Tomorrow never waits

Technical White Paper on

ZTE Carrier-Grade Virtualized BRAS

ZTE

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Abstract:

This white paper introduces severe challenges of traditional broadband remote access servers (BRAS) deployed on MANs, specifies architecture and features of ZTE virtualized BRAS (vBRAS) devices and comprehensively analyzes benefits the vBRAS takes to carrier networks. Also, the paper lays out ZTE's prospect of future metropolitan access network (MAN) re-architecting evolution.

Benefits:

- Meet carrier-grade network operation needs
- Enhanced resource utilization
- Better service reliability
- Shorter service provisioning cycle
- Saved IP addresses
- Simplified operation and maintenance (OAM)
- Open networks

1. Preface

Booming development of networks such as Internet and mobile internet, as well as related services urges underlying networks for more qualified transport. An inevitable network transformation in the entire communications industry is underway. Old conservative operator networks intended to be more cloudified and intelligent shall start the evolution from changing their devices.

Nowadays, the BRAS as critical as a portal of internet services is seriously challenged in the following ways:

Uneven resource utilization

Mismatching software and hardware resources always bother the customers, for example the resources on the control plane are seriously consumed by intensive concurrent sessions, while lots of resources leave idle on the user plane. In a word, the close BRAS system cannot schedule resources as per specific conditions.

Long service provisioning cycle

Tightly coupled software and hardware only allows device capacity improvement via thorough hardware upgrade. The new service provisioning always put off by the upgrade of multiple network devices and joint testing with service systems often extends for several months, which obviously cannot satisfy the changing internet services.

Dispersed management an complicated OAM

Independent and dispersed policy configuration on traditional BRAS devices, massive pre-configured complex user policies and unique configuration scheme of every single vendor make the OAM very complicated. At the same time, decentralized user address management results in huge address waste.

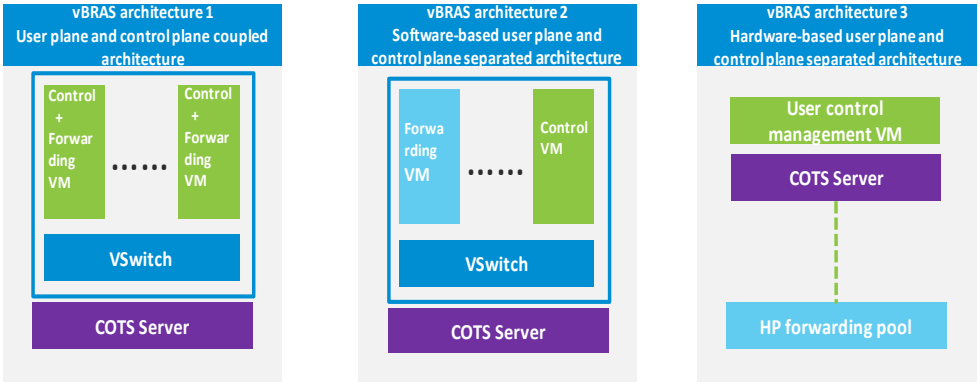
To tackle all these existing problems of the traditional BRAS, ZTE orienting to carrier networks starts re-architecting virtualized IP MANs by introducing the brand-new vBRAS to the market. Through SDN&NFV technologies, the vBRAS designed with control plane and user plane separated architecture and decoupled software and hardware allows the cloudified control plane, fast and flexible new service deployment and. centralized OAM. After conquering all the weakness of the traditional BRAS, for example, uneven resource utilization, long new service provisioning cycle and dispersed configuration and OAM, it effectively helps the operators to reduce their OPEX and CAPEX, becoming a powerful facilitator of building cloudified and intelligent MAN edges.

2. Architecture and Features of vBRAS

2.1. Architecture of the vBRAS Commercially Used in the Industry

Currently there are three sorts of vBRAS architecture **co**mmercially used in the market:

Figure 1 Industry's vBRAS Architecture



vBRAS architecture 1: user plane and control plane coupled architecture

The architecture couples the user plane and control plane together on one virtual machine (VM), which not only restrains integration with SDN technologies, but also weakens forwarding and QoS capabilities at the same time.

vBRAS architecture 2: software-based user plane and control plane separated architecture

The separated user plane and control plane are both carried by X86 servers. Restricted by the processing capability of the existing X86 chips, this architecture with poor forwarding and QoS capability pertains to the application scenarios with massive concurrent users but fewer concurrent sessions.

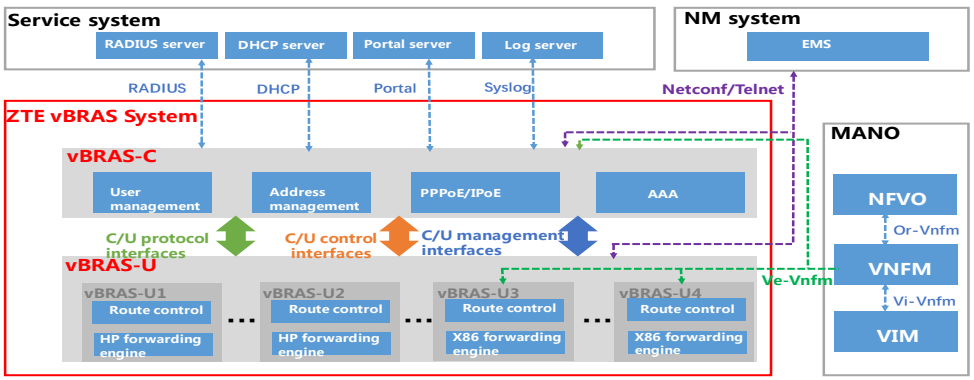
vBRAS architecture 3: hardware-based user plane and control plane separated architecture

Unlike traditional BRAS, this architecture in order to achieve powerful forwarding and QoS capability performs NFV-based user control and management via the X86, but deploys high-performance (NP) forwarding pools on the user plane. It is suitable for the network application scenarios with a large number of concurrent users and sessions.

2.2. ZTE vBRAS with User Plane and Control Plane Separated Architecture

ZTE based on the SDN technology releases the vBRAS with control plane (vBRAS-C) and user plane (vBRAS-U) separated architecture. The NFV is used to decouple the software and hardware of the vBRAS-C. The logical architecture is as shown in the following figure:

Figure 2 Logical Architecture of the ZTE vBRAS System



Service system

As a peripheral system platform, the service system includes but not limited to RADIUS servers, DHCP servers, log servers and Portal servers, responsible for coordinating with the vBRAS system to provide all sorts of services.

Network management system

It enables the management and configuration of the vBRAS system.

Management and orchestration (MANO):

It implements service orchestration and automated deployment of the vBRAS system, creation of virtualized network functions (VNFs), life cycle management, elastic capacity expansion and reduction, and management of infrastructure of network functions virtualization (NFV).

vBRAS system

It is composed by the vBRAS-C, vBRAS-U and the interfaces in between.

vBRAS-C

Responsible for user control and management is capable of implementing the following services:

- User access management: It includes user protocol message processing, keepalive service and management and distribution of user table entries.
- Policy management: It takes responsibility for the management and distribution of the policies, such as user access bandwidth and QoS policies.
- Address management: It allocates the addresses to the users via local or external address pools.
- User authentication, authorization and accounting services
- Configuration or management based on EMS or command lines
- Unified northbound interfaces: They are used to interconnect the external service systems.
- Interoperation with the MANO system: It takes in charge of one-touch vBRAS-C deployment and elastic capacity expansion.

vBRAS-U

Responsible for forwarding user data messages can implement the following services:

- Services offered by the user plane of the traditional BRAS, e.g. service forwarding, traffic statistics, implementation of the QoS policy.
- IP route/MPLS, multicast and CGN services
- MPLS L3/L2 VPN, GRE and IPSec VPN.
- Configuration and management based on EMS or command lines.

Interfaces between the vBRAS-C/vBRAS-U

- C/U protocol interfaces: Transfer PPPoE and IPoE protocols via VxLAN.

- C/U control interfaces: Use Openflow to enable the distribution of the service flow table entries from the vBRAS-C to the vBRAS-U, and the service events reported from the vBRAS-U to the vBRAS-C.
- C/U management interfaces: Distribute configuration from the vBRAS-C to the vBRAS-U via Netconf.

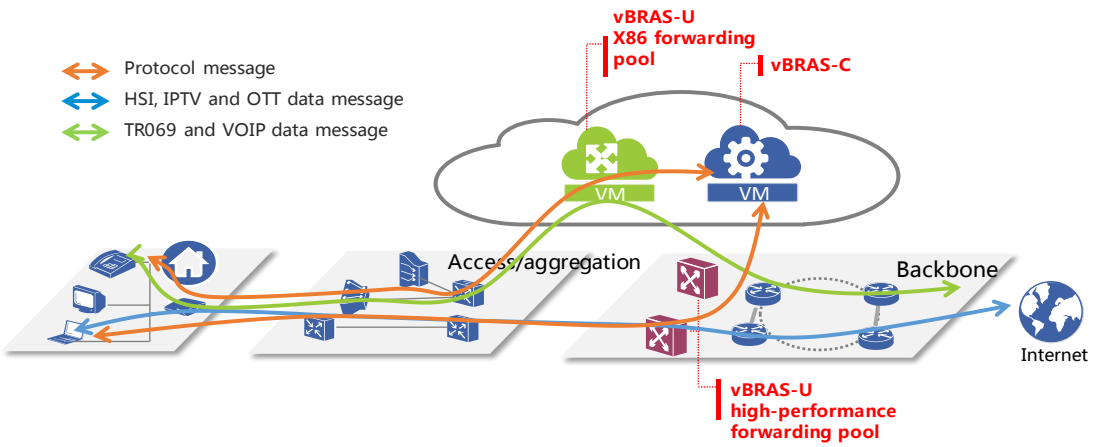
2.3. Technical Features of ZTE vBRAS

In addition to all the advantages taken by the SDN/NFV technology, ZTE vBRAS also provides the following features for the operators' networks:

Two types of forwarding pools comply with carrier-grade network operation

The NP forwarding pool and X86-based virtualized forwarding pool provided by ZTE vBRAS-U utilize a unified vBRAS control plane for centralized and unified management. Without changing the overall network architecture, the two forwarding pools can build networking together to bring in coordinative and optimized services and resources.

Figure 3 Coordinative Networking Based on Two Forwarding Pools



- The high-performance forwarding pool with Tbit forwarding capability carries the services with high bandwidth and strict QoS requirements (for example HSI, IPTV and OTT) to satisfy increasing bandwidth demands of the carrier-grade network.

- The X86 forwarding pool running on the universal X86 server supports elastic capacity expansion and the transmission of services with low bandwidth and few QoS requirements (for example TR069, VOIP and WLAN). It shares the user sessions and decreases flow table overhead of the high-performance forwarding pool.

Inherit all the services of traditional multi-service edge (MSE) devices

- PPPoE, IPoE and IPTV multicast services cover home triple-play services and individual WiFi services.
- IP Host, L2/L3 VPN and L2TP access cover enterprise internet private lines and VPN services.
- Powerful carrier-grade NAT (CGN) ensures the implementation and reliability of private network IPv4 services.
- Hardware-based high-performance H-QoS and smart acceleration help with fixed network traffic operation.

Provide better security and reliability mechanism.

- The load balancing and flexible elasticity make sure rational utilization of the resources on the vBRAS-C.
- Forwarding pool protection equipped with load redundant backup is more flexible and reliable than the hot backup technology of the traditional BRAS device.
- The forwarding pool makes the vBRAS-C safe by discarding protocol attack messages directly.

Open interface capabilities make the network architecture to keep up with the times

- The northbound interfaces based on ETSI NFV architecture enable coordinative control of end-to-end network resources, service chain orchestration and open network capabilities. It eliminates policy control bottlenecks and boosts broadband service innovation.
- Completely decoupled control plane and user plane featuring flexible deployment can either be deployed on the existing MAN edge or be evolved to the future cloudified network architecture seamlessly.

Offer extremely simplified OAM

- One-touch deployment enables creation of the most ideal vBRAS instances in one action.
- Unified network management of the forwarding pool on the vBRAS-C allows smart configuration.
- All graphic interfaces make performance statistics very clear at the first glance.

3. Benefits

Meet carrier-grade network operation needs

The control plane of the ZTE vBRAS system not only enables the access of 10 million user sessions, but also offers dynamic elasticity at the same time. The user plane with the NP forwarding pool is much more advanced than the universal X86 virtualized forwarding pool solution. With the help of ZTE vBRAS that gives considerate thought to the operator's network application scenarios, the customers shall never be afraid of the challenges of future high-bandwidth networks.

Improved resource utilization

Based on the C/U separated architecture, the centralized and cloudified control plane that offers powerful computation resources eliminates the resource restraints on the main processing unit (MPU) of the traditional BRAS. Therefore, the hardware forwarding pool under the same condition can support much more user sessions.

Enhanced service reliability

Unlike the traditional BRAS that asks the devices from the same vendor to implement protocol synchronization, heartbeat detection and fast switchover, the vBRAS of which the user plane works with pooling resources for backup can make use of the detection and coordinative processing of the control plane to implement fast fault switchover, which reduces the costs in reliability deployment greatly. The VBRAS-C supports both inner-plane component backup and multi-plane cross-site backup, which maximally ensures highly reliable broadband services.

Shorter new service provisioning cycle

With traditional vBRAS, the provisioning of new broadband services is very complicated as it concerns not only to interconnection and upgrade of the service system and the BRAS, but also to the upgrade of the software and hardware of the BRAS. So it often takes the customer several months to finish upgrading all the BRAS devices of one MAN. In contrary, the vBRAS only needs to interconnect the control plane and the service system, and distributes policies to the user plane from the control plane. So the customer can deploy new services in a very short time simply by upgrading the software of the vBRAS-C. More new innovative services can be provided much faster accordingly.

Fewer IP addresses

Traditionally to distribute IP addresses to the BRAS independently, every device should prepare adequate IP addresses in advance, which somehow causes huge potential waste. Centralized IP address management implemented by the control plane enables the vBRAS to distribute the resources to the forwarding pool on demand, so that the utilization of the IP addresses can be greatly improved.

Extremely simplified OAM

To replace the manual device-by-device upgrade and configuration of the traditional BRAS, the vBRAS employs the control plane to perform centralized OAM. After being configured with broadband services, the vBRAS-C automatically distributes the services to all vBRAS-Us. Also single logical architecture is laid out as only the vBRAS-C interconnects all the service platforms. As the vBRAS-C supports one-touch deployment, automatic identification of online vBRAS-U and plug-and-play vBRAS-U, the configuration becomes very easy.

Open network capabilities

Cooperating with NFV industrial chain actively, ZTE provides the VBRAS with open northbound interfaces which have already successfully interconnected the third party's controller at China Telecom Corporation Limited Beijing Research Institute (CTBRI). In China Mobile OPEN-O project, the vBRAS is deployed on the third party's VIM. After working together with the third party's applications and platforms, the open network capabilities boost the operators' service innovation.

Smooth network evolution

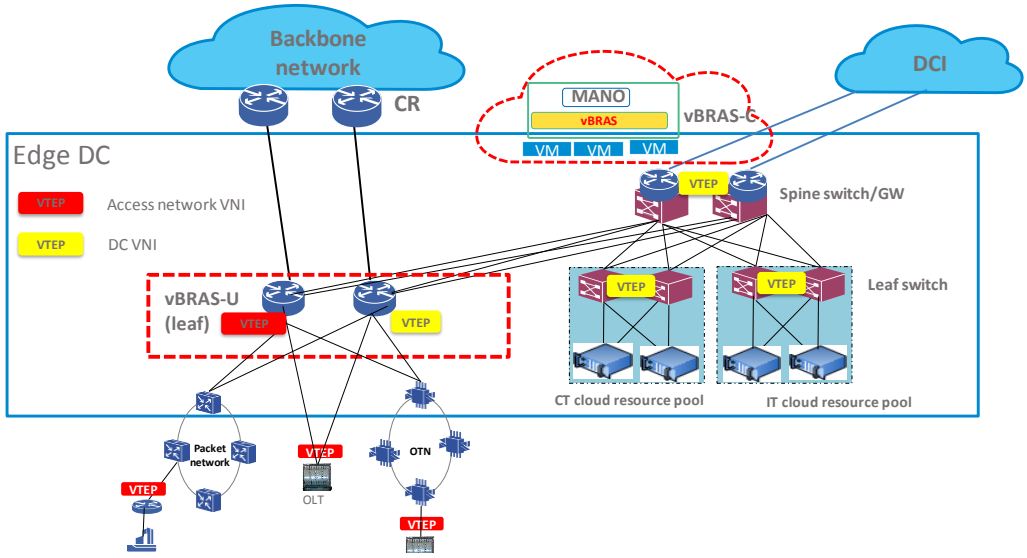
The vBRAS solution provided by ZTE is based on the operator's existing MAN architecture. In other words, without changing the old service system a little, it can support all the services running on the operator's existing network. Besides, as the vBRAS hardware forwarding pool makes good use of the legacy network elements, the solution gives excellent protection to the operator's investment..

4. Applications of the vBRAS on the Future MAN Re-architecting

The dramatic development of big video services such as 4K and VR services not only increases the traffic on the carrier network, but also raises higher requirements for network latency and reliability. At the same time, the internet of things (IoT) asks the operators to open policy control capability to machine-to-machine (M2M) applications, so that on-demand policy control, online big data analysis, dynamic policy adjustment, accomplishment of policy control and automated network OAM can be implemented. In addition, the enterprise users need flexible private line services and customizable localized services to offer on-demand connections and services. Therefore, brand-new network architecture is urgently requested to carry all these new services in the approaching future.

With strong passion for the network re-architecting technology, the worldwide mainstream operators nowadays have made a lot of attempts. As per years of rich experiences ZTE accumulated in communications industry and vBRAS applications, it unveils the following local network re-architecting solution:

Figure 4 Local Network Re-architecting Architecture Centralized on Edge Data Centers (DCs)

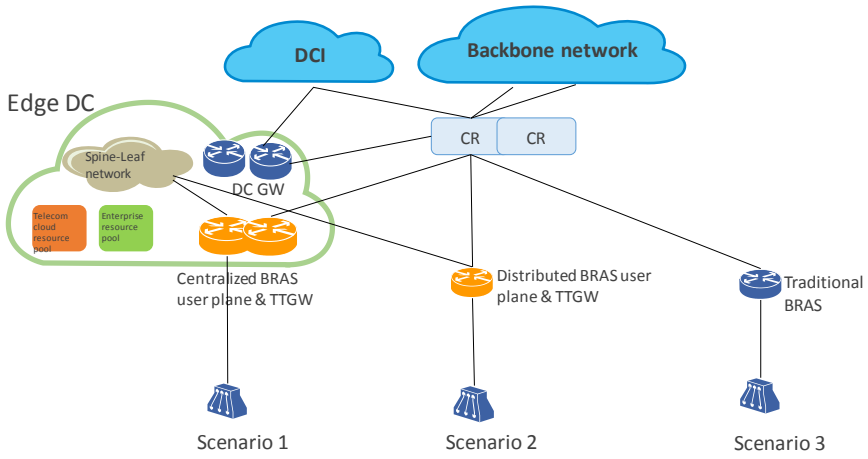


As the figure shows, the vBRAS-U of the vBRAS also acts as a leaf node of the data center, responsible for terminating VxLAN tunnels of all the access network flows. The vBRAS-C can be deployed either in the cloud resource pool of the edge DC or in a higher level DC.

When the user internet access flows are terminated on the vBRAS-U, the vBRAS will query the routes so as to forward the flows to CRs. In order to access the cloud resource pool within the DC, the VXLAN network identifier (VNI) of the access network should be mapped to the DC NVI via the vBRAS-U. At the same time, the vBRAS-U also serves for a service classifier. It encapsulates network service headers (NSH) in the packets to compose service function chaining (SFC) together with the VNFs.

According to the progress of local network re-architecting, the vBRAS can be deployed in the following three scenarios:

Figure5 Three Deployment Scenarios of the vBRAS



- Scenarios 1: Build the DC first. At the same time, the centralized vBRAS-U (Also be a tunnel terminating gateway (TTGW)) is deployed to implement BRAS service forwarding and traffic diversion. In this scenario, the most perfect DC-based network re-architecting can be made.
- Scenario 2: The rearchitecture of the DC cannot be finished temporarily. The traditional BRAS can be changed to the distributed vBRAS-U (also a tunnel terminating gateway). Later, the DC can be built on the basis of the distributed vBRAS-U on demand.
- Scenario 3: Preserve the existing system. Then change the BRAS to the vBRAS-U to build hybrid networking together with the vBRAS. In this scenario, the existing network investment is well protected.

5. Conclusion

Focusing on the features of the carrier networks and services, the vBRAS solution released by ZTE not only provides carrier-grade operation with intensive sessions, high bandwidth, high reliability and high efficiency, but also gives considerate thought to the openness and evolution of the carrier network. With control plane and user plane separated architecture, the high-performance user plane perfectly matches the requirements of the large video services such as 4K and VR for high performance, while the control plane enables open capabilities, easy maintenance and flexible services. The solution completely satisfies the development of future MAN, and will definitely bring huge benefits to the broadband services.

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Acronyms and Abbreviations

Acronym or Abbreviation	Full Name
BRAS	Broadband Remote Access Server
SDN	Software-Defined Networking
NFV	Network Function Virtualization
vBRAS	virtual BRAS
vBRAS-C	virtual BRAS Control Plane
vBRAS-U	virtual BRAS User Plane
MANO	Management and Orchestration
VXLAN	Virtual Extensible LAN

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