Proposal of Communication Networks for the Next-Generation Power Grid (TIPS) and Development of Demand Area Secure Communication Network

Background

We have been trying to develop the next-generation power distribution grid (TIPS) as power supply/use infrastructure for future low carbon society. The TIPS has four aims as follows: 1) integrated control of both supply and demand sides, 2) appropriate response to a large number of dispersed power sources, 3) prevention of massive blackout, and 4) upgrading of equipment management. For realization of these aims, advanced communication network capability is necessary. In particular, to develop communication networks with which many consumers and power distribution installations hook up at low cost and in a short period of time, use of optical fiber widely laid in demand areas for distribution automation or FTTH is considered to be effective.

Objectives

The purpose of this study is to propose appropriate communication networks for realizing the four aims of TIPS; and to develop an efficient construction technique of demand area secure communication networks at low cost using previously laid down optical fiber.

Principal Results

1. Proposal of new communication networks for realizing TIPS

Three networks shown in Table 1 and described below were proposed to realize TIPS.

a) Demand area secure communication network: effectively coordinates distribution installations, dispersed power sources, demand control or energy management system, customer premises equipments, etc.
b) Wide-area and high-speed control network: achieves disturbance control and equipment protection in an emergency.
c) Equipment operation and maintenance sensor network: realizes efficient collection of monitoring information and supervisory control of a large number of equipments.

2. Development of demand area secure communication network using existing optical fiber

In order to effectively construct the demand area secure communication networks using PON ＊1 previously laid for FTTH, we developed a new method described as optical signal for TIPS having narrow bandwidth spectrum multiplexes directly to PON signal having wide bandwidth spectrum (Fig. 1). These two signals surely interfere each other, but quality terms of the received two signals can be satisfied simultaneously by regulating each signal power. Fig. 2 shows that there exists a region in which two signals can be detected correctly and simultaneously depending on each received power of two signals. Safeness and independence of the proposed multiplexing method are high because of different modulation methods between the two signals, and replacement of existing PON terminals is not necessary. Fig. 3 illustrates an example of network configuration showing that a signal for TIPS multiplexes to existing PON using the proposed method. Because existing PON facilities are available without modification, new communication networks for TIPS can be developed rapidly and securely, and at low cost.

Future Developments

Prototypes of each network will be produced and evaluated experimentally, and appropriate network constitution methods will be developed.

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Reference

Y. Serizawa, 2009, “ICT Trends in Smart Grid Projects and Promising Solutions of Communications Network for TIPS”, CRIEPI Report R08028 (in Japanese) etc.
S. Morimura, 2009, “Experimental Study of Signal Interference on Media-Integrated Optical Fiber Communication Technology – for Applying to Demand Area Communication Network –”, CRIEPI Report R08024 (in Japanese)

＊1：Passive Optical Network: operates 1:n connection by dividing one optical fiber using a star coupler. Every terminal receives same optical downstream signal, and each terminal extracts assigned part for their own in time slot. This method is popular in the access optical fiber networks.

Table 1 Aims of TIPS and proposed communication networks

Aims of TIPS	Proposed networks	Features
Integrated control of both supply and demand sides	Demand area secure communication network	Having functions such as integrated use of optical fiber and radio wave, IP-based standard protocols, and information security measure in order to communicate effectively between many equipments distributed widely.
Appropriate response to a large number of dispersed power sources		
Prevention of massive blackout	Wide-area and high-speed control network	Including time synchronization function and wide-area and high-speed Ethernet technology.
Upgrading of equipment management	Equipment operation and maintenance sensor network	Collecting monitoring information of power installations for long periods. Having ad-hoc wireless communication function and plug-and-play function of monitoring sensors.

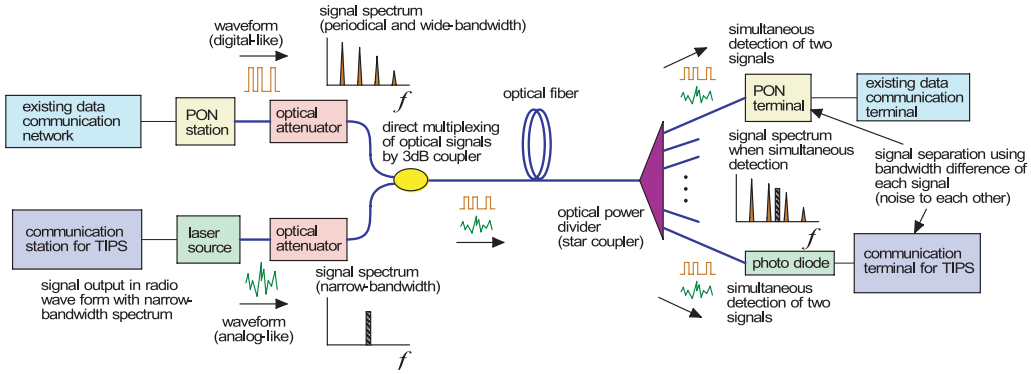

Fig.1 Basic configuration of multiplexing existing PON and TIPS signals

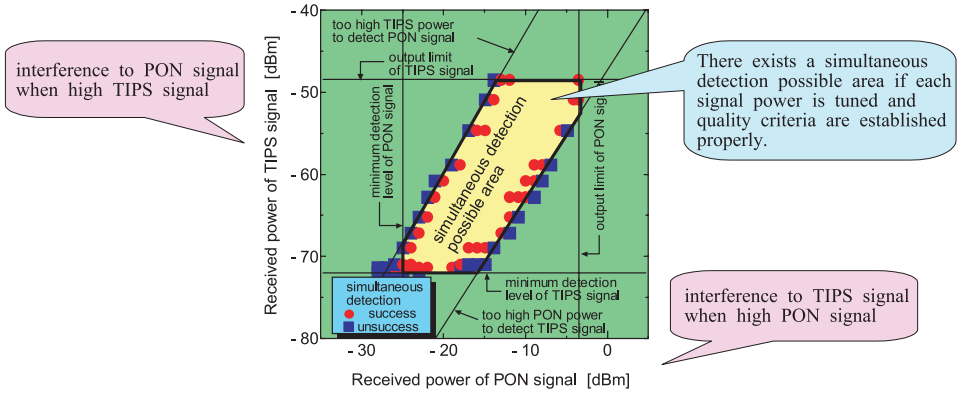

Fig.2 Simultaneous detection possible area of PON and TIPS signals

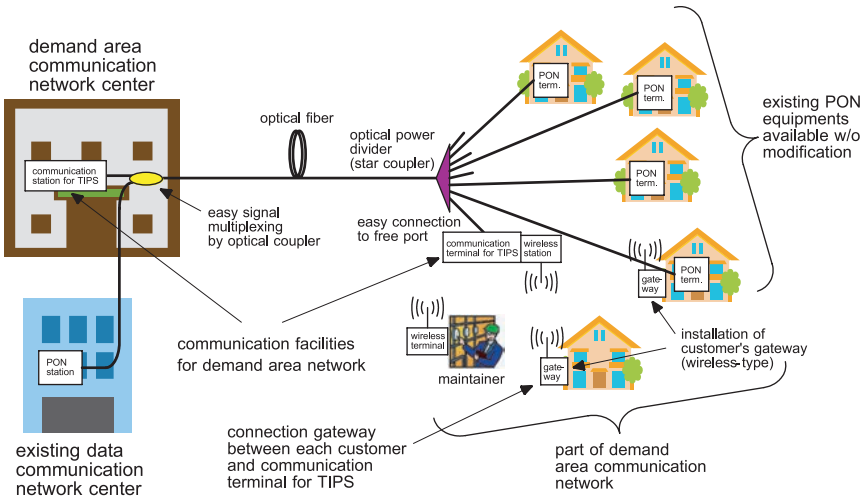

Fig.3 Example of demand area secure communication network using existing PON