

A fusion networking model for smart grid power distribution backbone communication network based on PTN

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Abstract. In current communication network for distribution in Chinese power grid systems, the fiber communication backbone network for distribution and TD-LTE power private wireless backhaul network of power grid are both bearing by the SDH optical transmission network, which also carries the communication network of transformer substation and main electric. As the data traffic of the distribution communication and TD-LTE power private wireless network grow rapidly in recent years, it will have a big impact with the SDH network's bearing capacity which is mainly used for main electric communication in high security level. This paper presents a fusion networking model which use a multiple-layer PTN network as the unified bearing of the TD-LTE power private wireless backhaul network and fiber communication backbone network for distribution. Network dataflow analysis shows that this model can greatly reduce the capacity pressure of the traditional SDH network as well as ensure the reliability of the transmission of the communication network for distribution and TD-LTE power private wireless network.

1 Introduction

Communication network for distribution is a key point in smart grid. In current communication network for distribution in Chinese power grid systems, optical fiber communication are most mainstream method, including industrial switch networks and EPON^[1]. Most of the fiber communication networks for distribution can be divided into backbone layer and access layer. The backbone layer which is bearing by the SDH network is used to gather traffic. In recent years, TD-LTE power private wireless network grow rapidly^[2]. The backhaul network of the power private wireless network is also bearing by the SDH network. As the distribution automation and measurement automation keep rapid growth of the scale, this traditional networking model will have a big impact with the SDH network's bearing capacity which is mainly used for main electric communication in high security level. The research of a new networking model is very necessary.

2 Capacity analysis of the power distribution backbone communication network

Figure 1. shows a typical networking model of fiber backbone communication network for distribution of industrial switches. The access layer is composed of "hand in hand" ring of the access switches in the power distribution room. The backbone layer which is mainly used for main electric communication is bearing by the MSTP link of the SDH network from backbone layer switches to core router.

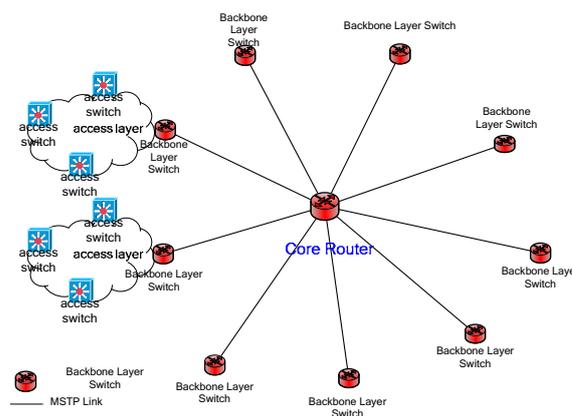


Figure 1. power distribution backbone communication network.

Table 1. shows the traffic statistics of backbone communication network for distribution. Table 1. shows that the distribution automation information is data packet which has a random data flow traffic. The network in Figure 1. configures the time slot of the MSTP link in 2*5Mbps. The MSTP link of the SDH network is mostly used for the TDM service like relay protections. When the SDH network carries the data packets, it will cause huge waste of to the time slots, and as the traffic of distribution automation information grow rapidly in recent years, it will make a big pressure to the SDH network.

Table 1. Traffic statistics of power distribution backbone communication network.

convergence point	Access switch number	Traffic(kbps)
1	92	129.536

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convergence point	Access switch number	Traffic(kbps)
2	60	211.2
3	66	219.648
4	100	1886.72
5	196	2007.808
6	234	3032.832
7	320	4336.64
8	568	4432.384
9	462	10407.936
10	1024	11875.072

3 Capacity analysis of the TD-LTE power private wireless backhaul network

Figure 2. shows a typical networking model of power private TD-LTE wireless backhaul network. In order to save the SDH time slots,each base station have a dedicated 3*2M channel MSTP to a convergence SDH device. Up to 5 to 6 base stations have a common 2*5 MSTP channel from the convergence SDH device to the core SDH device. In this model, the convergence SDH device use the layer 2 switch function to converge the data flow, each base station in fact have only 1.66Mbps time slot capacity in average. The 1.8GHz TD-LTE base station have 42 Mbps peak data rates for 3 cells when works at 5MHz bandwidth,as the bandwidth expanding,the cell peak data rates will grow as well. So the TD-LTE wireless backhaul network in SDH channel will be a great bottle-neck to the performance of the TD-LTE power private wireless network. In addition,the TD-LTE power private wireless backhaul network carries data packets,which is also a waste of SDH time slots.

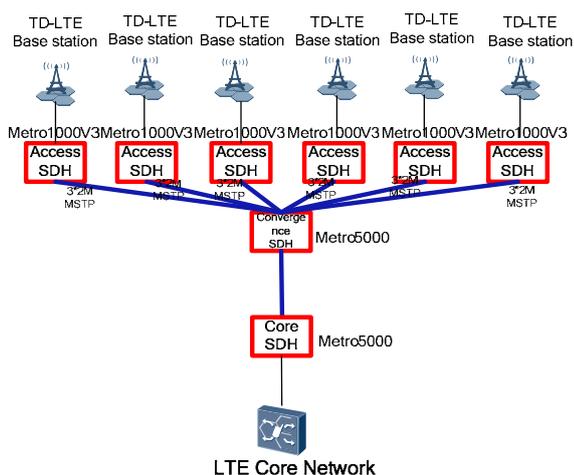


Figure 2. Typical TD-LTE power private wireless backhaul network.

4 A new fusion networking model based on PTN

4.1 Analysis of the PTN technology

PTN (Packet Transport Network) technology is widely used in the mobile backhaul network telecom operators. This technology is designed for the bursty traffic and statistical multiplexing characteristics of data packets networks^[3]. And compared to the common IP networks which are composed of switches and routers, PTN have great network management performance and Fault self-healing capability. In addition, PTN support 50ms path switching to ensure the self-healing ability of communication equal to SDH. Therefore, PTN is quite suitable for TD-LTE power private wireless backhaul network and power distribution backbone communication network, which carries data packets and have great demand in reliability and network management performance.

4.2 Network planning of the fusion networking model based on PTN

Figure 3. shows a fusion networking model for power distribution backbone communication network based on PTN. In this model, PTN network is the unified bearing of the TD-LTE power private wireless backhaul network and fiber communication backbone network for distribution. This model is divided into 3 layers, which are called PTN convergence ring, PTN backbone ring and PTN core nodes.

PTN convergence ring is the PTN GE ring which is composed of the PTN equipment in the 110kV substation. Each PTN equipment in the PTN convergence ring has two independent links to the industrial switches ring in the distribution room to converge the data flow of distribution automation and insure the reliability. Meanwhile, Each PTN equipment in the PTN convergence ring also connects to the BBU (Building Baseband Unit) of the TD-LTE power private wireless network in the 110kV substation by FE interface, as the backhaul equipment between the base station and core network.

PTN backbone ring is the PTN 10G ring which is composed of the PTN equipment in the 220kV substation. PTN backbone ring is used in converge the data flow in the PTN convergence ring and send it to the PTN core nodes. Meanwhile, each PTN equipment in the PTN backbone ring also connects to the BBU of the TD-LTE power private wireless network in the 220kV substation by FE interface, as the backhaul equipment between the base station and core network.

PTN core nodes converge the data flow in the PTN backbone ring and distribute it to the core network of the TD-LTE power private wireless backhaul network, NMS(Network Management System)of TD-LTE power private network ,master station of distribution automation system and NMS of fiber communication network for distribution. Each master station system has two independent links to the PTN core nodes, and each PTN core node has two independent links to different PTN equipment in the PTN backbone ring.

In this fusion networking model based on PTN, the distribution automation data, NMS data and the backhaul data of TD-LTE power private wireless network can be

divided into different VLANs or L3 VPNs to meet the data isolation security demand.

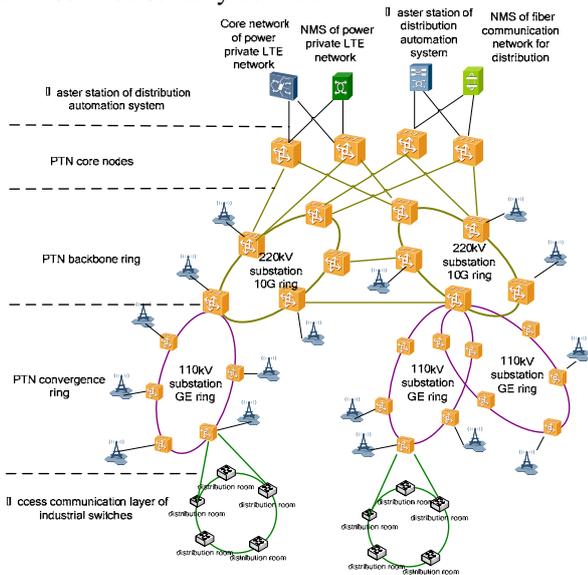


Figure 3. A fusion networking model based on PTN.

4.3 Path protection and data flow planning of the fusion networking model

In this network model, PTN convergence GE ring and PTN backbone 10G ring use the LSP APS protection. This path protection strategy uses PTN hardware to transmit the OAM message, and the switching time is less than 50ms, which has a high reliability. The key nodes PTN equipment can use TPS device protection to promote the device reliability. Moreover, VRRP, L3 VPN FRR and other protection technology such as linear protection switch, ring protection and dual-homing protection can also be used to achieve end-to-end production.

Table 2. shows the data flow analysis of the fusion networking model. Considering the TD-LTE power private wireless network uses the TDD (time division duplex),which allocate the uplink and downlink data packets in different time slots, each 230 MHz base station's backhaul flow demand is 15Mbps ,and each 1.8GHz base station's backhaul flow demand is 20Mbps.This above-mentioned bandwidths can meet the huge backhaul flow demand when the 230 MHz base station runs in 340 frequency points(25kHz per point) and 1.8GHz base station runs in 10MHz bandwidths in the future. The data flow demand of each access ring of industrial switches is 0.5Mbps*20distribution rooms=10Mbps.Each PTN convergence ring is deployed of 5 230 MHz base stations, 5 1.8GHz base stations and 20 industrial switches, the total bandwidth demand of a PTN convergence ring is 750Mbps. .Each PTN backbone ring is deployed of 10 PTN convergence rings, 5 230 MHz base stations and5 1.8GHz base stations, the total bandwidth demand of a PTN backbone ring is 7850Mbps.The PTN core nodes are 10GE.In this analysis, all the bandwidth demands are considered in max demand, actual bandwidth of the network will be less than the planning data flow. The calculation proves that the fusion networking model can meet the data flow demand of the

fiber communication backbone network for distribution and TD-LTE power private wireless backhaul network in max bandwidth configuration, on the premise that using the 1+1 path protection to ensure the communication reliability.

Table 2. Data flow analysis of the fusion networking model.

	eNodeB (Mbit/s)	Access ring of industrial switches (Mbit/s)	PTN convergence ring (Mbit/s)	PTN backbone ring (Mbit/s)	PTN core nodes
data flow demands	15Mbps (230MHz base station) 20Mbps (1.8GHz base station)	0.5Mbps* 20distribution rooms=10 Mbps	(15Mbps*5 230 MHz base stations+20Mbps*5 1.8GHz base stations +10Mbps*20 industrial switches in an access ring)*2(LSP APS protection)=750Mbps	(375Mbps*10 PTN convergence rings +15Mbps*5 230 MHz base stations +20Mbps*5 1.8GHz base stations)*2(LSP APS protection)=7850 Mbps	10GE

5 Conclusions

Traditional SDH/MSTP network is based on TDM technology, which is not suitable for the transmitting of the IP data packets of the fiber communication backbone network for distribution and TD-LTE power private wireless backhaul network. This paper presents a fusion networking model which use a multiple-layer PTN network as the unified bearing of the TD-LTE power private wireless backhaul network and fiber communication backbone network for distribution. The calculation result shows that this model can meet the data flow demand of the fiber communication backbone network for distribution and TD-LTE power private wireless backhaul network as well as ensure the reliability of the transmission.

References

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