1 Introduction

Smart grid technology is the new trend of world power grid, and the latest trends in today's world power system development, power grid intelligence has become the only way to develop smart grid construction for the world's energy and power industry, and also has been elevated to the height of the development of national strategies. State Grid Corporation proposed a "strong and smart grid" development plan, and planning to build 5000 smart substations during the "12th Five-Year" plan, build 7700 smart substations during the "13th Five-Year" plan [1].

Smart substation is an important foundation node for smart grid, is to support the realization of smart grid digital, interactive, automation and intelligent, network communication technology is one of the core technology of smart substation. Currently, industrial Ethernet switches are mainly used in building the communication system of smart substation, The price of industrial switches are too more expensive than the normal Ethernet switch, according to research, part of the cost of industrial switches in domestic smart substation that has been put into operation almost equals to the cost of whole substation protection and control equipments, sometimes it is more higher. Focus on the future, ten thousands smart

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substations will be built. It is worth to explore and study a more economical and practical solution than current used industrial-grade Ethernet switch. EPON (Ethernet Passive Optical Network) is an optical access network technology [2], it has been widely used in radio and television field, and also has successful application experience in power systems and electricity distribution network, one of these applications is the Zhejiang HaiYan distribution network based on EPON [3], another is the Jiangxi RuiChang electricity information collection based on EPON [4–6]. The connecting to home technology using electric optical fiber based on EPON and OPLC (Optical Fiber Composite Low-voltage Cable) has a bright prospect in many fields such as smart district; charging station for electric vehicles etc. Research will focus on using EPON communication technology in field of smart grid for a long time in the future.

This paper analyzes the operational characteristics of smart substation communication system based on EPON technology combined with the working mechanism, proposed a candidate solution to building the smart substation communication system in which industrial Ethernet switch is replaced by EPON communication device, thus the whole cost of communication system will be reduced, and promoted the application of smart substation technology, and also proposed the communication performance of two typical application solutions that using EPON to build the smart substation communication system. Finally the cost of using industrial Ethernet switch and using EPON communication device is analyzed.

2 Business analysis

2.1 Communication Application Requirement

Traditional substation communication networks is only used to transmit four remote information such as analog, signal, control, and pulse information in substation SCADA system. But various application functions are dependent on the network system in smart substation which uses IEC 61850 as its only method of communication and modeling standard. Communication network must have the function of transferring a variety of nodes information, including MMS of the station control layer, GOOSE and sample value (SV) of the process layer, etc. And realization of protection function (including the sample value transfer, trip that have strict real-time performance requirement) also depends on the communication network in the substation, therefore, the smart substation communication network must have a high real-time performance. According to the requirements of IEC 61850, the information transmission time of the process level bus current, voltage transformers(CT, VT) and protection, the real-time voltage and current sampled value between monitoring & control units and the protection trip GOOSE signal from the protection unit to the yard switching equipment are the most urgent, it should be less than 2 ms; The protection blocking GOOSE messages between protection units is of high transmission rate, the information transmission time is