White Paper of Built-in Blade in OLT
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Overview

Moving access network NFV (Network Functions Virtualization) and edge computing downward to the access layer requires to introduce computing and storage resources in AOs (Access Offices), and form an infrastructure to support the edge network cloud and edge service cloud. However, DC-based (Data Center-based) AO transformation encounters a lot of challenges including large numbers of AOs to be transformed, huge investment, long transformation cycle, and transformation difficulties. When the expected return is uncertain, operators sometimes are unwilling to invest heavily in AO transformation in the early stage. In fact, the construction of EDCs (Edge Data Centers) has similar problems, and the deployment and construction process are slow.

Therefore, computing and storage resources can be introduced in the AOs progressively by considering the AOs’ conditions and service requirements, and in a way that is different from the construction of IDCs (Internet Data Centers). Constructing the AOs by using the equipment with built-in blade enables on-demand introduction of computing and storage resources without the need of AO transformation, and supports the access network NFV as well as the provisioning of high-bandwidth and low-latency edge computing services, therefore, it is a feasible way to meet service-driven development, and is accepted by operators.

At the same time, the development of IT technology, especially the soaring development of low-power SoC CPU (System on Chip Central Processing Unit) and SSD (Solid-Sate Disk) has made the converged, distributive and embedded computing, and storage infrastructure become the development direction in the future. Introducing built-in blade in OLT (Optical Line Terminal), the important access equipment and integrated access node in the AO, conforms to the trend of technology development.
Using built-in blade to support the application of accelerated video services has two main purposes. Firstly, it makes use of the high bandwidth, nearby service, low latency, and low packet loss ratio of PON (Passive Optical Network) access to effectively enhance the user experience of video services. Secondly, it effectively offloads the bandwidth of the upper layer network, and reduces the network overhead.

Using built-in blade to support the VNF (Virtual Network Function) of fixed network access can provide the network virtualization function on part of the existing primary network paths without increasing the number of hops of service traffic, which ensures network transformation performance, makes QoS (Quality of Service) deployment simpler, and alleviates the traffic in the EDCs.

Using built-in blade to support the MEC VNF in FMC (Fixed Mobile Convergence) scenarios is similar to the VNF of fixed network access, which can effectively guarantee network performance and service transmission QoS, and relieve the pressure of EDCs.
TITAN’s built-in blade is installed in the subrack of ZTE’s optical access platform TITAN, and occupies two random service slots. TITAN’s built-in blade provides the following features:

1. Intel 16-core SoC CPU, 256GB memory.
2. 1ST capacity, SSD.
3. IPMI (Intelligent Platform Management Interface) management.
4. Less than 200W power consumption per blade.

TITAN’s built-in blade uses the new Intel® Xeon® D processor. Intel® Xeon® D processor delivers Intel’s groundbreaking data center processor architecture in a form factor optimized for flexible, scalable, high-density network, storage and cloud edge computing solutions. It brings the architectural innovations of the Intel® Xeon® Scalable platform to a system-on-a-chip (SoC) processor for lower power, high-density solutions, integrating essential network, security and acceleration capabilities. A software-programmable platform featuring robust virtualization supports, with low latency, high-bandwidth capabilities through a flexible design, for a variety of solution and service deployments in space and power constrained environments. Design innovation delivers seamless solution scalability from the data center to the edge. Intel® Xeon® D processor integrated new Intel® Advanced Vector Extensions 512 (Intel® AVX-512), it delivers workload-optimized performance and throughput increases for advanced analytics, compute-intensive applications, cryptography, and data compression. The Enhanced Intel® QuickAssist Technology (Intel® QAT), available as an integrated option, delivers chipset-based hardware acceleration, up to 100 Gbps, for growing cryptography, encryption, and decryption workloads for greater efficiency while delivering enhanced transport and protection across server, storage, and network infrastructure.

The management of the built-in blade can be separated from that of the OLT. The hardware management of the built-in blade is performed by PIM. The upper-layer software is managed by the corresponding management system of the VNF/APP running over it. The management of the built-in blade is included in overall service orchestration via the PIM system, and supports automatic service distribution, configuration and management. The built-in blade leverages a container Linux OS, and supports lightweight virtualization to avoid heavy overhead of VM (Virtual Machine)-level virtualization.
With the rapid development of broadband networks and the growing demand for personalized video playback, coupled with vigorous promotion of operators, video services have become a basic network service. However, when the video services develop rapidly, the users’ growing demand for video experience and the provisioning of value-added services attached to the STB put forward higher requirements on the software and hardware of the STB. The replacement of STBs is not only expensive but also has many engineering problems. Meanwhile, due to the diverse STB models, the hardware capabilities vary greatly, resulting in a series of problems such as difficult adaptation and slow provisioning of new services.

The vSTB solution emerges to address this situation. The vSTB solution allows the vSTB to operate on the server in the OLT, process services and UI (User Interface), convert the interface into a video stream and distribute to the pSTB (physical STB). The pSTB receives the video stream for decoding and playback, displays the UI, and plays the video content. In that case, the pSTB only needs to reserve the video coding/decoding, and I/O interface capabilities, and does not need to provide strong CPU, memory, and Flash capabilities. The vSTB solution can effectively shield the differences between the STBs from different vendors, facilitate unified distribution and deployment of new services, and dramatically reduce TCO (Total Cost of Ownership), therefore it is welcomed by operators.

The average traffic of waterfall UI using Big Video can reach 6 Mbps, and its requirement for end-to-end latency is shortened from a few hundred milliseconds to tens of milliseconds. From the perspective of latency reduction and traffic offloading, deploying vSTB in OLT’s built-in blade has tremendous advantages. Through downward deployment of the computing to offload the bandwidth, the vSTB solution can be deployed on-demand and conveniently without the need of considerably upgrading or transforming the aggregation core network.

According to tests and experiments, each built-in blade supports concurrent Internet connection of more than 1,000 vSTBs. vSTB leverages the NFV technology to process the big video services in the cloud, which reduces the requirements for STB, shields the differences between STB vendors and models, effectively prolongs the lifecycle of online STBs, and reduces the construction costs. Deploying cloud-based STB in TITAN’s built-in blade makes the solution deployment faster, the bandwidth utilization more efficient, and the service QoE (Quality of Experience) more enhanced.
Access CDN

With the booming development of video services, the proportion of video traffic in broadband networks is increasing. The growth of video traffic consumes large amount of backbone network resources, and brings a heavy burden to the operators’ networks. At the same time, industry analysis and statistics show that large part of video contents in the network are spread repetitively. Hot spot contents, in particular, may form a huge amount of repetitive traffic from the video source to the users in a short time. These repetitive traffic carries the same content and their paths from the content source to the network edge are identical, their paths only differ in the access network segment. By making use of this characteristics, the CDN (Content Delivery Network) is developing continuously and rapidly, and the CDN edge nodes are getting closer to users. The CDN extending to the broadband access network has become a trend.

Access CDN is a kind of CDN form in which the CDN node is deployed downward to the AO. The main driving forces of the Access CDN construction include:

1. The promotion of video content development: The video resolution is getting higher and higher, and a single video stream requires higher bandwidth. In particular, each 4K, 8K and VR video stream needs a bandwidth of 40 Mbps, 80 Mbps, and 160 Mbps respectively. Moving the CDN downward to the AO will dramatically reduce the transmission costs. In addition, high resolution and high data rate video traffic is increasingly sensitive to latency. The TCP transmission of 4K, 8K and VR videos requires a network latency of less than 20 ms or even 10 ms. Moving CDN downward to the AO can dramatically reduce the network transmission latency. High data rate videos require low packet loss and low jitter network transmission. The packet network has long transmission paths and a number of hops, which is hard to guarantee QoS, and the packet loss and congestion are unavoidable. Moving the CDN downward to the AO to provide services near users, and making use of the high-bandwidth and QoS features of the PON networks not only avoid congestion and packet loss, but also sharply simplify the QoS control technology, and provide network basis for the high data rate video services.

2. The promotion of fiber access network development: PON-based fiber access networks have high convergence on the OLT. As shown in Figure 5.3, the OLT generally has 2 to 4 10GE uplink ports, and the total bandwidth of the downlink PON port reaches several hundred Gbps. If all the service traffic pass the OLT to be connected upstream, it is obvious that the ultra-high bandwidth of the PON network does not bring ultra-high throughput, resulting in a waste of bandwidth. If the CDN is moved downward to the AO, the bandwidth of the PON network can be fully utilized to transmit high data rate video contents, thereby dramatically improving the overall network throughput and reducing the per-bit transmission cost of video contents.

3. The promotion of IT technology development: The development of SoC CPU and SSD makes it possible to construct compact and low-power embedded computing and storage infrastructures.

4. The promotion of video content hotspot effect: Both IPTV and OTT have concentrated head effect. That is, in a period of time, the hotspot contents are concentrated. The figure below shows the IPTV content heat statistics of a city, from which we can see that Top 2000 contents account for more than 60% of the total video traffic, and the storage of Top 2000 contents is approximately 4.5T. Therefore, the Access CDN only needs to store 4.5T contents to offload more than 60% of the TSTV (Time Shifted TV)/TVod (True VoD) / VoD traffic.

Figure 5.3 High Convergence of PON Networks

Figure 5.4 IPTV Content Heat Statistics of A City

Figure 5.5 OLT with Built-in Access CDN

1. Improves the users’ QoS: It makes use of the high-bandwidth features of PON networks to deploy high data rate 4K, 8K and VR video services closer to users, provides the features of high throughput, low latency, no congestion and good experience, and effectively responds to the burst traffic of hotspot videos.

2. Saves network bandwidth: Offloads 70% of on-demand traffic through nearby services, greatly saves the bandwidth of the aggregation network, metropolitan area network and relevant network devices, sharply eliminates the load of the CDN central nodes, and effectively drives down the bearer cost of the video networks.

3. Simplifies project implementation: Built-in blade provides the features of low power consumption, high performance, on-demand deployment, and excellent scalability, and dramatically reduce the service deployment and capacity expansion workload without the need of equipment room transformation and frequent network upgrade.

4. Easy for deployment: The OLT supports the Gateway Proxy offload solution, and transparently plans the BRAS (Broadband Remote Access Server), access mode and IP (Internet Protocol) addresses to enable convenient and efficient network deployment.

5. Shares the infrastructure: Built-in blade supports constructing an edge cloud computing platform and NFVI platform. The VNF, CDN and other edge computing services can share the infrastructure, which promotes the construction of the edge network cloud and the service cloud at a low cost.
In the 5G era, data traffic will grow exponentially, and video services will become the basic broadband network service. To satisfy the provisioning of experience-sensitive services, providing services near users becomes a trend. With the deployment and application of VR/AR, Internet of vehicles, automatic driving, and industrial control, the requirements for network service optimization, downward deployment of contents, and low latency become more and more urgent. It is expected that most of these services can be computed and processed where they occur, i.e. at the network edge. To ensure service experience quality and to reduce transmission costs, these services need to be provided at the network edge, i.e. MEC application.

At the same time, integrated AO has become the deployment mode adopted by a majority of mainstream operators. Deploying the BBUs (Bandwidth Based Unit), DUs (Distributed Unit) and OLTs in the AO requires that the AO provide the NFVI needed by edge computing. TITAN’s built-in blade provides an economic-friendly and efficient way for NFVI construction in the AO. The MEC VNF and APP can be deployed in AO NFVI as per demand. As shown in Figure 5.6, the vCU (virtual Central Unit), ToF (Traffic offload Function), UPF (User plane Function), MEC APP, and CDN can be dynamically uploaded to the AO NFVI to form a dynamic and highly-efficient edge computing system.

Network edge intelligence will become an important development direction in the future. With the advent of the 5G era, coupled with the expansion of network construction and home networks, there will be abundant services need to be processed at the network edge such as IoT services and security services to meet real-time service processing, and to guarantee high-quality use experience. Located at the first hop of the fixed network access service, the OLTs are close to home networks, and usually share the same AO or site with mobile base stations and mobile transmission. Using idle slots of the OLTs to deploy lightweight blade processing units can not only meet the requirements of fixed network edge computing, but also provide computing and storage resources to vicinal mobile services, therefore, it is a convenient, efficient and reliable mode to deploy edge computing.

At the same time, with the development of microelectronics technology, edge processing is developing from pure CPU processing to heterogeneous computing such as CPU+ASIC. The new memory technologies like XPOINT can use a unified technology to build a storage system for edge computing, and ultimately reduce the size and power consumption of the overall edge computing devices, meet the stringent requirements for low power consumption, less footprint, high reliability and low cost, and realize the processing capabilities of the central offices at the network edge at a low cost and low power according to the characteristics of different services.

Aiming at the development trend of FMC (Fixed Mobile Convergence) in the future, ZTE launched the industry’s first OLT built-in lightweight blade processing unit, which leverages the large amount of idle OLT slots in AOs to open up a broad imagination for multi-access computing in the future. ZTE will continue to do research in the lightweight edge computing arena, leverage cutting-edge technologies to implement low-cost, low-power edge computing infrastructures in support of flexible combination as per service, and lay a solid foundation for the operators’ network buildout and service development.