

# Research of the application of the new communication technologies for distribution automation

Guoxin Zhong<sup>1</sup>, Hao Wang<sup>1,\*</sup>

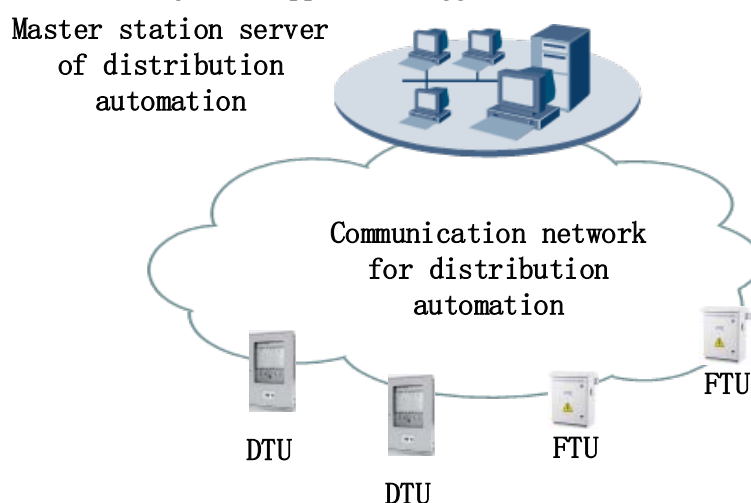
<sup>1</sup>Guangzhou Power Supply Co.Ltd.,Guangzhou,China

\*Corresponding author e-mail: wanghao\_hust@sina.com

**Abstract.** Communication network is a key factor of distribution automation. In recent years, new communication technologies for distribution automation have a rapid development in China. This paper introduces the traditional communication technologies of distribution automation and analyse the defects of these traditional technologies. Then this paper gives a detailed analysis on some new communication technologies for distribution automation including wired communication and wireless communication and then gives an application suggestion of these new technologies.

## 1. Introduction

A typical distribution automation system consists of distribution terminals, communication network and master station server, which is showed in Figure 1. The distribution terminals can be FTU (Feeder Terminal Unit) or DTU. Distribution automation systems can monitor, protect, control and manage the electric distribution network effectively. In recent years, communication network become a key factor of the coverage and the reliability of distribution automation systems. Based on analyzing the defects of the traditional communication technologies of distribution automation, this paper will discuss some new communication technologies for distribution automation including wired communication and wireless communication and then gives an application suggestion of these new technologies.

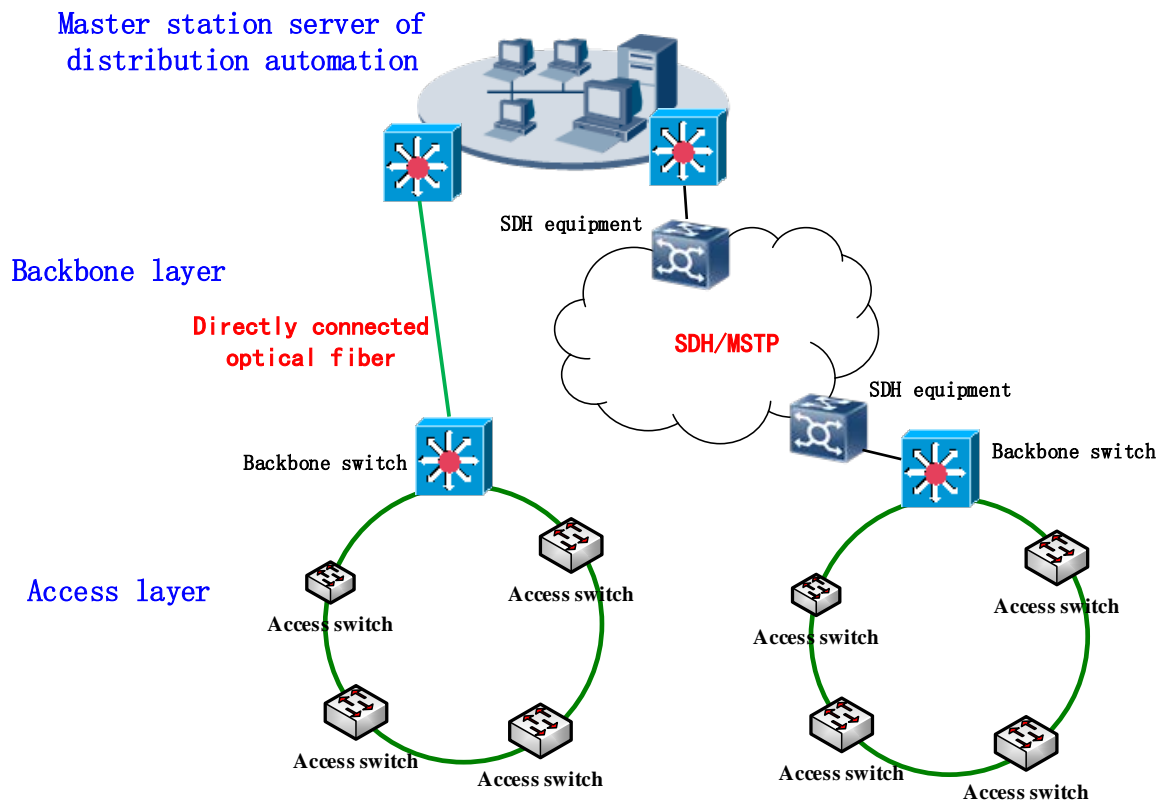


**Figure 1.** Structure of a typical distribution automation system.



## 2. Wired communication technologies

Fiber-optic networks are the most commonly used wired distribution automation communication networks in China. Fiber-optic networks for distribution automation are usually divided into two layers showed in Figure 2. Sometimes these two layers can have a further division of three layers (add a core layer), this paper mainly discusses the two-layers structure.



**Figure 2.** The two-layers structure of the fiber-optic networks.

### 2.1. The backbone layer of the fiber-optic networks in traditional technologies

The backbone layer of the fiber-optic distribution automation communication network consists of the backbone switches in the transformer substations and the communication channels between the backbone switches. The communication channels can be directly connected optical fibers or SDH/MSTP networks. However, the optical fiber resources from one substation to another are limited and the construction of optical fibers will have a huge cost, so directly connected optical fibers in backbone layer cannot meet the future communication demand of distribution automation.

The format of the messages sent by the distribution automation terminal is IP packages. The SDH/MSTP network is a TDM network but not packet-based network, it has low slot resource utilization rate when transmitting IP packages. So SDH/MSTP networks cannot meet the large data flow growth of distribution automation messages in the future.

### 2.2. The access layer of the fiber-optic networks in traditional technologies

The most widely used communication technologies for the access layer of the fiber-optic distribution automation communication network are these two fiber communication technologies: industrial switch network and EPON. However, there are some problems existing in these traditional technologies, which cannot meet the communication performance demand of the access layer in the future.

The industrial switch networks often form interconnected rings to ensure the automatic network recovery by applying spanning tree protocols such as STP or RSTP. But it will cost several seconds for the spanning tree to adjust its topology when the network failures happens, and this time cost will be longer when the scale of the network grows larger. And the depth of the spanning tree exceeds the limit of the protocols will cause risks of the network.

The EPON networks often use star connection structures. The failure of the OLT (Optical Line Terminal) equipment will make the whole network unavailable. The OUN (Optical Network Unit) of the EPON network is a passive optical component, which cannot be managed by the network management system. The ratio of the passive spectrometers of EPON is fixed, so EPON network cannot adapt to the large-scale network expansion scenarios because adjust the ratio of the passive spectrometers and replace them is difficult work.

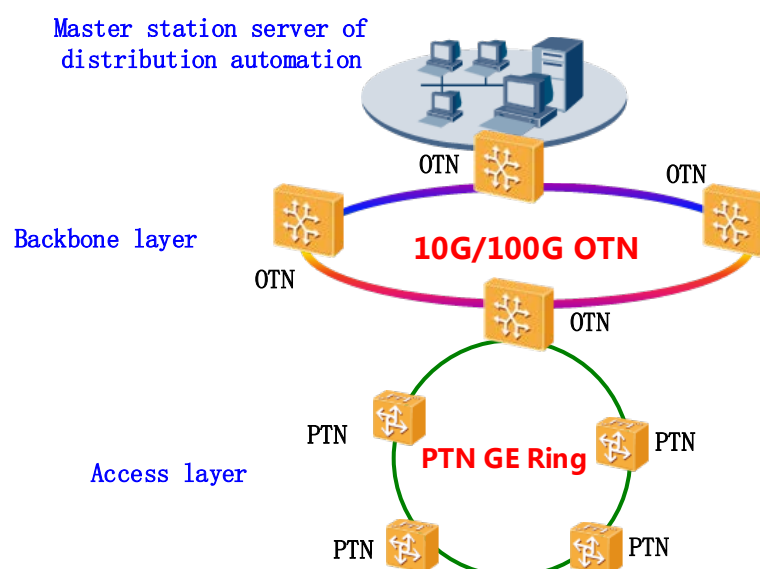
### 2.3. The application of the new wired communication technologies for distribution automation

The defects of the traditional wired technologies above will be obstacles of the future development of the distribution automation, so the application and popularization of new wired communication technologies is very necessary.

OTN (Optical Transport Network) [1] technology is based on the wave division multiplexing technology. OTN network solves the problems that the traditional WDM network doesn't have the ability of scheduling the wavelength/subwavelength services, and has weak network capability and weak protection ability. OTN is designed for the backbone transmission network of the next generation. OTN network is suitable for the backbone layer of the fiber-optic network to meet the large data flow growth in the future.

PTN (Packet Transport Network) is packet-based network with statistical multiplexing characteristics[2], which is suitable to transmit the IP packet messages of distribution automation. PTN network has stronger network management functions[3] than the industrial switch network and EPON network. So PTN network is suitable for the access layer of the fiber-optic network.

The network model of the distribution automation fiber-optic network based on OTN and PTN is showed in Figure 3. The backbone layer consists of 10G/100G OTN and the access layer consists of PTN GE rings.



**Figure 3.** The network model of the distribution automation fiber-optic network based on OTN and PTN.

### 3. Wireless communication technologies

Wireless communication networks for distribution automation include public wireless networks [4] and power private wireless networks. Traditional public wireless networks rent the cellular networks from the telecom operators, the cellular network can be GPRS, CDMA/CDMA2000, WCDMA, and TD-LTE/FDD-LTE. The private wireless networks of power grid constructed in China include 1800MHz and 230MHz private TD-LTE network [5] based on the working frequency.

The cellular communication technology will enter the age of 5G in the near future. 5G mobile network has 3 application scenarios: eMBB, mMTC and uRLLC, which can adapt to different service applications in the power grid including distribution automation. LPWAN (Low Power Wide Area Network) including LoRa and NB-IoT can also be used in the communication of the distribution automation terminals which don't have strict bandwidth and time-delay requirements.

### 4. Conclusion

Traditional communication technologies cannot meet the development demand of distribution automation in the future. Wired communication technologies including PTN and OTN, wireless communication technologies including 5G and LPWAN will play important roles in the distribution automation communication network in the future.

### References

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