

# Development of ICT Infrastructure Building Techniques Based on General-purpose Communication Technology

### Background and Objective

Currently, for power system protection, the proprietary and legacy communication method is still widely used rather than general-purpose communication technologies such as Internet Protocol (IP). Customer communication networks including smart metering and communication networks for monitoring and maintenance of power system facilities are yet to be developed and

general-purpose communication technologies are also expected to be applied to the communication. This project investigates the improvement and validation of the developed techniques based on general-purpose communication technologies which contribute to reducing construction cost of utility communication networks.

### Main results

#### 1 Applicability evaluation of IP-based microwave radio communications for power transmission line protection

To apply IP-based communications to trunk power transmission line protection with their reliability and cost effectiveness maintained, the IP-based microwave radio system has yet to be utilized. Since power transmission line protection requires stringent communication delays, communication performance of the IP-based microwave radio system was evaluated with respect to end-to-end delays and delay

variations (Fig. 1). The evaluation showed that a time synchronization scheme implemented in microwave radio equipment could realize IP-based power transmission line protection. It also clarified that the number of communication channels and their end-to-end distances were determined by the interface speed and the number of microwave radio equipment installed (Table 1) (R14007).

#### 2 Development of an estimation method for impedance on electrical wiring in dwellings for PLC system design

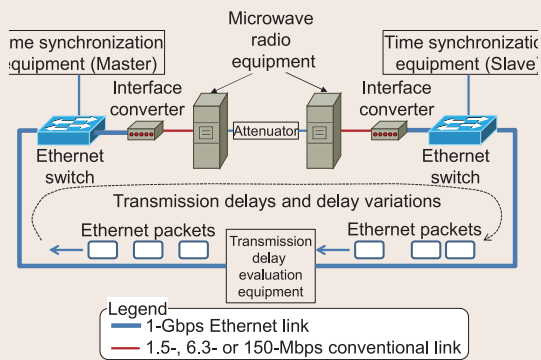
A high-speed kHz-band PLC (Power Line Communication) is an effective communication technology for smart-meter networks. It is necessary to estimate the typical impedance value ( $Z_h$ ) of electrical wiring in dwellings for easy evaluation of applicability to apartment buildings. It was clarified that the impedance of appliances is extremely low and  $Z_h$  is governed by reactance of wiring cables by measuring

impedance characteristics in actual dwellings. Based on the above results, we presented a simple equation to estimate  $Z_h$  from the average length of wiring cables and number of parallel circuits (Fig. 2). By using the equation, it becomes possible to evaluate applicability of PLC to apartment buildings without measuring the appliance characteristics (R14004).

#### 3 Outdoor field testing of a multi-point sensing system based on a remote optical power supply

We have developed a new multi-point optical sensing system (MPOSS) based on remote optical power supply technology. Prototype optical nodes for outdoor installation were developed, and are installed along the distribution line at the Akagi Testing Center (Fig. 3). Continuous operation testing in an outdoor field was conducted from

November 2014 to March 2015, and it was confirmed the optical nodes and data acquisition function have stably operated by remote optical power supply. The results shows the MPOSS can be applied to transmission line monitoring in winter.



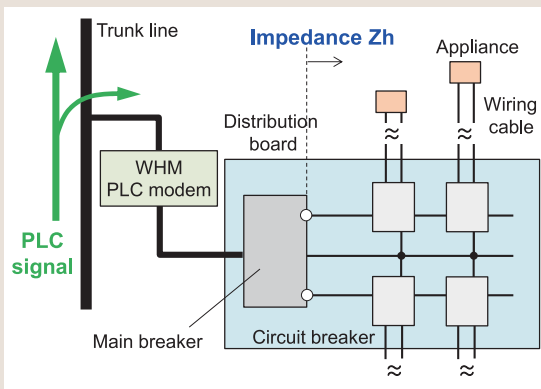
**Fig. 1: System configuration for evaluating transmission delay performance**

Transmission delay performance of a microwave radio link connected to Ethernet switches (IP equipment) and master/slave time synchronization equipment was measured.

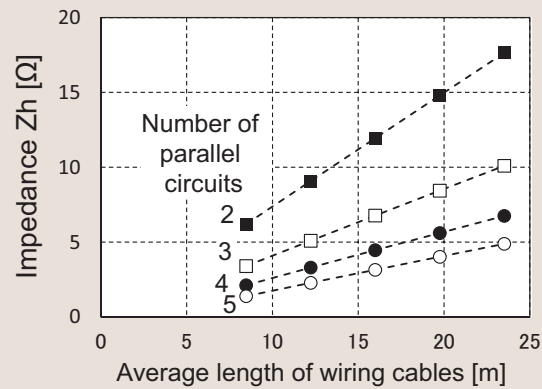
**Table 1: Relationship between interface speeds of microwave radio equipment and viable protection relay communication channels accommodated**

Radio equipment interface speed [Mbps]	With or without branching	Number of repeater equipment	End-to-end communication distance [km]	Number of communication channels
1.5	Without	1	100	2
6.3	Without	4	250	3
	With	1	100	3
150	Without	4	250	5

Viable communication channels accommodated and end-to-end distances are determined by the existence of branching and the number of repeaters. The end-to-end communication distances are reduced by the queuing due to incoming frames from intermediate branch circuits.



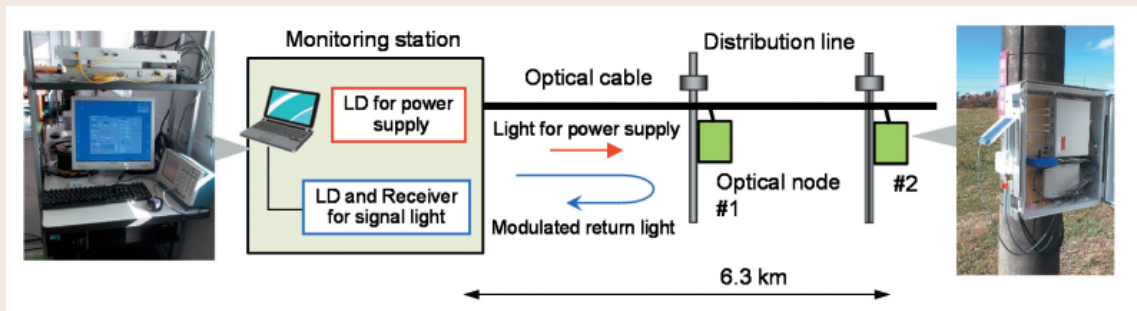
(a) Configuration of wiring and definition of  $Z_h$



(b) Estimated results of  $Z_h$

**Fig. 2: Estimation method of impedance on electrical wiring ( $Z_h$ ) in dwellings**

Impedance of dwelling side including all wiring cables and appliances is defined as  $Z_h$ . It depends on average length of wiring cables and number of parallel circuits. So,  $Z_h$  can be estimated from these parameters.



**Fig. 3: Field testing setup of multi-point sensing system based on optical power supply**

Two optical nodes, at a distance of 6 km from the monitoring station, are driven by light for power supply. Sensing information collected to the optical node is transmitted by a signal light with a wavelength differing to that of light used for power supply.