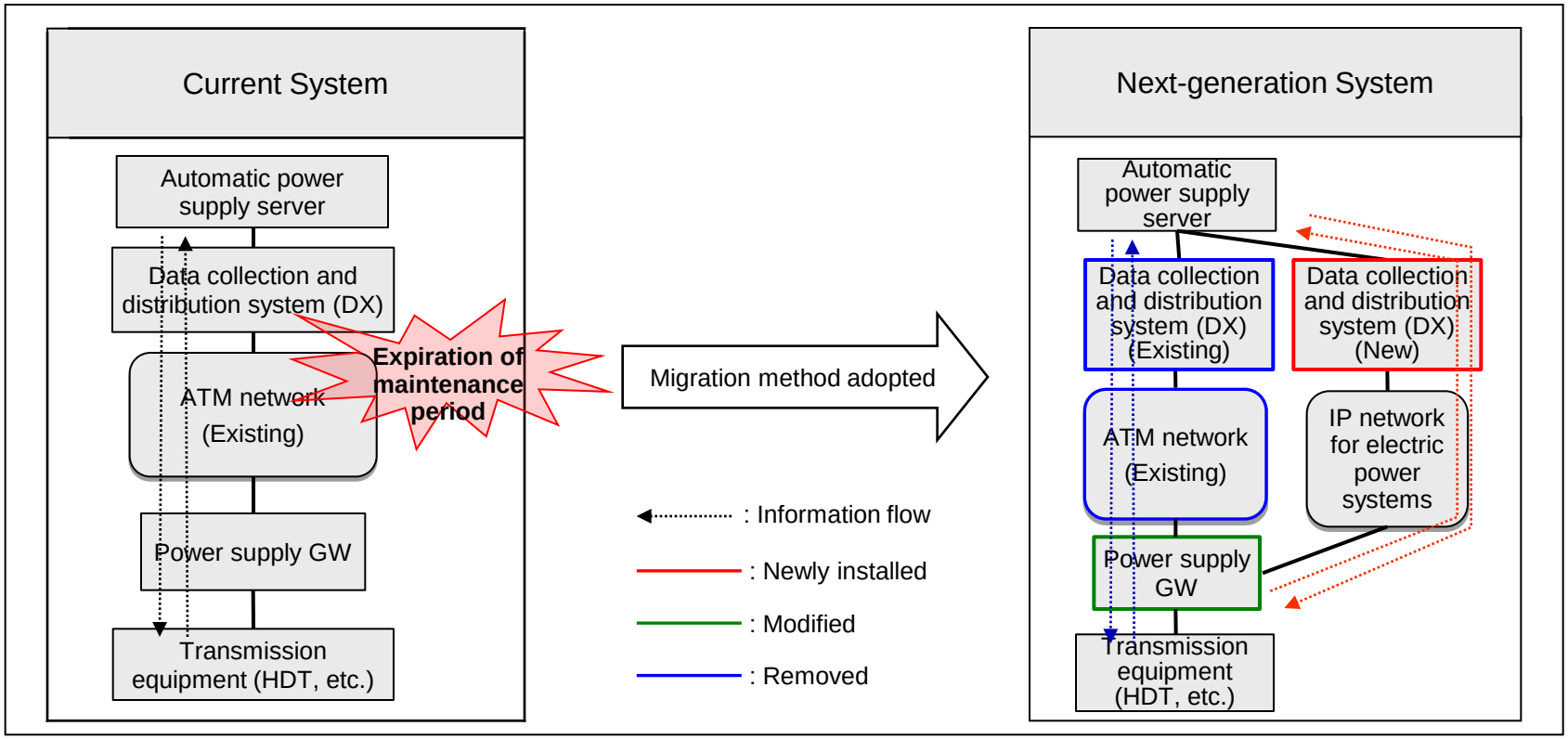
During this undertaking, a next-generation data collection and distribution system (DX) has been developed with the aim of renewal of the Central Load Dispatching Center backup system.

=> The new data collection and distribution system (DX) is provided with a function to switch control to the backup facility.

Overview of Network Migration

- Current: The power supply information transmission system (i.QPA) is configured using an ATM exchange network.
- Next-generation: The i.QPA is configured using the existing IP network for electric power systems.

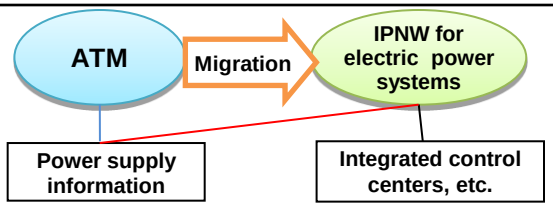
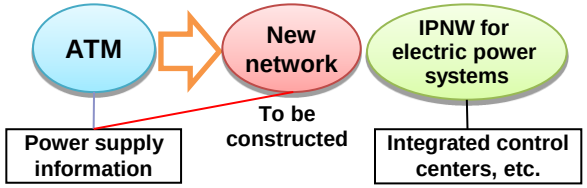
  => A data collection and distribution system (DX) has been developed.



Migration to IP Network for Electric Power Systems

- The existing IP network for electric power systems is utilized to hold down network construction costs.
- Even constructing a dedicated network will not enable distribution of risk in the event of a transmission path failure, because transmission media such as fiber optic cables will be shared with the IP network for electric power systems.

Table 1: Selection of Accommodating Network

Item	Integrated Network (Adopted)	Dedicated Network
Outline	• The i.QPA will be accommodated by the existing IP network for electric power systems.	• A new dedicated network will be constructed to accommodate power supply information only.
Migration Method		
Costs	• Low costs for new network equipment installation and transmission path construction compared to a dedicated network • Low maintenance costs due to the small amount of additional equipment	• High costs compared to the integrated network due to the wide range of new installations • A new network monitoring system must also be developed.
Operation and Maintenance	• Migration to the existing IP network for electric power systems means that a high level of maintenance capabilities already in place from the operational track record to date is available.	• The new network may become a new model, and this will mean that familiarization with new knowledge and technologies will entail a certain length of time and generate costs.

Migration to IP Network for Electric Power Systems

- Network requirements of the i.QPA

(1)IP network capable of supporting the Transmission & System Operation Division system computers that will act as servers (for migration to IP) in the future
(2)Network comprising two sides with a traffic disruption time of 2 seconds or less
(3)Satisfaction of the system requirements including reliability, delay time and maximum allowable traffic disruption time
(4)Use of a microwave multiplex radio link as a backup line when all fiber optic lines are disrupted

Table 2: Network Requirements of i.QPA

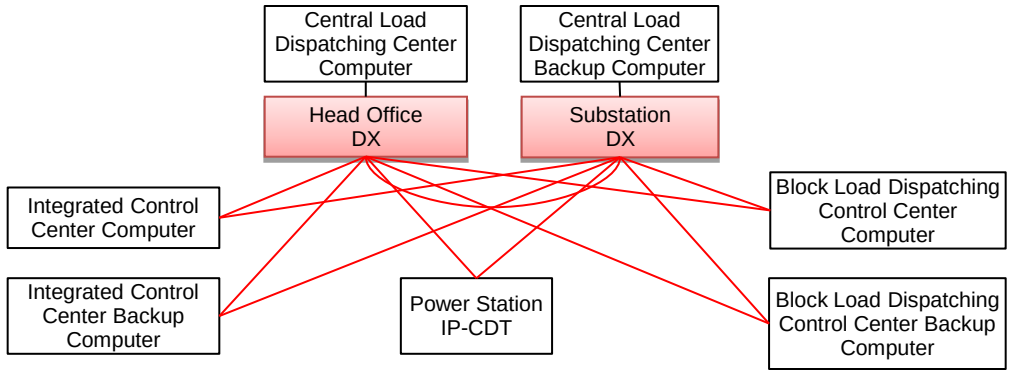
Requirements/ Network		Unavailability Rate	Transmission Delay Time	Maximum Allowable Traffic Disruption Time
System Requirements		2.0×10^{-5} or less (Source: Electric Technology Research Association No. 58-4)	For information transmitted to Central Load Dispatching Center: 4 sec or less For other information: 8 sec or less *For IP: 1.75 to 4.75 sec	For monitoring: 18 sec For control: 2 sec
Network	ATM Network [Current Network]	2.14×10^{-8}	For information transmitted to Central Load Dispatching Center: SVTM: 4 sec or less Control: 2 sec or less For other information: SVTM: 8 sec or less	For monitoring and control: 0 sec (Duplex communication and packet acceptance on a first-come basis with the second discarded)
	IP Network for Electric Power Systems [Next-generation Network]	6.69×10^{-8} (When both sides-A and B are used) 2.14×10^{-7} (When only side-A is used) *Microwave radio not considered.	A few hundred msec or less *For the network only	For monitoring and control: 0 sec (Duplex communication using both sides-A and B, and packet acceptance on a first-come basis with the second discarded)

SVTM：Operational status of electric power equipments such as circuit breaker and monitoring data of current/voltage at major electrical stations such as the power stations, HV power lines and major substations' bus lines.

Development of New Data Collection and Distribution System (DX)

- Roles of the data collection and distribution system (DX)

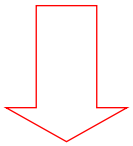
(1)Centralized collection, editing and distribution of power supply information
(2)Switching of control between the Central Load Dispatching Center and its backup by interconnection with the automatic power supply server

Item	Star Configuration with DX at its Top
Configuration	
Communication Section	• Upstream (IP terminals => DX) • Downstream (DX => IP terminals)
Advantages	• Easy management of paths • Easy management of power supply information elements (through distribution of all elements)
Disadvantages	• High DX processing load => To be addressed by load distribution of DXes between the Head Office and substation • Stoppage of all DXes will result in total stoppage of information transmission between the facilities => DXes are installed in a dual configuration at both the Head Office and substation, ensuring a high degree of reliability.

Development of New Data Collection and Distribution System (DX)

- Development of a function to switch control to the backup facility

  When control information from both the Central Load Dispatching Center computer and the Central Load Dispatching Center backup computer is received by receiving terminals, problems such as unexpected failures may occur if the information received from both computers does not match.



The data collection and distribution system (DX) has been furnished with a sequence to ensure transmission of control information from only one of the 2 facilities through control switching.

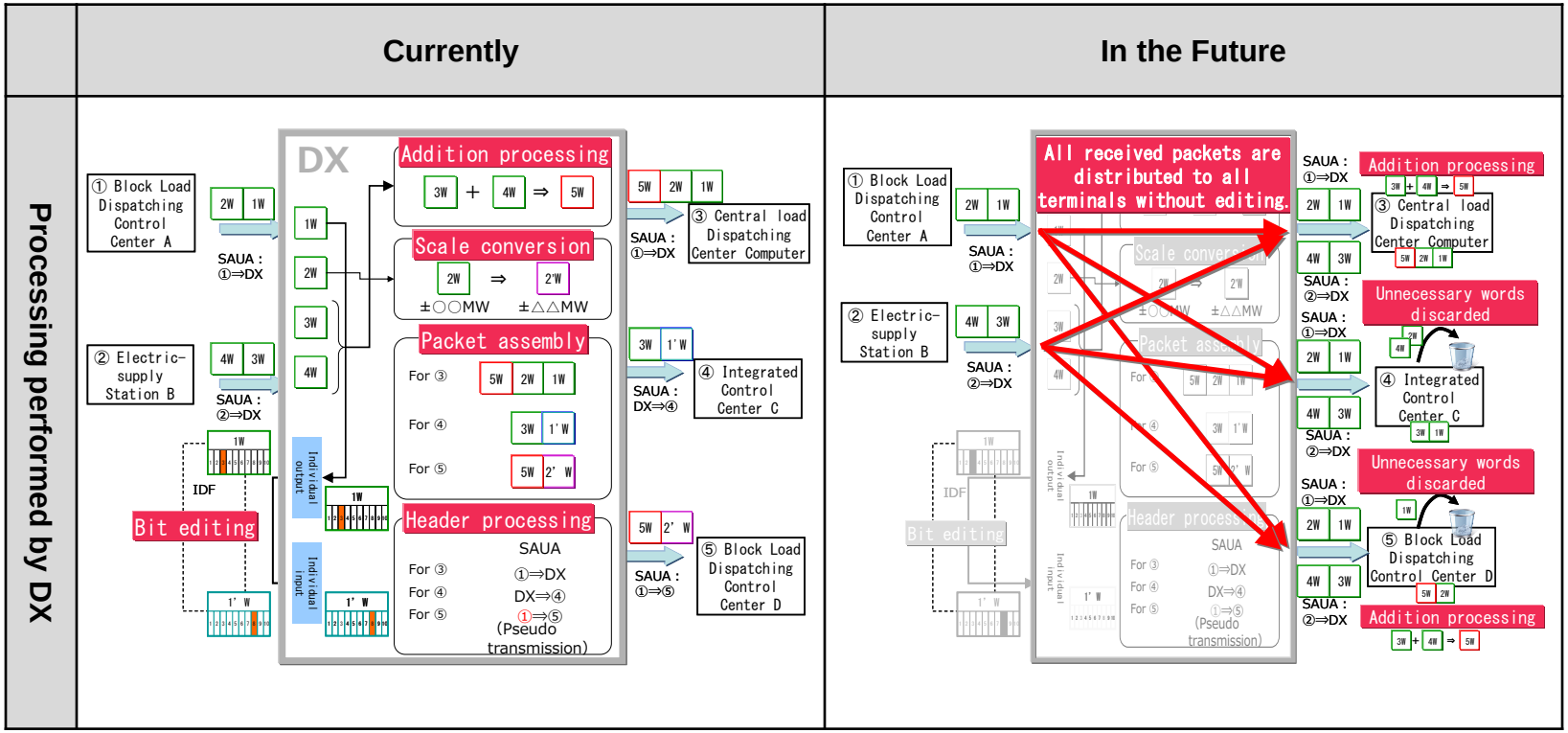
*For the detailed flow, see “Fig. 2: Control Switching Process Sequence and RAS Packet Format” shown in the paper.

Development of New Data Collection and Distribution System (DX)

- Features of the newly-developed data collection and distribution system (DX)

Currently: In addition to data collection and distribution functions, editing functions are provided.
(Word editing, bit editing, pseudo transmission, addition processing and scale conversion)

In the future: The goal is to achieve a DX configuration that will specialize only in data collection and distribution to allow distribution of all received data to all terminals without editing.

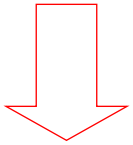


Development of New Data Collection and Distribution System (DX)

- Measures during the period of migration of all power supply information terminals to IP

To realize the future image of the data collection and distribution system (DX) as described before, all power supply information terminals must be migrated to IP.

=>The power supply information terminals mean HDT and CDT that transmit and receive control information essential to ensuring stable supply of electric power.



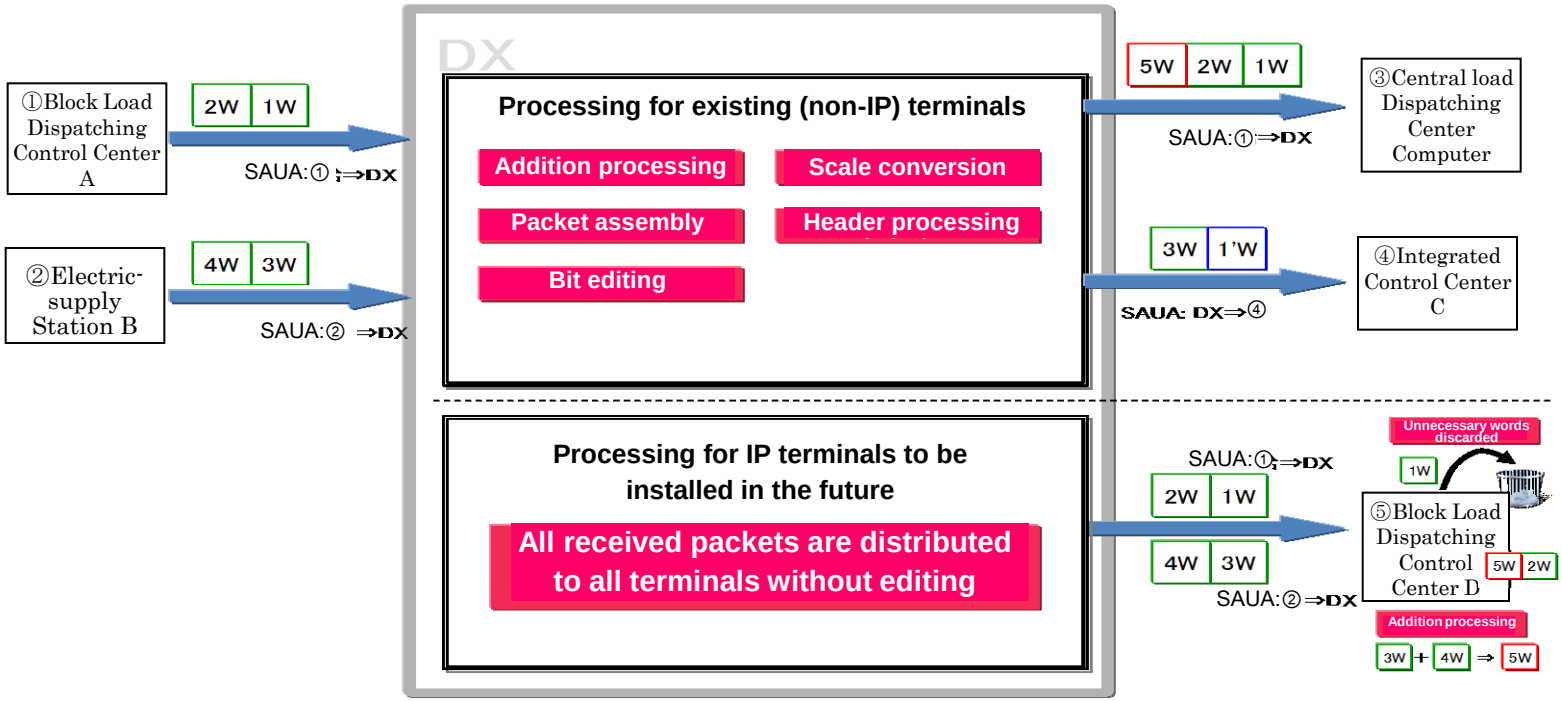
However, simultaneous migration of all power supply information terminals to IP is difficult to implement in terms of cost, and therefore, consideration needs to be given to the period of migration of all terminals to IP.

Development of New Data Collection and Distribution System (DX)

- For the reasons mentioned before, the newly-developed data collection and distribution system (DX) has the following functions:

(1)Processing for existing (non-IP) terminals
Data will be distributed to existing terminals after implementing processing such as word editing within the data collection and distribution system (DX) as is done now.

(2)Processing for IP terminals to be installed in the future
All received data will be distributed to all IP terminals.



Summary

- The power supply information transmission system is essential to ensuring stable supply of electric power and must be highly reliable and capable of low delay.

- In the future, interconnection of renewable energy to the power system will grow and, to cope with resulting rapid fluctuations in the amount of power generated, the number of load dispatching instructions issued (as control information) is expected to be increased to suppress or urgently increase the amount of power generated by base-load power sources.

- In addition, considering the ever-growing importance of the power supply information transmission system, we believe that the newly-developed system will fully satisfy system requirements and contribute to the stabilization of the power system.

Thank you !

Next:
Answers to the Special Report Questions

Special Report Q1-1

Q1-1
Migrating from the existing proven network to a new one based on another technology is critical. What are the most important criteria, scenarios and best practices to guarantee a smooth migration?
What are your 'learned lessons' and advices?

- **To ensure smooth migration, "detailed discussions with relevant parties" and "functional testing in an environment simulating actual field conditions" were conducted.**
- **It is important to prepare a switchover procedure from the standpoint of "how migration to the new system can be achieved with minimum impact on the system currently in operation." In preparing a switchover procedure, the requirements of the division responsible for load dispatching operation, such as allowable system downtime, must be satisfied.**

Special Report Q1-2

Q1-2
Switching to a backup dispatching center can be critical. How is this tested? What is the impact of the switching process on technology, organization and procedures?

- **A simulated environment was built to carry out testing of switching to the Central Load Dispatching Center backup and the results verified normal operation.**
  => Field testing of switching to the backup is currently being arranged with the division responsible for load dispatching operation.

- **For technology: Realization of the function fully capable of switching to the backup**
- **For organization: Implementation of regular training and reviews of personnel in charge**
- **For procedures: Preparation of a switching procedure manual**

Thank you again !