Next-Generation Communication Network System

Background and Objective

Power system ICT (Information and Communication Technology) infrastructures indispensable in the next-generation grid have been well implemented for power generation and delivery, but have yet to be developed for customer communications including smart metering and power asset maintenance and diagnosis. In addition, communications for power system protection are still proprietary and legacy (non-IP-based) whereas others mostly are IP-based.

This project deals with network design and development of fundamental technologies for demand area communications interconnecting customers, distributed energy resources and distribution grids, wide-area and high-speed communications promoting reliable and flexible power system protection and control, and sensor communications enhancing asset management and operations.

Main results

1. Performance evaluation and security requirement analysis for the demand area network

We evaluated the performance of meter data collection using a protocol suite combining IEC 62056 and multi-hop wireless LAN (IEEE 802.11g). For the estimation of the data collection time, we developed a simple simulation program incorporating experimental result of the multi-hop wireless LAN and IEC 62056 transmission characteristics. The estimation results show that the meter data collection is completed within several seconds for about six hundred meters (Table 1) [R10035].

We also performed security risk assessments for typical system configurations. The required security countermeasures were mapped to each system configuration. Fig. 1 illustrates an example of security countermeasures deployment to a typical network configuration [R10019].

2. Proposal of Ethernet deployment method for the wide-area and high-speed control network

As Ethernet, providing a real-time transmission feature, is promising for wide-area monitoring, high-speed control and protection of power system, we had already proposed a wide-area Ethernet architecture that accommodates substations in a hierarchical manner. We newly proposed a flat-type Ethernet structure that achieves a more real-time feature to show its applicability to wide-area protection system interconnecting many substations [R10029].

3. Developments of a Plug-and-Play method and other technologies for the sensor network

In the power facilities condition monitoring sensor system, a Plug-and-Play (PnP) method to automate the software setup of sensor data processing was proposed and the fundamental procedure was verified by an experimental system. This method is expected to improve the efficiency of maintenance operation because the modular software at every monitoring object associated with IEC 61850 can be automatically deployed and linked in response to the detection of sensor installation (Fig. 3) [R10023].

In the wireless sensor network system to collect many sensor data, we proposed an easy estimation method of data acquisition time with the number of sensor nodes and the link topology, and verified its validity for a typical ZigBee network [R10038]. For the optical sensor network system using optical ground wire (OPGW) for power transmission facilities monitoring, we successfully demonstrated the basic performance of optical remote power supply to multi-point optical sensor nodes [R10006].

Other reports [R10012] [R10033]

Table 1 Estimated data collection time

Number of meters*	624 (25×25, an access point is located at the center of target area)
Target area	1 km×1 km
Meter allocation	Uniformly distributed at 40m intervals
Method of multi-hopping	Select a meter with a certain reception level and the minimum number of hops
Radio propagation	Line-of-sight and ground plane reflection taken into account
Communication protocol	IEC 62056
Estimation results**	No. of maximum hopping: 8 No. of average hopping: 4.8 Max. response time: 5.9 [ms] Overall collection time: 2.8 [s]

* A target area is expected to have 500 to 1000 meters.
** The estimation is based on the number of hops.

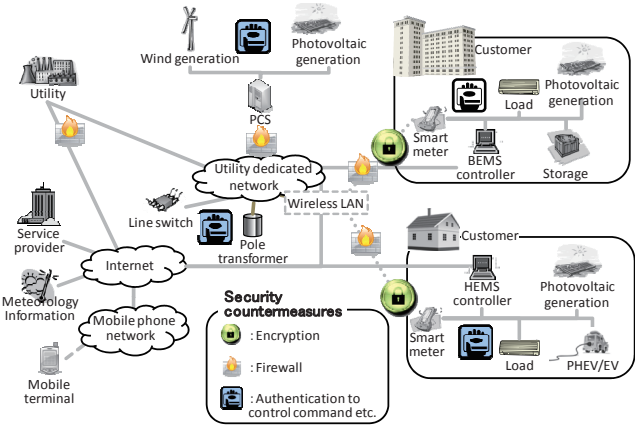

Fig. 1 Example of security countermeasures deployment to demand area network

The countermeasures and their deployment were developed based on the system configuration and the risk assessment results.

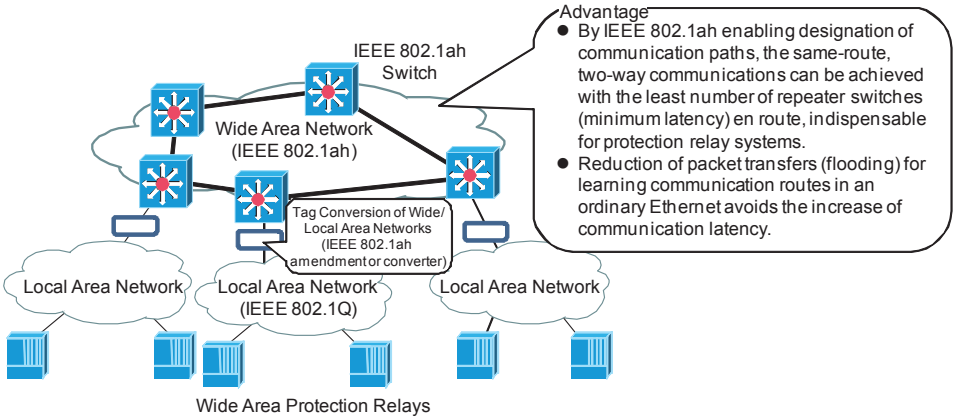

Fig. 2 Flat-structured wide-area Ethernet network suitable for wide-area protection system

The wide-area Ethernet standard, IEEE 802.1ah, is amended to achieve a flat structure with a tag conversion mechanism, realizing simplified network configuration with every route designated and unnecessary traffic reduced for power system protection communications.

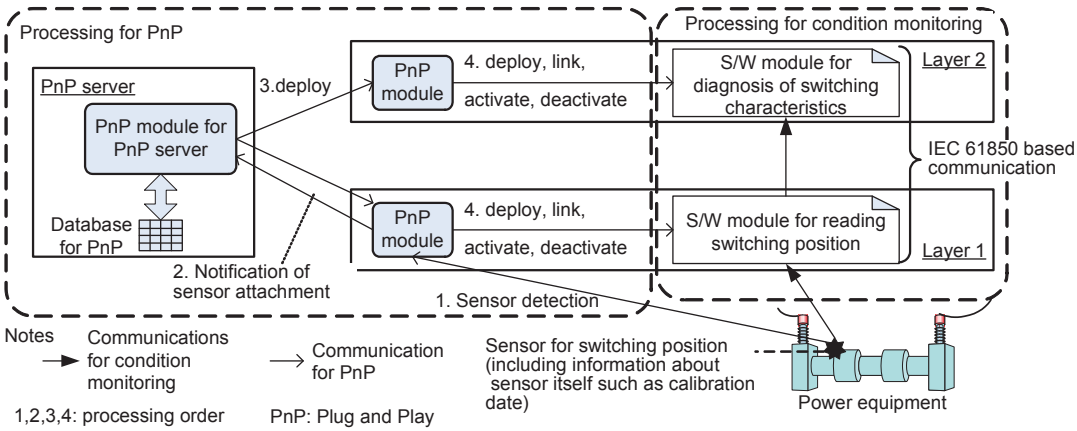

Fig. 3 A method to realize the PnP of sensors for power facilities maintenance

The PnP modules deploy and link the appropriate software automatically triggered by the data detection of sensor installation.