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 being IP-based.

This project deals with the network design and the 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 of the communication method for demand area network

We evaluated the performance of IEC 62056 protocol using a test system. The system consists of a simulated utility device and an IEC 62056-implemented embedded board regarded as a customer gateway (Fig. 1) which assists information exchange among utility devices and customer premise devices. The result shows that major application information can be accommodated in the protocol in the delay time point of view except for control information transmission of distributed generations requiring several ten milliseconds in delay time [R090009]. We also developed an estimation method of power line communication (PLC) transmission losses which is one of principle design parameters of PLC communication network for collective housing [R09022].

2. Evaluations of time synchronism of wide-area and high-speed control network

Fundamental evaluations were conducted for the network architecture that utilizes off-the-shelf and standardized IP-based technologies, and implements various modular functions and applications in a distributed manner throughout the network. Employing wide-area Ethernet (L2) and highly precise time synchronization scheme (IEEE 1588), four prototype devices with four applications implemented were examined to achieve a time synchronization error of microseconds sufficient for power system protection and cooperative operations among different functional modules [R09011]. An applicable structure of IEEE 1588-based network suitable to wide area power system was also proposed [R09012].

3. Evaluation of wireless communication characteristics in the field sensor network for power facilities maintenance

For the wireless sensor network that enables the condition monitoring of power facilities, radio propagation characteristics including reflections and shadings by metal structures in substations which influence communication performance were experimentally estimated. We clarified the characteristics of several radio frequency bands valid for wireless sensor networks can be represented by the four-wave interference calculation model and proposed a prediction method for stable communication with two frequency channels in a band, by applying the properties that the receiving power difference by frequency is remarkable at the dip point of the receiving level (Fig. 3) [R09013].

Other reports [R09024]

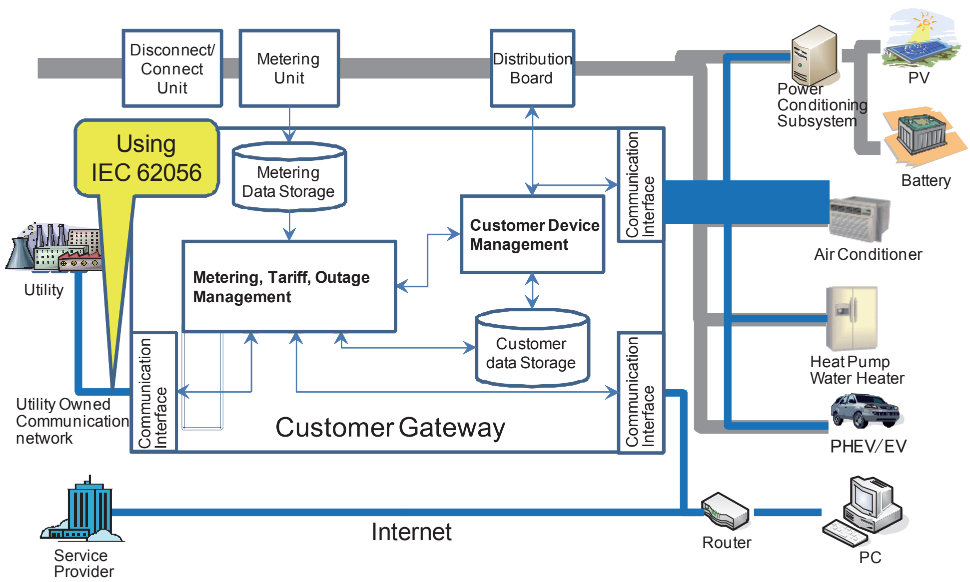
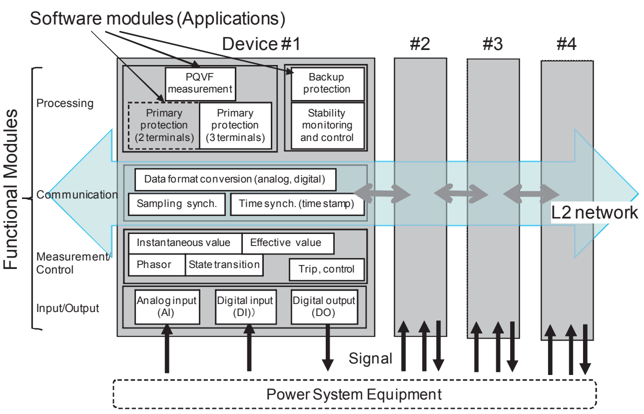
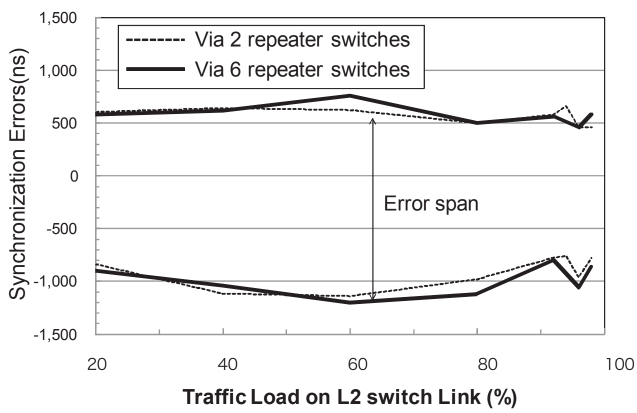


Fig. 1 Customer Gateway structure and applied IEC communication standard

IEC 62056 (Electricity metering - Data exchange for meter reading, tariff and load control) was applied for utility-customer communication and the performance was evaluated.



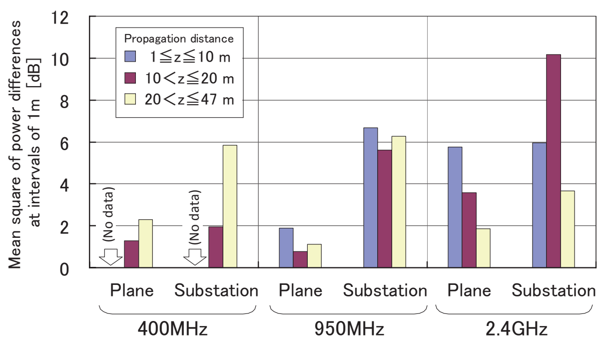
(a) Configuration of prototype device



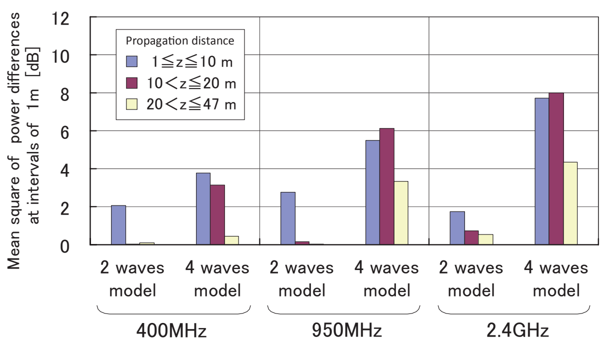
(b) Time synchronization errors between devices

Fig. 2 Prototype devices and time synchronism accuracy

The composite of functional and software modules of each device realizes the redundant and distributes configuration of various applications throughout the network.



(a) Experimental result (plane area and line switch area of substation)



(b) Calculation result (2- and 4-wave interference models)

Fig. 3 Characteristics of spatial fluctuations of receiving power

The fluctuation level of receiving power is estimated by a two-wave interference model (direct wave and reflected wave by ground) in plane area and a four-wave interference model (additionally two reflected waves by metal structures) in substation.