Optical access network trends

New trends like network structure flattening, increasingly intelligent management and maintenance, integrated bearing of convergence services, even higher network security and reliability, make it critical for the optical access network to adapt both on the network and equipment layers.

By Ao Li
As a result of telecom restructuring, the time is near for China’s three major telecom operators to launch full-service operations. As a basic bearer network, the access network has to bear multiple services such as voice, data, video, enterprise access and backhaul services of the radio base station.

Traditional copper wired access networks are constrained by attenuation in signal transmission, so the coverage of an end office is usually within 3km and a large number of end offices are deployed in the network. This poses a challenge for operators to build equipment rooms and auxiliary facilities and to control OPEX. The dispersed distribution of end offices requires adding a metropolitan convergence layer. Consequently, there are more network layers in metropolitan areas, the structure is complicated and network OPEX gets higher.

The introduction of the optical access network with a coverage of 20km ensures that optical line terminals (OLTs) can be advanced to the traditional metropolitan convergence nodes at the initial stage of optical access network construction. It simplifies the network structure of the convergence layer for the access network and reduces the number of end offices. This is important not only for the network upgrades of traditional fixed operators, but also for the new networks from emerging broadband operators who lack equipment room resources.

While accelerating optical fiber access applications, operators should pay attention to setting up OLTs in a centralized manner under unified planning to realize “large capacity and fewer nodes deployment” and to optimize the network structure of the wired access network.

The large capacity, high access bandwidth, high reliability, and multi-service QoS support capability features of the optical access network enable the access network to evolve towards a unified, converged and efficient bearer platform.

The optical fiber broadband access network was deployed on a considerable scale in China during 2007. The future development strategy of China’s FTTx has set a clear objective for operators to “vigorously advance the substitution of fiber for copper cable, deploy access networks of optical fiber, realize FTTB (fiber to the building) and FTTV (fiber to the village) in newly built areas and strengthen renovation of existing metro areas.”

Current statistics show that more than 4.5 million Chinese homes are passed by FTTx. The network has been built by taking FTTB/C as the predominant mode and FTTH as the supplementary mode. In actual network construction, the optical access network also faces multiple challenges and must consider the following issues comprehensively.

Construction, operation and maintenance

By substituting fiber for copper cable, operators can reinforce the effectiveness of overall planning for access optical fiber, OLT, ODN and system devices during FTTx network construction.

It is necessary to strengthen the linkage between front-end and back-end devices, power supply assurance, IT support, project construction, operation and maintenance and to quickly transform the access capability into service capabilities.

The actual situation indicates that FTTx deployment now faces numerous problems that arise due to the lack of adequate capability and experience on the part of the operator in the construction, operation and maintenance of the optical fiber access network, especially in operation and maintenance.
First, the deployment, configuration, and upgrade of devices is a complicated and cumbersome affair. The types of devices and the quantity of network elements are increasing and their management and maintenance are complicated and laborious. Multi-service configuration and service provision involve multiple devices and multiple back-end support systems and operation is very complicated.

Second, the number of remote nodes requiring maintenance and management has doubled along with the gradual devolution of optical fiber. As remote devices are removed from the equipment room, the operating environment of the device is poor and the fault rate is on the rise. The devices are widely dispersed, leading to a significant amount of troubleshooting workloads.

These issues have imposed very high requirements for FTtx device management, device deployment, service issuance, fault monitoring, and control capability on network security.

Capacity configurations for PON OLT

The large capacity, fewer offices and network flattening trend implies an increase in the number of users covered by the OLT, which creates new requirements for OLT capacity. The number of passive optical network (PON) ports per board, board bus bandwidth, uplink port capacity of OLTs, and the system’s switching capacity all need to be increased. This trend is reflected in the emergence of large-capacity OLTs (with 800GB switching capacity, eight PON ports per board and 10GB uplink ports).

When network layers are simplified, it is preferential that OLTs should be directly connected to the upper-link BRAS/SR equipment. In addition, the growing OLT capacity and the increasing number of users covered in the future will impose an increasingly higher requirement on FTtx network reliability.

One primary requirement for PON devices is to fully consider protecting the key components of OLTs (such as redundancy protection for the power panel, main control board, and uplink board). For networking protection, the OLT needs to provide dual uplink protection to key customers or critical services, avoiding any single-point fault and providing reliable access.

At the initial stage of FTtx construction, uplink redundancy protection can be realized for OLTs directly connected to the BRAS/SR by way of link bundling or VRRP. The carrier-class Ethernet protection technology can then be introduced to realize millisecond protection between active and standby links of OLTs as well as the dual-homed configuration of BRAS/SR of the OLT.

Requirements for PON ONU

In the FTTB/C mode, as the remote device of the PON, the optical network unit (ONU) should meet network and service needs in functionality and performance. PON ONU devices support the switching between VLAN 1:1 and n:1 and cross-VLAN multicast replication, meet the requirements for QoS deployment and support the queue dispatching based on 802.1P and priority. The ONU will provide the built-in voice function based on service development needs.

Different building and application environments have different requirements for the ONU port density. Generally, the configurations of 8, 16, 24 and 32 ports can cover requirements in various scenarios.

The narrowband to broadband (NB-BB) ratio of the ONU is specified based on the service penetration rate. To guarantee long-term operating performance, the ONU should be able to work in the -10°C to +55°C environment and have a solid design for heat dissipation. The plug-in ONU can dissipate heat by using a fan with a minimum service life of 50,000 hours. The integrated ONU can use a natural heat dissipation design in lieu of a fan in consideration of the special stairway installation environment and the impact on households. ONUs should also have superior lightning protection performance. Power supply ports and DSL/POTS ports when equipped with 4kV lightning protection capability can provide remote surveillance over temperature, municipal...
Expert’s Forum

Optical access network trends

power, battery and access control. The ONUs mainly use the local power supply of AC 220V or DC -48V and may use a backup battery or UPS as required. The height of ONUs needs to be low in order to meet the installation requirements of the narrow staircase environment.

The ONU is a terminal access device that can also be connected to the BTS and support the private line access for small- and medium-sized business users. In the substitution of fiber for copper cable scenario, the ONU platform architecture supports smooth upgrades from the existing ADSL2+ to VDSL2 or LAN so as to support smooth upgrading of service bandwidth.

FTTx device management

New issues facing network management and maintenance that come with the introduction of the PON system are: an increase in the number of access points, the shift from single service to multiple services, the greater granularity or refinement in service management and an increase in the amount of maintenance workloads for the optical cable network. As the number of ONUs increases significantly after mass deployment of the optical access network using the PON, the operation, management and maintenance of ONUs become quite important.

Under the FTTB mode, the management and maintenance of Pon ONUs uses the combined management mode of OAM + SNMP (EPON) or OMCI + SNMP. The OAM or OMCI is responsible for managing functions related to the PON protocols. The SNMP interface is responsible for functions related with ports, protocols, and services. Under the FTTH mode, the management and maintenance of PON ONUs uses the joint management mode of OAM/OMCI + TR-069.

The PON OLT and ONU devices under the FTTB mode are managed and configured according to the network management system (NMS) of PON devices by providing northbound interfaces, or by allowing PON devices to directly open the SNMP MIB database to support the NMS of the IP MAN network and softswitch network and to configure and manage services such as VLAN, QoS and voice access remotely.

Access devices with built-in voice under the FTTH mode can be managed by using the ACS management system specified in the TR-069, or by temporarily using the PON NMS. In principle, standalone NMSs will no longer be established for FTTH voice access devices. As for the built-in voice access devices under the FTTB mode, NEs of different vendors can be managed by their respective NMSs. A small number of new external integrated access devices (IADs) can also be incorporated into the vendor’s PON NMS. Access gateways (AGs) should be managed by the softswitch NMS in a unified manner.

Integrated service bearer capability

When constructing an FTTx network, operators need to consider their ability to meet the future requirements of bearing integrated multi-services. The FTTx network can be equipped with customer and service-differentiated bearer capability for high quality access of voice and video services. The FTTx access network should deploy the 802.1P-based QoS strategies and implement corresponding priority queues for OLTS and ONUs. In addition, the FTTx must have service traffic classification, priority marking, and priority queue dispatching capability to realize service packet forwarding based on service priority and assure the quality of different services.

In respect to WLAN functions, to fulfill the requirements of multiple services that are always online and those that are intermittent, renovation of Radius and the related DHCP system for IPoE access authentication method is enabled directly on BRAS/SR if the service volume is large and the BRAS cannot support multi-service access control well, multi-edge structure networking can be used. The same MAN can simultaneously use the mixed networking of both single-edge and multi-edge structures.

To fulfill the requirements of multiple services such as IPTV, WLAN and VoIP, operators should consider introducing the dynamic host configuration protocol (DHCP) into the IP MAN and gradually building the DHCP platform. The management system of the DHCP platform can be deployed in a centralized way.

The DHCP server function can be enabled directly on BRAS/SR if the requirements of the DHCP system for security, reliability, and scalability are not high. Based on the actual needs of services, the IPOE access authentication method capable of centralized management can be introduced in conjunction with the renovation of Radius and the related support system, smoothly adapting to services that are always online and those with multicast requirements.

Editor: Xue Hua xuehua@huawei.com