OLT Built-in Blade Server White Paper 2.0

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1 Overview

With the worldwide construction of FTTx networks and the advent of the gigabit era, video services including 4K/8K, Cloud VR, cloud gaming, and online education are constantly emerging and consume massive amounts of network resources. In particular, the most-watched videos frequently demanded by users cause a large amount of repeated transmission traffic. To enhance service experience and save bandwidth of the convergence network, the operators urgently need to deploy services at the network edge or even to the access office. Moreover, the home broadband services are not limited to common Internet services. How to achieve refined network operation and guarantee the quality of value-added services have become a major concern of the operators. To address these issues, the access network NEs need to provide the load status, NE health, connection and pipeline transmission quality, as well as specific service and application experience quality detection functions. The development of the cutting-edge network management, control and detection technologies represented by Netconf/YANG and Telemetry promotes the system architecture of the fiber access network to develop towards an intelligent network. This architecture puts forward high-frequency information collection and KPI/KQI stream detection requirements for access NEs. The O&M enhancement and experience optimization require the access network to have powerful computing and storage capabilities. On the other hand, the optical access network has made great success in the home broadband field, and is expanding to industries such as enterprises, campuses, and factories. With the continuous construction of smart campus, campus scenarios also require edge computing and storage, such as video image recognition, industrial intelligent control, unified management and control, and data security. Therefore, edge computing facilities need to be deployed inside the campus.

No matter videos closer to users, enhanced computing capability of the access network, or the campus service requirements, the edge computing and storage capabilities need to be introduced to the network. However, additional devices need to be introduced and the access office needs to be constructed into a Data Center (DC). A comprehensive access office usually has wireless access equipment, wired access equipment, and transmission equipment, therefore reconstructing the access office into a DC is expensive and difficult due to the large number of devices, small space, unavailable power supply and different air conditioning environment. The computing and storage resources can be introduced to the access office gradually by considering the access office conditions and service requirements. The built-in blade server allows for the on-demand introduction of computing and storage resources without the need of reconstructing the access office, and supports NFV of the access network and the development of high-bandwidth and low-latency edge computing services. It is a practical and feasible solution driven by services, and has been recognized by industries. At the same time, with the development of IT technologies, especially low power consumption System on Chip Central Processing Unit (SOC CPU) and Solid State Disk (SSD), the integrated, distributed and embedded computing and storage infrastructure will become a major development direction in the future. As a piece of important access equipment in the access office, the introduction of the built-in blade server complies with this technical development trend.

2 Major Application Scenarios of the OLT Built-in Blade Server

Based on the analysis of FTTx network development and service scenarios, the application scenarios of the OLT built-in blade server include:

1) Most-watched video applications closer to users: Video traffic has a time-related feature and tidal effect. The service requirements are huge and the frequent is high in holidays and during important sports events, and the network capabilities cannot meet these requirements. Using the built-in blade server to support video services has two major purposes, one is to leverage the high bandwidth, proximity service, low latency, and low packet loss features of PON(Passive Optical Network) access to effectively improve QoE of video service users, and the other is to offload video traffic locally, save upper-layer network bandwidth and reduce network overhead.
2) Access network experience and O&M capability enhancement applications: Intelligent analysis of second-level service KPIs, and identification of low QoE users. The built-in blade server can be used to expand the O&M and network functions of the access network. On the one hand, it implements precise O&M and fully exploits the potential customers and traffic for value-added operation. On the other hand, it reduces the pressure of the legacy access equipment, and enhances the computing power of the access network.
3) Edge Multi-Access Edge Computing (MEC) applications: Local offloading (such as 5G UPF, 5G TOF, BNG-U), Multi-Access Edge Platform (MEP) and ME APP. MEP provides services to ME APPs, such as indoor positioning and Radio Network Information Service (RNIS). In fixed-mobile convergence (FMC) scenarios, the built-in blade server in support of the MEC can effectively guarantee network performance and service traffic transmission QoS, meet service requirements for low latency and security, and reduce the pressure of edge data centers.
4) Virtual Network Function (VNF) applications: Campus scenarios such as virtual Access Controller (vAC) and virtual Firewall (vFW). The built-in blade server in support of the VNF can provide the network virtualization function locally on the legacy main network path,

without increasing the number of hops of service traffic, which ensures the network transmission performance, simplifies the network deployment, and reduces the traffic of the upstream edge data center.

3 Design Concept of the OLT Built-in Blade Server

Based on device deployment and service requirements, the OLT built-in blade server design needs to have the following features:

1) Lightweight design: The built-in blade server can be inserted into the card cage of the OLT to effectively use the existing resources of the OLT without occupying extra space in the access office. Compared with the standalone blade server, the built-in blade server features lower power consumption and more flexible installation. At the same time, the built-in blade server employs some new technical applications, such as lightweight SoC CPU and SSD, to have better forwarding performance, stronger I/O storage capability and wider ambient temperature adaptability.

2) Diversified management: It provides different management modes to meet different application requirements. For the functions that need to be managed in collaboration with the devices in the upper-layer data center, the built-in blade server can be managed separately from the OLT. As a piece of network equipment, the OLT is managed by the Element Management System (EMS), and the built-in blade server is managed by the Physical Infrastructure Manager (PIM) and is incorporated into the overall management system that complies with Network Function Virtualization Infrastructure (ETSI NFVI) to implement flexible and automatic management and configuration. When the built-in blade server is used as an enhanced O&M application of the access network, it can be managed like a PON service line card, without the need to deploy additional management platform, thus simplifying the network and saving the investment. In addition, to achieve system reliability and configuration flexibility, the OLT software is independent of the built-in blade server software, and their upgrade does not affect each other.

3) Network function coordination: The built-in blade server is connected to the OLT through the interconnection interface. The abundant network capabilities of the OLT can collaborate with the computing and storage capabilities of the built-in blade server to form a compact and secure solution. For example, the ACL function and the traffic control function of the OLT can serve as a firewall for the built-in blade server. The powerful layer-2 switching function of the OLT can provide layer-2 connections to the VMs (virtual machines) on the built-in blade server. The Gateway proxy function of the OLT provides powerful traffic distribution functions to the edge computing applications. The coordination saves a lot of computing resources for the

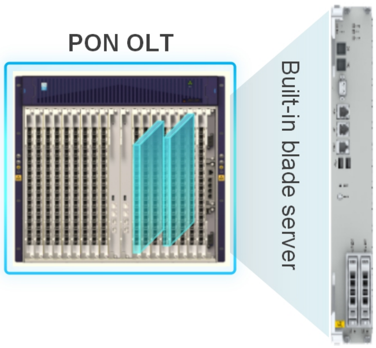
built-in blade server, and eliminates the overhead of the VNF that needs to be carried and operated by the built-in blade server.

4) Flexible configuration: The built-in blade server uses the line card design concept, the use of which is similar to the PON service line cards. It supports flexible insertion, removal, expansion, and configuration of components such as memory and hard disk, coordination of multiple line card for storage capacity expansion, and uploading different software to implement various lightweight functions, and meet the computing and storage requirements.

4 Introduction to ZTE OLT Built-in Blade Server

ZTE OLT built-in blade server can be configured with different hard disks and memories to meet diverse service requirements. In terms of hardware, ZTE OLT built-in blade server has a depth of 300 mm and can be installed in the OLT card cage, see Figure 4-1.

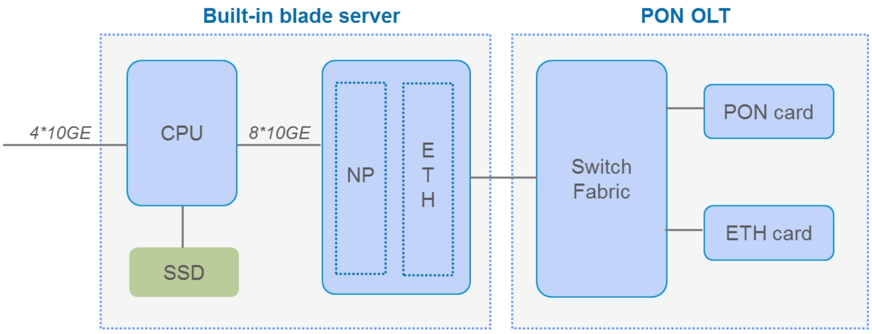
Figure 4-1 OLT Built-in Blade Server



The OLT built-in blade server can be configured with two hot-swappable hard disks, each of which provides a capacity of up to 8T, and a total of which provides a maximum capacity of 16T. It can also be configured with 4 pieces of memory up to 256G. At the same time, to better adapt to the access office environment, the low-power-consumption SoC CPU and SSD are used to provide a wider temperature range.

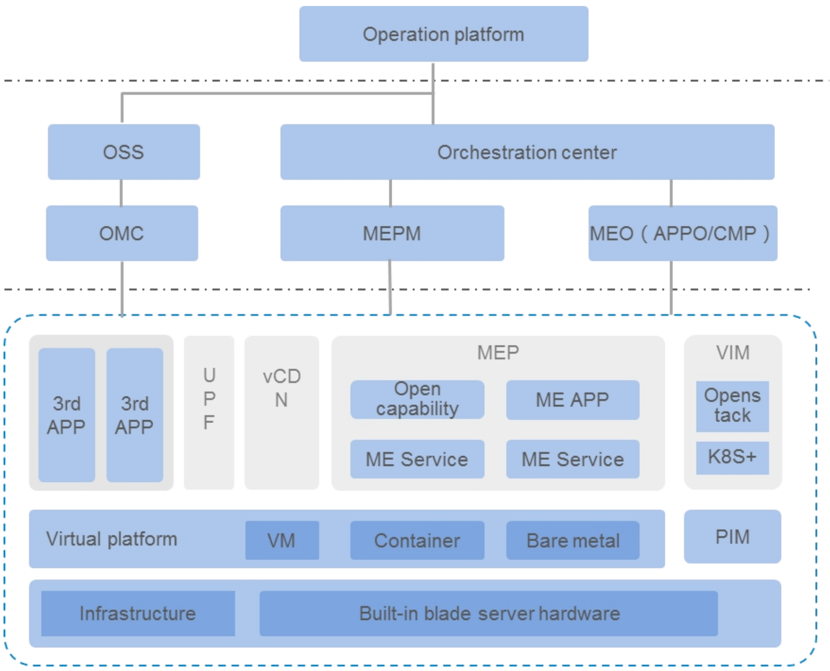
The built-in blade server not only effectively utilizes the chassis, power supply, heat dissipation, and other resources of the OLT, but also implements communication with the OLT. The built-in blade server consists of CPU, memory, interface module, and other components. The CPU implements the general computing function, and the memory and the SSD implement data storage and caching. The chip of interface module has the programmable capability and can forward high-performance network data. The built-in blade server also provides independent panel interfaces, including management, data, display, and USB interfaces.

Figure 4-2 Schematic Diagram of the OLT Built-in Blade Server



The management of the built-in blade server can be separated from that of the OLT interface card. The external PIM manages the hardware (including BIOS) through the Baseboard Manager Controller (BMC) system. The built-in blade server can be installed with virtualized platforms, support VM, container or bare metal mode, and support the deployment of MEP, UPF, vCDN and third-party APPs. It supports configuring and managing MEP-related services and data through MEPM, and implements the FACPS management on the UPF, vCDN and general MEP via OMC. It manages the edge node cloud platform resources and APP lifecycle through the MEO, orchestrates edge computing services through the orchestration center, and provides one-stop highly-efficient services for unified operation through the operation platform.

Figure 4-3 Built-in Blade Server Management Architecture

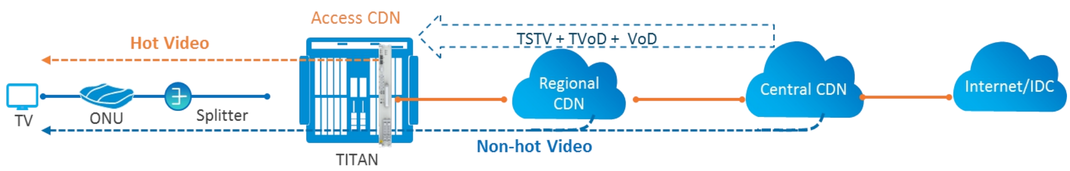


5 Typical Applications of the OLT Built-in Blade Server

5.1 Access CDN

The rapid development of big video puts forward higher requirements for network bandwidth and delay. The Content Delivery Network (CDN) allows users to obtain the proximity required contents, thus effectively guaranteeing service experience. So far, it has been widely used. However, for the most-watched videos in busy times like holidays and important sports events, the user demand will soar in a short time and form a large number of repeated traffic transmission. These contents usually include Time Shifted TV (TSTV) programs and True VoD (TVoD) and VoD. As a result, the network load is too high and user experience is affected. It becomes a trend to deploy the CDN to the network edge. Access CDN is a type of CDN network where CDN nodes are moved to the access office (OLT equipment room), which can further reduce the pressure of the OLT upper-layer network.

Figure 5-1 Built-in Blade Server for Access CDN



As shown in Figure 5-1, in the solution of deploying Access CDN in the OLT built-in blade server, the special Gateway Proxy function of ZTE PON OLT is used to offload traffic locally so that the user can access the programs stored in the Access CDN. The Access CDN solution has the following advantages:

1) Improves user QoE: It leverages the high bandwidth feature of the PON network to deploy high bit rate 4K/8K and VR video services in proximity to the user, featuring high throughput, low delay, congestion-free and good experience. In addition, it can effectively address the burst traffic impact of most-watched videos in a short time.

2) Saves the network bandwidth: By providing services in proximity to the user, it offloads 70% VoD traffic, which greatly saves the bandwidth of the convergence network, metropolitan area network and related network equipment, greatly reduces the load on the CDN central node, and effectively reduces the transmission cost of big video.

3) Simplifies engineering implementation: The built-in blade server features low power

consumption, high performance, on-demand deployment, and high scalability. It does not need equipment room reconstruction or frequent network upgrade, greatly shortening the workload of service deployment and expansion.

4) The OLT supports the Gateway Proxy offloading solution. It is transparent to BRAS (Broadband Remote Access Server), access mode and IP (Internet Protocol) addresses for quick deployment.

5) In addition to the bare metal mode, the Access CDN can also be dynamically deployed on the blade VM or container in the vCDN mode. It can work with other edge computing applications such as image and video uploading to share blade hardware resources, and promote the construction of edge network cloud and service cloud at a low cost.

5.2 O&M Enhancement

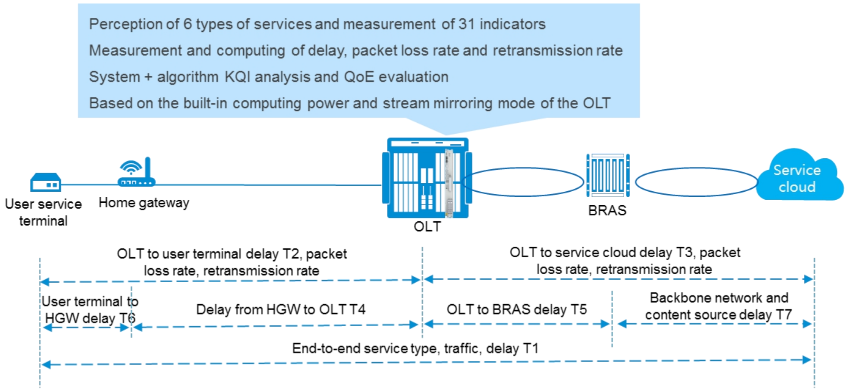
The enhancement of broadband network O&M has always been a focus of operators, not only the EMS needs to have intelligent management, control, and analysis capabilities, but also the NE needs to provide brand-new KPI measurement, fine-granularity traffic statistics, real-time status information collection, and high-frequency and efficient data reporting capabilities. It is becoming a consensus in the industry to use built-in blade servers to expand OLT NE capabilities.

5.2.1 User QoE Detection

At present, the fixed-network broadband O&M system still focuses on equipment, and cannot actively obtain and evaluate users' real service experience. Instead, it only relies on passive O&M of user complaint, resulting in high number of broadband user complaints, long time for troubleshooting broadband faults, and unsatisfactory user experience. In the recent years, some operators have actively carried out user service perception evaluation pilots by using ONT built-in probes and external centralized probes. However, the final broadband experience improvement effect is not obvious due to the heavy investment, difficulty implementation, and immaturity of the solution. Being deployed on the OLT built-in blade server and located inside the access equipment and is close to users, the user QoE detection solution has unique advantages, and can accurately and comprehensively evaluate broadband users' service perception, identify low QoE users, and locate the reasons. This solution provides an indispensable basic data platform and infrastructure platform for the operators to transform to active user-centric O&M.

The service quality detection solution based on the built-in blade server not only perceives user services, but also ensures that user service data is not sent out. A hundred percent of the user service data is processed locally through the OLT internal traffic mirroring, which solves the user data security problem. In addition, it provides a unique ODN detection function. The PPPoE-based two-way handshake signaling detects and perceives the quality of the link delay between the ONT and the OLT and between the OLT and the OLT/BRAS.

Figure 5-2 Built-in Blade Server for Service Quality Detection

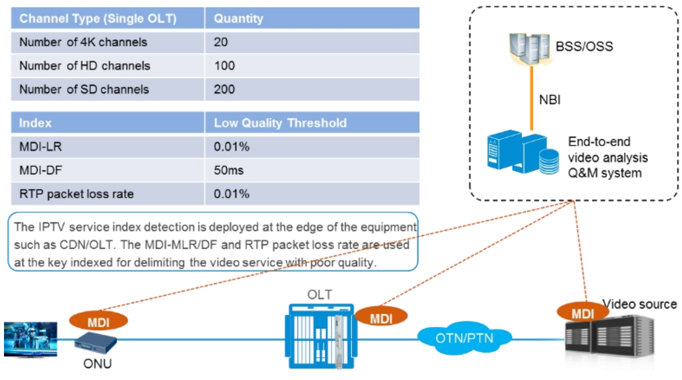


The service quality detection solution based on the built-in blade server can be flexibly deployed, plug and play, and free from network cutover and service interruption problems. It achieves full service traffic visualization, streamlined management and network planning, the solution can carry out complete traffic and behavior analysis, user service perception evaluation and low QoE diagnosis for home broadband users, as well as the 5G vertical application traffic visualization and quality evaluation. At the same time, it adds several key indicators to better describe the factors affecting user experience, and precisely locate the faults of broadband access networks and home networks.

5.2.2 IPTV MDI Detection Scenario

IPTV has become a basic service of broadband operators. According to the statistics on previous faults, PON network faults account for a high proportion. Therefore, it is necessary to detect the transmission quality of all or most-watched IPTV livestreaming channels on the OLT uplink ports and the PON ports. However, the CPU processing capability of OLT line cards cannot support multi-channel concurrency detection, built-in blade servers can be used. As shown in Figure 5-3, MDI detection can be deployed on the ONU, OLT and video source server respectively. The indexes can be sent to the O&M system in real time so as to facilitate remote detection and fault delimiting. A single blade server supports the MDI of 20 of 4K channels, 100 HD channels, and 200 SD channels concurrently, and can locally store one week's history data.

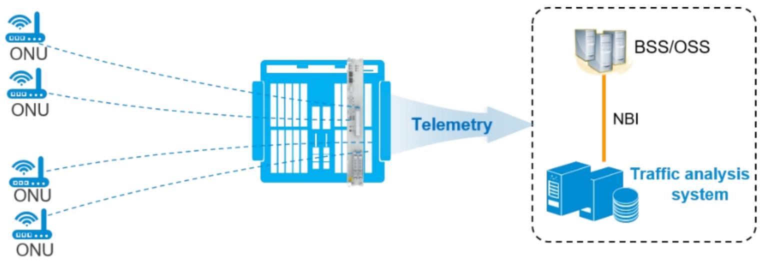
Figure 5-3 Built-in Blade Server for IPTV MDI Detection



5.2.3 Second-Level Traffic Data Collection

Originated from the data center, the data collection technology Telemetry has been used by the operators to collect the traffic of PON networks in a centralized manner, in place of the traditional traffic collection based on SNMP/MIB. The technical upgrade can shorten the traffic collection frequency from 5 minutes to a second level, and the collection granularity from the physical PON port level to the logical GEM port level. In this way, the network performance management and load management are more streamlined, providing a basis for network planning, real-time traffic scheduling optimization, QoS configuration optimization and real-time fault detection. The existing cards of the mainstream OLTs, including the main control cards and PON line cards, do not have the capability of collecting, processing, and storing per service flow per user. These capabilities can be expanded by using built-in blade servers. A single blade server can detect the second-level traffic data collection of more than 64K GEM ports concurrently, and can also store the history traffic collection data locally.

Figure 5-4 Built-in Blade Server for Second-level Traffic Data Collection



5.3 Enterprise Campus Application

In recent years, the Passive Optical LAN (POL) solution has become the customer's preferred choice, and the construction of all-optical campus network has become a consensus of the industry. The campus scenario generally has the following requirements:

1) Integrated wired and wireless access, including POL, Wi-Fi 6 and 5G.
2) Edge computing application. Due to data security requirements, data needs not to be sent out of the campus. Typical edge computing applications include video detection and facial recognition.
3) Low delay requirements such as industrial control systems and autonomous driving on campus.

Traditionally, the customers need to invest extra money to build service systems such as network firewalls, wireless controllers, information management systems, and Softswitch/IMS systems, which are installed on standalone servers in campus equipment rooms. These standalone devices constitute a complex network, which increases network deployment difficulty and O&M costs. With the OLT built-in blade server, the standalone physical devices (such as security firewalls and wireless controllers) can be virtualized as software VNF applications as needed and installed on the built-in blade server, forming an open network that is simple, easy to upgrade, easy to modify, and easy to add new functions, and helping customers build open POL campus networks and create more values.

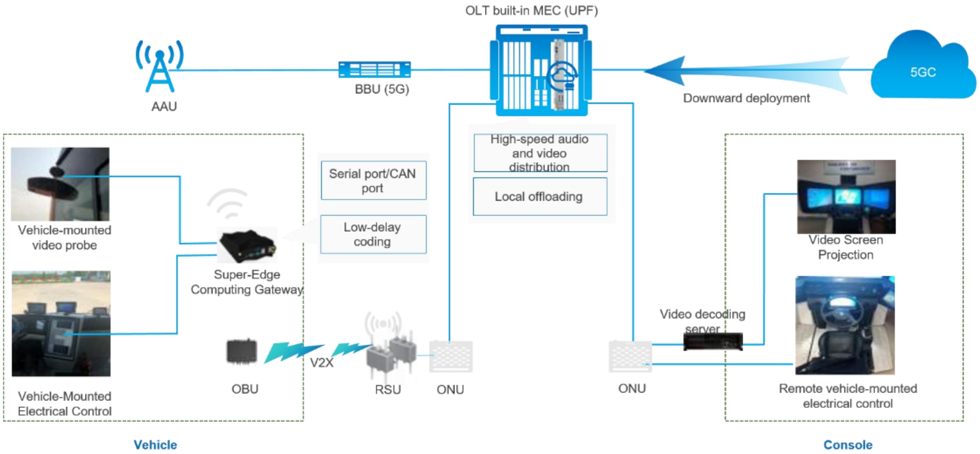
5.3.1 Remote Driving Application

With the reconstruction of smart campus, remote driving and autonomous driving scenarios such as smart buses, dock logistics, and mining emerge, which impose high requirements upon network capabilities. In addition to the support of 5G networks, MEC local offloading is required to provide ultra-large bandwidth and ultra-low latency. In addition, optical access networks need to access remote cockpits and provide large-bandwidth, stable, and reliable wired connections.

Figure 5- 5 shows remote driving in the campus scenario. Based on the 5G+POL FMC network, the video information of the HD camera on the vehicle needs to be transmitted to the remote driving center screen in real time, so that the driver can control the vehicle remotely. At the same time, the control signaling of the control console needs to be transmitted to the vehicle remotely for driving control. Remote driving requires high bandwidth and latency. The super edge computing gateway is deployed in the vehicle, and the 5G SIM card is built in the gateway to provide the video low-latency coding function, and support the CAN protocol conversion to implement remote control of vehicles. The remote driving console is usually deployed inside the campus and connected through wired access to ensure the access bandwidth and reliability.

To further reduce latency, the 5G offloading function is deployed on the OLT built-in blade server in the access office. The 5G backhaul network is used to interconnect with the Building Baseband Unit (BBU). The BBU on the road directly sends video information to the UPF module on the OLT built-in blade server for local offloading. Meanwhile, the MEP is deployed to rapidly distribute video information from the camera to the video decoding server in the control center, which saves the bandwidth of video streams to the 5GC and the BRAS, reduces the end-to-end forwarding delay to less than 10ms, and the end-to-end video transmission delay to less than 200ms (including the video codec processing delay).

Figure 5-5 Build-in Blade Server for Remote Driving



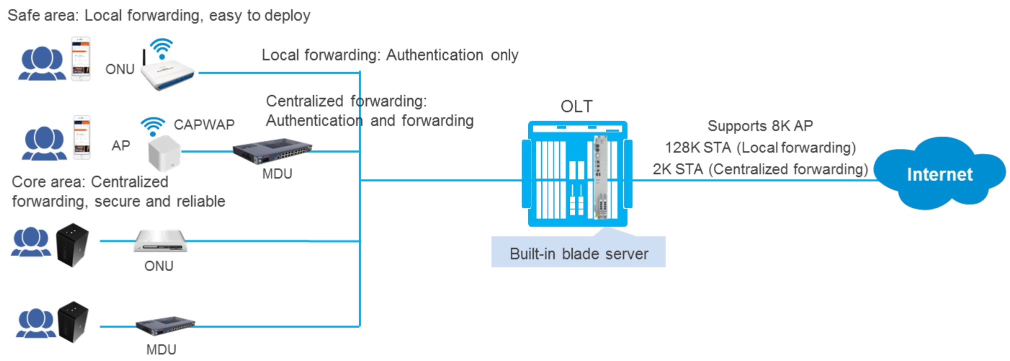
Firstly, the advantage of using the OLT built-in blade server is that 5G UPF can be deployed to implement local forwarding of service traffic, reduce the latency greatly and meet the requirements of the autonomous driving service. Secondly, the built-in blade server shares space and power supply resources with the OLT, so the deployment is more economical and flexible. Thirdly, in addition to helping the cockpit of the campus to realize the POL wired connection, PON with a P2MP architecture allows for one feeder fiber to connect to a large number of Road Side Units (RSUs) The fiber connection features low power consumption, environmental protection and anti-electromagnetic interference, providing stable connection in various outdoor changing environments.

5.3.2 vAC Application

With the wide use of emerging services such as mobile office and wireless terminals in enterprises, wireless traffic accounts for an increasingly higher proportion of the total traffic. As a centralized management and control device in the wireless network, the AC equipment gradually becomes a traffic bottleneck due to its forwarding capability and port restrictions. Additional AC equipment needs to be added to expand the network capacity, which occupies the equipment room space and requires extra reconstruction works.

With the POL all-optical reconstruction of the campus, OLTs are widely deployed on the campus, and ACs are built in the OLT blade server. One the one hand, it can effectively improve the utilization of equipment room resources, use redundant slot resources, save dedicated AC equipment, save equipment room space, and guarantee customer investments. On the other hand, it improves the forwarding capacity. The OLT does not have the CAPWAP packet parsing capability, and needs to be configured with an AC equipment. When wireless service traffic enters the OLT, it needs to be routed to the AC equipment, causing unnecessary delay. Due to the restriction of the forwarding performance of the AC equipment, the overall wireless service traffic forwarding capacity is limited. By processing CAPWAP encapsulated packets on the blade server, the decapsulated wireless packets can be forwarded as wired packets, which simplifies the forwarding path, and the forwarding capacity is no longer a bottleneck.

Figure 5-6 Built-in Blade Server Implements the vAC



6 Outlook

Network edge intelligence will become an important development direction in the future. With the accelerated digital transformation of the 5G era, the expansion of network construction scale and rapid evolution of home networks, the services that need to be processed at the edge, such as IoT services, video services, and security services, become more extensive, and service experience becomes critical. It is urgent to meet the real-time requirements of service processing and the high quality assurance of user experience. The OLT is deployed in the integrated service access office, which is the first hop of the fixed network access service, and is the nearest to the home network. The lightweight blade processing unit deployed in the idle slot of the OLT is an edge computing deployment mode that is convenient, and reliable.

ZTE focuses on the development trend of enhanced edge computing in cloud-network integration in the future. Based on the resource advantage of the large number of OLT idle slots in the access office, ZTE first launched the OLT built-in lightweight blade server, opening a broad imagination for multi-service edge computing in the future. With the increasingly diversified value-added optical access services and rapidly expanded application scenarios, to meet the requirements for improved user QoE, NE service perception and quality detection are implemented based on big data, and the service visualization, measurement, and operability are implemented based on the AI technology. The OLT built-in blade server with computing capability helps achieve distributed intelligent O&M architecture to implement local processing of massive O&M services, reduce network load, and increase real-time processing, driving the OLT built-in blade server evolves from the traditional computing type to the intelligent type with AI computing capability. ZTE will continue the research in the lightweight edge computing field, and actively track the latest microelectronics technologies. Through innovating the architecture, improving the manufacturing technique of in-house developed chips, and leveraging state-of-the-art encapsulation technologies, the system can be highly integrated, the volume and power consumption can be continuously reduced, and the next-generation low-cost, low-power-consumption, and service-based edge computing infrastructure can be built, laying a solid foundation for operators' network construction and service development.