

Construction of China Mobile's Optical Transmission Network

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1 Hierarchical Architecture

According to the principles of optical transmission hierarchy and division, China Mobile's optical transmission network is divided into three layers: inter-provincial backbone transmission network, intra-provincial backbone transmission network and local transmission network. Figure 1 shows the structure.

1.1 Inter-Provincial Backbone Transmission Network

The inter-provincial backbone transmission network covers most provinces throughout China, providing large capacity inter-provincial circuits for each provincial capital and converging tandem node cities, and connecting each intra-provincial backbone transmission network. The inter-provincial circuit takes VC-4 as a basic unit to provide circuits at the speeds of STM-4/VC-4/4c and STM-16/VC-4/16c, and 2.5 Gbit/s and 10 Gbit/s wavelength channels.

1.2 Intra-Provincial Backbone Transmission Network

The intra-provincial backbone transmission network provides transmission circuits and connects each local transmission network. The intra-provincial circuit takes 2 Mbit/s as a basic unit to provide circuits at the speeds of STM-1 and STM-4/VC-4/4c, and the intra-provincial backbone WDM transmission network also provides a wavelength channel.

In order to ensure the reliability of connec-

Abstract:

The hierarchical architecture of China Mobile's optical transmission networks, including the inter-provincial backbone transmission networks, intra-provincial backbone transmission networks and local transmission networks, are introduced. Their topologies and transmission technologies are presented, as well as the network management scheme.

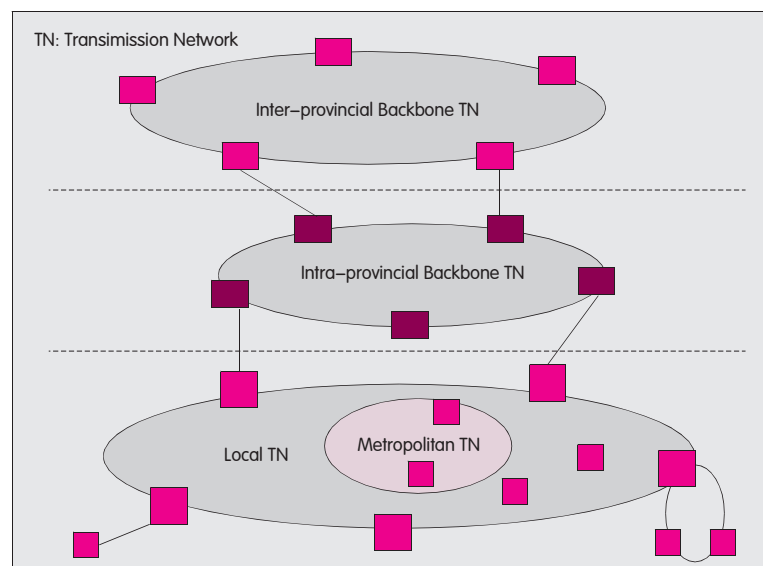


Figure 1. Hierarchical architecture of China Mobile's optical transmission network.

tion between the intra-provincial and the inter-provincial backbone transmission networks, in principle two connection nodes are required. If the conditions cannot be satisfied, then the intra-provincial backbone transmission network can be temporarily connected to one node of the inter-provincial backbone

transmission network.

1.3 Local Transmission Network

The local transmission network provides transmission circuits among local towns. The access portion of the local transmission network provides accessibility for base stations, buildings and residential districts. The provision of local transmission network takes 2 Mbit/s as its basic unit, and provides circuits at the speeds of STM-1 and STM-4/VC-4/4c. The local WDM transmission network also provides a wavelength channel. One or two gateway nodes are set up between the local transmission network and the intra-provincial backbone transmission network.

The metropolitan transmission network is a sub-network of a local transmission network, while both of them belong to the same layer. The metropolitan transmission network's features include dense service demands and large service quantity. It is the basis for developing a broadband IP network. The metropolitan transmission network provides transmission circuits for service nodes such as switches, base station controllers and routers within the same city.

2 Topological Structures and Transmission Technologies

China Mobile's optical transmission network adopts a loop network as its main structure and a link system as supplementary; the whole transmission network adopts SDH/WDM technology. The following are the detailed principles of choosing a topological structure and transmission technologies for inter-provincial, intra-provincial backbone transmission networks and local transmission networks.

2.1 Inter-Provincial Backbone Transmission Network

The inter-provincial backbone transmission network adopts a loop network structure. The loop network is featured by simple network topology, high network reliability and fewer links required. The inter-provincial backbone transmission network is composed of a number of loop networks according to geographic locations and traffic loads, and every loop network covers a certain area. In order to ensure net-

work reliability and proper routing, two joint nodes are required between adjacent loop networks, and a double-node interconnection (DNI) protection function is required. The DXC4/4 equipment is set up on joint nodes of loop networks and on the nodes with high traffic, to ensure the flexibility of cross-loop circuit assignment. In the areas where no loop network is available, a link system can be used to connect the loop.

Two nodes of an inter-provincial backbone transmission network should be set up in every province to improve the reliability of connecting an intra-provincial backbone transmission network to an inter-provincial backbone transmission network. If conditions do not allow, one node can be set up first. According to the service distribution features of an inter-provincial backbone transmission network, the loop network style adopts multiplex section protection ring. According to the current traffic loads and service development conditions, the inter-provincial backbone transmission network should adopt the $N \times 10$ Gbit/s ($N \geq 32$) WDM system and the 10 Gbit/s or 2.5 Gbit/s SDH system in the east part of China, and the $N \times 2.5$ Gbit/s ($N \geq 16$) WDM system and the 2.5 Gbit/s SDH system in the west.

On selection of a loop network technology, when the service traffic is heavy, a four-fibre ring is more economical than a two-fibre ring. In addition, the four-fibre ring has the switching function so it is better for maintenance and can restore rapidly when the fibre fails. Moreover, it can deal with several failures at the same time, which is very beneficial for an ultra-length multiplex section protection ring. Therefore, in the eastern areas four-fibre multiplex section protection rings of 10 Gbit/s are adopted as the main technology. Nevertheless, in the western areas two fibre multiplex section protection rings of 2.5 Gbit/s are adopted as the main technology.

2.2 Intra-Provincial Backbone Transmission Networks

The intra-provincial backbone transmission networks adopt loop networks as the main structure. According to the number of network nodes and geographic locations, one or more loop networks can be set up with DXC 4/1

connection equipment, or with ADM which can provide stronger service assignment function, and this topology is adopted amongst loop networks. It is the first choice to set the nodes with high traffic as public nodes of several loop networks. Two joined nodes are required between adjacent loop networks and a double-node interconnection (DNI) protection function is also required.

The number of gateways within each province corresponds to the number of nodes on an inter-provincial backbone transmission network. DXC4/1 or ADM equipment, which provides stronger service interconnection functions, is set up on a gateway node, achieving service convergence and channel regrouping.

In the eastern provinces of China, the intra-provincial backbone transmission network can adopt the 2.5 Gbit/s or 10 Gbit/s SDH systems, according to different traffic loads, and the 16~32 waves WDM system can be adopted for higher traffic. But in the western provinces the 2.5 Gbit/s SDH system can be adopted, and the 16~32 waves WDM system can be adopted for higher traffic.

On selection of the loop network technologies, the channel protection ring or the multiplex section protection ring can be adopted according to different service distribution modes. Generally, the channel protection ring is more favourable for convergence services and the multiplex section protection ring is more suitable for equally distributed services.

2.3 Local Transmission Networks

The local transmission network mainly adopts loop structure, with the link system as a supplement. Based on the number of network nodes and geographic locations, one or more loop networks can be set up with DXC 4/1 connection equipment, or with ADM which can provide stronger service assignment function, and this topology is adopted amongst loop networks. It is better to choose the nodes where the MSC is located as public nodes for multiple loop networks in order to reduce the switching between circuits of different loops.

As the end of a transmission network, the access portion of a local transmission network possesses such features as multiple points, wide coverage, and fewer circuits between

nodes. In the access portion, the loop network or link system can be chosen as required.

One or two gateway nodes are set up on each local transmission network for the connection to the intra-provincial backbone network, for which the DXC 4/1 connection equipment, or ADM that provides stronger service assignment function, can be set up on gateway nodes. When the local transmission network reaches a certain scale, two gateway nodes are required to connect the intra-provincial backbone transmission network.

The local transmission network can adopt the 2.5 Gbit/s or 10 Gbit/s SDH systems according to different traffic loads. At a high traffic load, the WDM system of 16~32 waves can be adopted. On selection of the loop network technologies, channel protection ring or multiplex section protection ring can be adopted according to different service distribution modes.

To the metropolitan transmission network, the equipment capability should be comprehensively considered to meet users' requirements for IP, data, multimedia and other broadband services. In cities with high service traffic, a metropolitan area OADM system can be adopted.

In the access portion of a local transmission network, as the network construction principle, optical fibre access should be widely adopted, with wireless and copper line access as supplements. For the transmission technology, SDH, PDH or a microwave system, etc. can be adopted as required. The access portion equipment requires many kinds of interfaces to satisfy the access requirements of services such as base station, Ethernet network and IP. The system capability should satisfy the requirements of many access services such as base station service, voice, data and multimedia.

3 Network Management

An important feature of an optical transmission network is an excellent and strong network management capability. It is important for improving network operation efficiency and reducing maintenance costs. The construction of an optical transmission network management system is related to its network structure, multi-manufacturer environment, and especially the maintenance system that will be

built later.

3.1 System Components

Generally, a transmission network management system includes a local care terminal (LCT), a network element management system (EM) and a network management system (NM). A local care terminal (LCT) has simple functions, being generally used for on-the-spot debugging and equipment testing. A network element management system (EM) carries out the maintenance and management for SDH network element equipment. The management functions include fault, configuration, performance and security managements.

Based on the SDH network layer, a network management system carries out the management of a whole network, which includes point-to-point channel configuration, locating network malfunctions, point-to-point performance supervision and network recovery and protection.

The network element management system and the network management system are the main components of the optical transmission network management, of which the network layers' network management is most important and should be emphasised in network construction.

3.2 Network Management Scheme

According to the architecture of China Mobile's transmission network, its NM system should include three parts: the WDM network management, SDH network management and DXC network management. In the near future, in order to rapidly construct a management system for China Mobile's transmission networks, different manufacturers' network management sub-systems will be used to manage the whole network.

Because the transmission network is commonly an environment of multi-manufacturers, the whole network can be divided into several management layers or areas and each layer/area adopts a single manufacturer's equipment and its corresponding management sub-system. Management sub-systems can fulfil end-to-end management of transmission networks within a layer or an area. Manual coordination is required for channel deployment

and management of different layers/areas.

SDH and WDM belong to different network layers, so network element management systems and network management systems of SDH and WDM should be set up respectively. It is better to use the DXC equipment from the same manufacturer in the whole network and a DXC network management system is set up in the whole network to realize DXC end-to-end deployment. The network management sub-systems can be physically centered in a machine room and under unified management.

In order to ensure the realisation of the project in the near future, the number of equipment manufacturers in the whole network must be limited. For the inter-provincial backbone transmission network, SDH equipment can be chosen from 2 or 3 manufacturers, and WDM equipment from 1 or 2 manufacturers, but DXC equipment for the whole network can only be chosen from a single manufacturer. Therefore, each manufacturer should provide a network management sub-system. As to the intra-provincial network, each province should adopt equipment from one manufacturer, or divide the intra-provincial network into several layers, and then equipment from one manufacturer can be chosen for each layer. In choosing an equipment manufacturer, the network management capability should be an important factor.

It is a long-term goal for China Mobile's transmission network management to adopt unified network-layer management system to manage multiple manufacturers' network equipment. On the network element management layer, manufacturer's management system can be deployed; on the network management layer, a unified SDH and WDM network management system organised and developed by China Mobile can achieve the automatic deployment of end-to-end circuits and protection of the whole network. **ZTE**

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Biography

Li Yang graduated from Xidian University and gained master's degree, is a senior engineer with Transmission System Department of ZTE Corporation. His research interest is optical transport layout.