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ZTE TECHNOLOGIES

VIP Voices

MTN South Africa: Never Falling Behind the Curve

Expert Views

Unremitting Innovation to Touch the Future

Special Topic: Intelligent 5G Transport

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Cover Figure | Godfrey Motsa, CEO of MTN South Africa

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> We have the best network in the most important areas—one of them is in the Western Cape, which is undertaken by ZTE. Therefore, to compete in the telecom space, the first thing you need to do is to build a strong network.

— Godfrey Motsa, CEO of MTN South Africa

MTN South Africa: Never Falling Behind the Curve

Reporter: Yue Lihua

MTN has been rated the best mobile network in South Africa that boasts the most advanced networks on the continent. The company is now increasingly focused on delivering relevant digital services to the local people. Godfrey Motsa, CEO of MTN's South Africa unit, explains how it is driving digital transformation in South Africa.

MTN witnesses strong competition in the South Africa yet remains a strong player. What makes MTN SA such a strong player in the market?

There are a number of factors. The first one is the partnership with our technology partners. As an example, we are No. 1 in the technology space because of the infrastructure that we've built. We have the best network in the most important areas—one of them is in the Western Cape, which is undertaken by ZTE. Therefore, to compete in the telecom space, the first thing you need to do is to build a strong network.

Of course, you need a strong distribution, a strong brand and competitive offerings. These are what keeps us in the game but the foundation is the network. The network comes from the equipment that you deploy, from the services that you have, from the features that you have, and from the partners that help you manage it from end to end. What keeps us in the game in South Africa and be the No. 1 network is the network that you have built.

The digital consumption is rising rapidly. How did you manage to maintain the best network quality?

We are all on our way to digital revolution. The digital revolution is mostly enabled by the smartphone. If you look at the smartphone penetration in South Africa, it is over 60 percent. From the operator's side, we've invested a lot in smartphone penetration. But the smartphone has to run on a strong network and you need to have applications on that as well. It's a game of partners. You need to make sure that you put a strong network in place, that your customers have the smartphones, and that you present the opportunities

for them to leverage all the digital services that come out of that.

One of our strategies is pushing digital services. One of the things we've done is the launch of Ayoba. We have strong ambitions for it, the "Wechat of Africa". We've also launched mobile money in South Africa called MoMo. Things like video, payment, music streaming, gaming and lifestyle are really important in helping us push the digital revolution.

But the traffic is skyrocketing and we continue to invest in the infrastructure. So to your point, how do you balance the traffic growth, the consumption of digital services, and still keep the Bozza quality network? At MTN, it is basically continuing the investment and making sure that you balance the game.

The fierce market competition is resulting in lower margins. What steps have you taken to protect your heavy investment?

We spend most of our money on Capex. We are running a Capex envelope of 8-9 billion rands. We are also spending 4 billion rands on the Opex for the network. The first place to start, when you are looking for savings and efficiency, is the people like ZTE. That's why we are always demanding the best equipment, the maximum capacity at the lowest possible price. I think we are really grateful that we have partners like yourself. You understand our pains. You understand that we serve the emerging market customers so that our ARPUs are lower than those of the developed markets. But, of course, we should be able to balance the investment, the equation, and the return that comes out of that. Now it is again the partnership that is really important for sustainability.

What kind of explorations does MTN wish to make in the 5G era?

I think, of course, the future is 5G. It is worth mentioning that MTN SA is the first network to trial 5G technology successfully indoor, outdoor and in mobility environment. We have done a massive trial with ZTE in Cape Town for AfricaCom 2019. It was well received. In pushing 5G, we are working with our government to make sure that we get the right spectrum for it. But we are also working with our partners like ZTE. We are impressed by the end-to-end approach that you are looking at—from the radio to the transport, to the core, and also to the services. 5G is the evolution we will see and 5G is going to be service-intensive. It is important for us to take advantage of that. We are really excited about 5G.

How has been the cooperation between ZTE and MTN in the 5G field?

Nowadays, the partnership with ZTE is really fantastic. As I mentioned, the premier event on the continent is AfricaCom. We did AfricaCom in Cape Town, which is basically a ZTE region for MTN. It was really successful. We are looking at the opportunities of how we can stabilize things further. Besides applications, the primary thing is still the 5G terminals. We are looking at that as well with ZTE, and we are impressed by the roadmap and the lineup of the 5G terminals coming out of the ZTE factory. We are optimistic and excited about our strong partnership on 5G as well. We are going to build mutually beneficial businesses together.

What's your long-term goal and overall strategy for sustainable development?

I think, as a business, especially in the space we are in, the long-term gain is about winning with customers. We all know that customers' needs are changing all the time. We also know that technology is rapidly evolving. So it is to never fall behind the curve from a customer's perspective and from a technology's perspective. For these things to be realized on a sustainable basis, we need strong partnership. You need different people working together as partners to deliver for the society. ZTE TECHNOLOGIES

Towards 5G Business Success

Global Customers Talk About Cooperation with ZTE for a Win-Win Digital Future

Reporter: Hua Lei

While operators are stepping towards digital transformation, ZTE focuses on creating more value for customers, and, with its competitive end-to-end 5G solutions, has carried out 5G cooperation with more than 70 operators globally.

Building Simplified, Intelligent and Premium 5G Networks

Hutchison Drei Austria

Drei is a leading telecommunications provider in Austria. In June 2019, Drei partnered with ZTE to develop and deploy Austria's first operational 5G network, available to selected business clients in Linz. It has expanded its 5G coverage in Linz and other regions throughout Austria since then.

Jan Trionow, CEO of Hutchison Drei Austria

Our cooperation with ZTE in 5G is a continuation of our long-term partnership. We led on 3G and 4G, and we have the ambition to jointly lead on 5G as well. So we started to work on 5G technologies in our innovation lab in Austria together with ZTE.

Matthias Baldermann, CTO of Hutchison Drei Austria

We are looking back at the very successful partnership, which was started about 10 years ago. Meanwhile, we have established a lot of trust between the teams. And what is also very important is that we have chosen Austria as one of ZTE's innovation centers worldwide, which enables us to conduct early testing of any new technologies, particularly 5G. That

brought us to situations where we could complete the first Massive MIMO implementation in Europe. We started with 5G in mid-2019 and have now more than 100 operating sites in all regions of the country. We are at the start of a broad journey towards rolling out 5G nationwide in Austria.

China Mobile

China Mobile, the largest mobile operator in the world in terms of subscribers, has completed the first phase of the 5G deployment covering 50 cities. China Mobile and ZTE have carried out extensive collaboration in the 5G field.

Zhou Xin, Vice Director of 5G Work Office, the Beijing Branch of China Mobile

The Beijing Branch of China Mobile and ZTE had extensive cooperation in the early stage of 5G commercialization. The two companies provided 5G + 4K live broadcast at the opening ceremony of the 2019 World Horticultural Exposition.

Meanwhile, the Beijing Branch of China Mobile and ZTE launched a 2.6G + 4.9G double-layer 5G network demonstration area in the financial and commercial street in Beijing.

In 2019 FIBA Basketball World Cup, the two parties provided 5G + 8K ultra HD video live broadcast.

At present, the Beijing Branch of China Mobile and ZTE are engaged in extensive, in-depth and close cooperation in the fields of new media, science and technology campuses, smart parks, commerce, finance and others, thereby starting new chapters in the 5G business model.

PT Telkom Indonesia

Telkom, the largest telecommunications service provider in Indonesia, has signed a 5G agreement with ZTE, to build 5G network and explore new 5G fields in Indonesia. The collaboration is hoped to provide benefits, especially for the development of digital ecosystems in Indonesia.

Joddy Hernady, EVP Digital and Next Business, Telkom Indonesia

In the 4th quarter of 2019, Telkom and ZTE have already signed a Memorandum of Understanding (MoU) for joint innovation program in 5G. The joint innovation program covers several aspects: the first one is the joint study and research on the key technologies of 5G, for example, 5G transport, 5G network slicing, SDN/NFV, and intelligent network. The second one is the joint research and study on the end-to-end network architecture, including the network capability assessment for 5G. The third one is the establishment of a laboratory in Telkom's office, as agreed by both parties. So we are in the process of developing a laboratory for 5G testing. And the fourth one is the joint study on the use cases. Those are the four key areas we're going to cooperate in with ZTE.

5G+ Enables Various Industries

China Unicom

As long-term strategic partners, China Unicom, ZTE have collaborated on "5G+" research and exploration. In collaboration with Tianjin Unicom

and Port of Tianjin, ZTE released 5G&MEC smart port industry applications.

Chen Fengyan, General Manager of Government & Enterprise Business Department of the Tianjin Branch of China Unicom

In August 2018, the Tianjin Branch of China Unicom and ZTE started deploying the 5G commercial network and the MEC system in Wuzhou docks of Tianjin Port. After more than one year of joint efforts, we have successfully achieved exemplary application scenarios like autonomous driving and remote control of shore bridges under the 5G technological conditions. These application scenarios fully showcase that the reliability, security, and stability of 5G technologies can fulfill the technical requirements of 5G commercial applications in smart ports.

PT Telekomunikasi Selular

Telkomsel, a subsidiary of Telkom Indonesia, is the largest cellular operator in Indonesia. It is preparing for the implementation of 5G technology in Indonesia.

Marfani, VP Network Architecture, Telkomsel

Talking about the 5G adoption, Telkomsel now is in a very good position to adopt this technology with multiple potential solutions and also approaches while waiting for the policy from the government and also the and technology maturity.

Akhmad, VP Network Planning & Engineering, Telkomsel

Telkomsel and ZTE, one of our strategic partners, are engaged in in-depth exploration and cooperation in the current 4G LTE network. In 2019, ZTE had deployed more than 6200 sites in the city region and 90% of them are already on air. ZTE is also one of Telkomsel's potential partners in developing 5G in the future.

Rudolf Hermanses, VP Synergy Management, Telkomsel

In collaboration with ZTE, we developed DMobileXLab, which is a device mobile application experience lab that focuses on device and mobile application testing. This lab explores mobile phone performance and leverages telco capabilities for mobile app developers, and also a part of the optimization phase that requires fine tuning process to cover a variety of variables. ZTE TECHNOLOGIES

Unremitting Innovation to Touch the Future

Zhang Wanchun
SVP of ZTE Corporation

In the past year, although facing many challenges such as network investment, vertical industrial application, business model and ecological construction, the pace of 5G development is still unstoppable. Over 60 networks around the world have started to provide commercial 5G services. ZTE has established extensive cooperation with more than 70 operators and hundreds of vertical customers on 5G. Currently, ZTE has implemented over 60 related use cases involving dozens of industries such as manufacturing, energy, ports, transportation and education.

Unremitting Innovation to Build Cost-Effective Networks for Operators

Wireless communications has always been a high-tech industry and is always under the iterative evolution. ZTE always regards innovation as the source of customer value; focuses on technology breakthroughs in key fields; targets swift time-to-market; delivers optimisation in real application scenarios; helps operators lower the total cost of ownership (TCO); and enables business innovation. ZTE has, and will continue to build cost-effective pan-5G (meaning multi-RAT coexistence in the 5G era) networks for operators through unremitting innovations.

First, ZTE has launched a full series of multi-frequency and multi-mode integrated wireless products to support the simplest deployment of pan-5G networks. Our FDD-based tri-band ultra broadband radio (UBR) can reduce the number of modules by 70% and power consumption by 30% compared with a traditional solution. The 400M ultra

broadband AAU and 300M QCell fully meet RAN sharing requirements, and there is also a full series of products to provide the most cost-efficient deployment across a range of coverage scenarios, including dense urban, suburban, indoor, high-speed railway, tunnel, local hot- and blind-spots. An all-in-one baseband unit (BBU) is compatible with 2G/3G/4G/5G on one BP board, with an industry-leading performance and capacity and NFV, which supports open services capabilities. In terms of simplifying network architecture, ZTE's dual-mode non-standalone (NSA) and standalone (SA) BTS enables flexible network architectures and a smooth evolution.

In addition to making the most competitive products, ZTE is pursuing construction of the superior performance pan-5G network. As the most important 5G technology, Massive MIMO is critical for network performance. In 2016, ZTE's Pre5G concept was the first to employ Massive MIMO technologies in commercial 4G networks. Pre5G not only brought substantial profits to operators, but also accumulated a lot of commercial experience, laying a solid foundation for further optimization of 5G products. In the test of the global 5G commercial networks, ZTE achieved leading system performance, with 5.3 GB/s in the downlink using 16 streams and 256QAM; and 1 Gb/s in the uplink 1 Gb/s with 8 streams and 64QAM. ZTE has delivered many top-quality networks with more than 1 Gb/s user data rates across the world, and also simplified the deployment and optimization process of Massive MIMO equipment. We also launched other innovative solutions including Super DSS and FAST to deliver a superior performance.

Super DSS can enable tri-mode dynamic spectrum sharing of 2G/4G/5G and 3G/4G/5G, compared with more typical dual-mode DSS systems covering 4G/5G. FDD assisted super TDD (FAST) is an innovative ZTE technology based on FDD and TDD carrier aggregation, which improves the performance of both down- and uplink, effectively extending the latter's coverage and reducing latency.

ZTE has improved the energy efficiency of the gNB by around 50% by launching a 7 nm chip and GaN PA, and a next generation 5 nm chip and PA are on the way. In addition to the smart on/off approach using traditional methods, AI-based intelligent traffic prediction will dynamically adjust the resource allocation and power output to effectively control energy consumption. A deployment of ZTE's AI-based power saving solution in a large-scale commercial network reduced average daily energy consumption by 10%.

Actively Promoting SA Commercialization to Enable Business Innovations

SA has become the industry's new goal for 5G networks. SA can fully display the value of 5G networks, enabling differentiated consumer services and fragmented business services, and truly enable 5G business model innovation.

As the pioneer of SA technology innovation and commercialization, ZTE released the first commercial version of an SBA-based Common Core in the industry. Our Common Core supports comprehensive access of 2G/3G/4G/5G and fixed networks; MEC and E2E slicing; meets all kinds of vertical application scenarios; and has been commercially launched in China Mobile's NFV network. ZTE was the first in the industry to release a slicing store, which can support one-touch deployment and flexible slicing to deliver one network for all industries, and deliver true model innovation. On the wireless side, ZTE's full series of products support SA commercial and NSA/SA dual-mode BTS, offering a flexible architecture and smooth evolution. In terms of SA commercialization, ZTE completed 5GC full verification tests with many mainstream operators, and deployed a large-scale NSA/SA dual-mode commercial network with China Mobile; Europe's first E2E network slice in Austria; the region's first call based on an SA architecture and Qualcomm's X55 chip with Orange; and a full E2E commercial verification using the X55 with China Telecom.

ZTE Always on the Way to Deliver Superior Networks

To continue to improve networks, ZTE will apply more innovative solutions in the near future including introducing a 3D plastic antenna, dielectric filter, and integrated antenna filter unit (AFU) to further reduce the weight and volume of AAUs. New generation 5 nm chips with better algorithms will deliver super-powerful capabilities, and obviously lower energy consumption, together with new generation GaN PA, cooling structure and materials.

5G has come and 6G is on the horizon. In 2018, ZTE established a dedicated team to systematically research 6G network architecture, new spectrum and air interfaces, integration of the technology with AI and blockchain technologies, and focusing on the cutting-edge basic materials and components related to 6G. At present, ZTE has several innovative cases in the field of wireless research, including super-surface, easy deployment, AI air interface and 3D connections.

Moving forward, ZTE will continue its pursuit of perfection and is willing to cooperate closely to deliver the future together with our industry partners. ZTE TECHNOLOGIES

Innovating to Unleash the Value of Fixed Networks in the 5G Era

Fang Hui
Vice President of ZTE Corporation

Last year saw an explosive growth of fixed broadband (FBB) and mobile broadband (MBB) networks as well as the volume deployment of gigabit access. The compound annual growth rate of the 10G PON market will exceed 30 percent in the next five years and more than 70 countries worldwide have started or are planning 5G rollouts. Judging from the broadband initiatives of different countries, the business strategies of operators, and the competitive landscape, an era of dual-gigabit speeds based on FBB and MBB has arrived and the two access technologies will coexist for a long time. FBB and MBB will work together to further accelerate technical innovation and network transformation.

China accounts for 60 percent of the global fiber-to-the-home (FTTH) market. Back in 2018, the Ministry of Industry and Information Technology (MIIT) of China launched an initiative to "promote gigabit rollout, increase the adoption of both fixed and mobile broadband, and offer the same speeds on the same networks". China's three national operators released detailed gigabit broadband plans in 2019 and have since deployed gigabit access for homes and 10G speeds for enterprise buildings in some cities. In 2019, the China-based Broadband Development Alliance (BDA) proposed 10 application scenarios for the gigabit network in a bid to guide the industry on how to commercialize the technology. In their broadband buildouts and broadband acceleration deployments, the Chinese operators have come up with a number of measures that include "driving the development of FBB with MBB, maintaining the competitiveness of MBB with FBB, and promoting MBB with FBB". These approaches have been proven to help FBB and MBB networks grow together and complement each other.

The difference between the user bases

of FBB and MBB also means that the two broadband access modes will live a coexistent, mutually-reinforcing manner for quite some time. Homes and enterprises constitute the vast majority of FBB users. This largely fixed user base demands that FBB meet high standards in terms of stability, reliability, security, bandwidth, and QoS. By contrast, MBB as represented by 5G mainly serves individual users and a few indoor coverage scenarios. Although 5G vastly improves bandwidth, security and QoS over 4G, it still lags behind FBB in bandwidth. Thanks to the different user groups they target, FBB and MBB have different characteristics and employ different technologies. They will promote and complement each other in the foreseeable future.

Innovation in Cost-Effective Bandwidth Upgrades Ensures Basic Broadband Capabilities

10G PON is one of the major technologies of gigabit networks and it is expected to be deployed on a large scale in the next five years. As the successor technology to 10G PON, 50G PON is projected to be put into use in around 2025. An important consideration for operators choosing gigabit broadband technology is that the network equipment must have good evolution capabilities. For example, a platform should support multiple technology generations and existing network resources should be reused to reduce upgrade costs. ZTE provides a family of end-to-end solutions to implement fixed gigabit access. At the system side, ZTE offers the industry's first three-rate Combo PON solution for 10G PON networks to be built on a large scale in the most cost-effective manner. One Combo PON port supports both GPON and XG(S)-PON access, thus creating a smooth upgrade of bandwidth. Different optical network units (ONUs) can be deployed on demand at the user side, where they can form part of a mesh Wi-Fi network to deliver seamless whole-home gigabit coverage and enhance user experience. Since its launch, the Combo PON solution has led to more than 30 operators around the world collaborating with ZTE to test, trial and deploy it. In the process, the solution has become a preferred solution for operators to build 10G PON networks.

Innovation in Fixed-Mobile Convergence (FMC) Expands and Exposes Network Capabilities

To make FBB and MBB work in tandem, concerted efforts from standards organizations, operators, equipment vendors and other industry stakeholders are needed. The 3rd Generation Partnership Project Group (3GPP) and Broadband Forum (BBF) are jointly formulating 5G-FMC standards. 3GPP works on producing standards for 5G Core (5GC) networks to support the convergence of FBB and MBB, while BBF focuses on enhancing wired access networks so that they can interconnect with 5GC networks. In the FMC field, ZTE is an ardent promoter, an active industry player, and a member of multiple standards bodies. It actively participates in the formulation of 5G-FMC standards.

As its standardization advances,

FMC is gaining wide attention in the industry, with some operators already implementing FMC at the service and network levels. FMC brings operators two benefits. On the one hand, they can provide FMC-based packages to increase user loyalty and boost market competitiveness. On the other hand, they can use the convergence of FBB and MBB networks to improve network resource utilization and reduce network construction cost. Years ago, ZTE began to work with Indonesian operator Telkom to implement mobile backhaul over the operator's existing FTTx network. It has connected 16,000 2G/3G/4G base stations through an FTTx network for Telkom and helped the operator build the world's largest FTTM network. Meanwhile, ZTE continues to tap the potential of copper infrastructure. It released a copper-based enhanced fixed wireless access (FWA) solution that utilizes G.fast technology and in-building copper resources to route 5G signals into the home in a low-cost, stable and reliable fashion.

Innovation in IT+CT Integration Boosts Network Efficiency and Value

As video becomes a basic service of broadband networks and as user attention shifts from bandwidth to experience, operators are also changing the focus of their service operations. To meet users' increasing experience requirements, operators need to find a way to make the most of their legacy network resources and employ differentiated means. Building information technology (IT) functions in communications technology (CT) devices is an industry trend. With IT capabilities introduced into CT devices, a network can have higher utilization, more functional scalability, higher elasticity, and more freedom to accommodate future services.

ZTE actively explores the application scenarios, technologies, and product practices of IT+CT integration. One innovation of ZTE in this area is embedding blade servers in an optical line terminal (OLT), which is a telecom access device, to further expose its capabilities. Based on the blade servers, ZTE launched the Access CDN solution to move the content distribution network (CDN) to OLTs in access offices (AOs). By locally accelerating services such as video and pushing service provision closer to end users, the Access CDN solution can significantly reduce packet loss, latency, and pressure on upper-layer networks. The solution has been commercially deployed by multiple operators to cache and accelerate video services, helping them address network issues including traffic congestion, poor experience and insufficient upstream bandwidth. Through the deployments, the solution has demonstrated that it can offload 50 percent video traffic, relieve pressure on upper-layer networks, slash the proportion of video stalling time by 98.5 percent, and increase the play success ratio from 98 to 100 percent, thereby drastically enhancing user experience.

As a leader in the field of FBB, ZTE understands that only innovation can lead to steady, sustained development, create more value, and win the future. Over the years, it has been committed to bandwidth acceleration and technology innovation. In the 5G era, ZTE will go on innovating and creating success for customers. ZTE TECHNOLOGIES

An Exploration of Intelligent 5G Transport

Bo Kaitao

Chief Engineer of ZTE Transport Management and Control Planning

In the 5G era, a large amount of industrial application requirements have brought about rapid growth of network scale and service capacity, resulting in a great complexity of network architecture. Meanwhile, network users' expectations for service delivery quality and efficiency increase year by year. These pose new challenges to the transport network. The key to 5G transport network construction is to build a network efficiently and conveniently, release services quickly, perceive the network status in real time, perform service self-healing, fast fault diagnosis, traffic prediction and optimization, and make the system open and reliable. With the introduction of technologies like AI, big data, cloud computing into the telecom industry, it has been agreed that intelligentization is the inevitable road for 5G transport.

Key Technologies for Intelligent 5G Transport

Intelligent 5G transport requires many new technologies, among which the key technologies include intent-based network, intelligent control, machine learning, knowledge graph, network-based mirroring, and cloud native.

IBN

Intent-based network (IBN) matches business intent based on an awareness of the "holographic state" of the network and with the help of AI technology. Compared with the traditional networks

that are managed manually, the IBN focuses on business intent. It automates network operations based on the intent, verifies in real time whether the desired intent is executed, and makes continuous adjustments to form a closed-loop O&M control system.

Intelligent Control

In the 5G era, intelligent transport network control technologies mainly include SR, centralized control, slicing and telemetry. Segment routing (SR) simplifies the control protocol and is more conducive to end-to-end network programming. The centralized control technology can uniformly control the resources of the entire network to guarantee the routing and SLA requirements for different industries. Network slicing provides multiple logical networks on top of a common physical network infrastructure to meet differentiated requirements of different industries or scenarios. Telemetry actively sends data at fine-grained levels for real-time feedback within seconds or even milliseconds, providing accurate data support for network control.

Machine Learning

Machine learning, an important field of AI, is crucial to 5G transport. Based on the big data of the 5G transport network, it can be used for model training, and plays a key role in network traffic analysis, traffic prediction, exception analysis, network simulation, intent identification and fault diagnosis. It uses different technologies and algorithms in the above application scenarios, such as classification clustering, random forest, Bayesian network, and intensive learning.

Knowledge Graph

Knowledge graph is a multi-relational graph that contains multiple types of nodes and edges. Its application in 5G transport is to use graphs to connect discrete data. The edges in the graphs have their own semantic attributes. The algorithms based on the graph theory can efficiently perform data search and reasoning, and provide valuable analysis results and decision-making support. Typical applications include network configuration check, failure analysis and diagnosis. The knowledge graph can continuously improve and optimize the knowledge logic and models through manual accumulation and machine learning, so that network intelligence can form an improvement closed-loop.

Network-Based Mirroring

Network-based mirroring is to synchronously simulate a real network and capture comprehensive, real-time data of the network that covers topology, traffic, services and protocols. The data involves configuration data, status data, and real-time data, and includes not only current network data, but also historical and future data. It provides powerful data support for machine learning, knowledge graph, intelligent control and IBN application as well as various network services.

Cloud Native

In the 5G era, the ability to develop new services, apply to new scenarios, and quickly respond to new requirements are becoming increasingly important. The

cloud-native architecture uses PaaS to build an open service platform, adopts the app model to establish an open application model, provides open interfaces, and implements continuous integration and delivery through DevOps, thereby obtaining open capabilities that are efficient, elastic, and secure. Capability openness connects product R&D, quality assurance and network O&M processes to enable shorter service release cycles, faster time-to-market, less invasive upgrades, and higher delivery quality. The cloud native architecture provides a basic platform for intelligent 5G transport.

ZTE's Intelligent 5G Transport

Based on its great strength in intelligent technology, ZTE strives to build the highlands of intelligent 5G transport to accelerate 5G network construction and simplify O&M complexity.

Here are some typical practices that operators are most concerned about.

ZTE's Intelligent Management and Control Product

Based on a cloud-native microservice architecture, ZTE uses a self-developed ICT-PAAS platform and an app framework to support third-party app development and OpenAPI so as to develop its intelligent management and control product ZENIC ONE. The ZENIC ONE is composed of rich services/microservices. They are organized in accordance with the closed-loop lifecycle of the entire network, and are deployed or extended based on service scenarios. They also support flexible node & container expansion and unlimited network management scale. The ZENIC ONE includes an AI platform and a BigData platform to provide powerful data analysis and intelligent processing capabilities. In 2019, the number of equivalent NEs managed by ZENIC ONE reached 300,000+ as compared to 30,000 by the traditional OMC. The product has been successfully deployed on the cloud platforms in many provinces in China (e.g. China Mobile Guangdong).

Automatic Intent-Based Service Provisioning

The ZENIC ONE includes an intent engine, an automation engine, and a perception engine. The intent engine consists of three components: intent translation, intent perception, and intent assurance. Intent-based service provisioning mainly involves intent translation. ZTE's intent-based automatic service provisioning is simple and fast. The user only needs to select a service scenario, and the system will perform an intelligent analysis and display only the information that must be entered for this scenario. Other default recommended data is provided by the intent engine based on the scenario and self-learning. Then the system automatically provides multiple service solutions that comply with the user's intent. After the user selects a solution, the system converts it into the device configuration information according to the internal processing flow and sends it to the relevant device through the automation engine, thereby completing the service provisioning. The intent-based service provisioning have been applied to A1's existing network in Belarus, increasing service provisioning efficiency by 80%.

Optical Layer Adaptive Control

The optical layer adaptive control is mainly to enable the system to automatically deal with optical network emergencies without the need for human intervention so as to maintain the stability of the customer's service. ZTE's optical layer adaptive control function can optimize optical power, compensate for optical damage and obtain better OSNR performance for the optical link through machine learning algorithms without changing the rate, the spectral interval, and the modulation mode, so that the optical link can obtain better OSNR performance. In the case of limited resources, machine learning algorithms can be used for flexible spectrum modulation conversion with rate control to increase the room for path selection. In the event of a failure, the function can make full use of current physical resources to ensure customer service connectivity, providing the most reliable service guarantee. It has been tested and verified by multiple operators.

Network Simulation

Network simulation can identify potential hidden dangers or bottlenecks in a timely manner without affecting the operation of the existing network, improving the quality and efficiency of network planning and O&M. ZTE's network

simulation function relies on network-based mirroring to simulate the internal and external environment changes that may occur in a real network and trigger the execution of specific network simulation behaviors (e.g. fault simulation, traffic simulation, quality simulation, and protocol simulation). In addition, the system can simulate one or two faults to evaluate the overall anti-attack capability of the network, study the network robustness and provide quantitative results to guide subsequent network planning, adjustments, and hidden trouble elimination. Take traffic simulation for example. Capitalizing on network-based mirroring service that provides the network topology, protocols, and historical data and change information of traffic, the traffic simulation and prediction algorithms will be invoked according to the user's expected traffic increase. The traffic simulation results are presented to the user in the form of a traffic topology diagram that identifies network bottlenecks and offers suggestions for network optimization or expansion. These simulation behaviors have been tested and verified by multiple operators.

Configuration Check

Configuration check is to identify network configuration anomalies and potential risks quickly and automatically, improving the efficiency of network O&M. ZTE's configuration check function uses the knowledge graph technology to extract the configuration structure feature of the device from the existing network to generate the device's role fingerprint. Meanwhile, it completes network sub-graph mining, learns semantic rules through statistical/connection approaches, performs analysis in view of graph neural networks, and finally scans device configuration based on device roles and NLP technology to identify abnormal configurations and potential risks. This function won the Best Network Intelligence Award at the Broadband World Forum in 2019. It has now been deployed on the entire IPRAN network of China Unicom Guangdong, and played an important role in network assurance during the Spring Festival 2020.

Fault Diagnosis

Fault diagnosis is a high-frequency operation of network O&M that determines the network quality to a certain extent. ZTE's fault diagnosis function uses the fault relational dependency graph based on the knowledge graph technology to automatically diagnose faults of various networks and service objects, and uses the Bayesian network-based fault propagation graph to improve the probability analysis of suspected root causes, making fault location more accurate. The function has been verified on existing networks of China Mobile Shenzhen with diagnostic efficiency increased by 70%.

With intelligent 5G transport gradually becoming a reality, ZTE will invest heavily in intelligentization and work closely with operators and industry partners to apply the ZENIC ONE to more commercial networks and address the needs of industries and niche markets more flexibly and quickly. ZTE TECHNOLOGIES

SDON: The Best Guarantee for Optical Network Reliability and Service Performance

Wei Dengpan

Marketing Manager of ZTE WASON&SDON

The rapid development of 5G networks has led to sustained growth of the vertical industry. Optical transport network (OTN) is an important infrastructure network carrying 5G services, and its capacity, performance, efficiency and reliability have become a major concern of the industry. ZTE's 100G/beyond 100G OTN, combined with software-defined optical network (SDON) functions, can provide customers with the best network performance and the most reliable service guarantee, so that the optimal policy solution can be provided in service creation, recovery and optimization scenarios, and intelligent, flexible and reliable service control can be achieved.

Composition

ZTE's SDON solution is composed of management and control components and optical system components. Its architecture is shown in Fig. 1.

The management and control components located in ZTE's management and control system (ZENIC ONE) contain several functional modules involving service management, path calculation, optical optimization algorithm, and optical optimization policy. Based on the optimization objectives and constraints as well as optical measurement and AI prediction, these functional modules cooperate with each other to generate a specific modulation command set and send it to optical system equipment.

The optical system components located in the optical system equipment consist of the functional modules that involve optical data detection, software defined optics (SDO), automatic power optimization (APO), optical spectrum shaping, and optical loss compensation. After receiving an optical modulation command set from the management and control system, the functional modules execute instructions of the command set, complete optical optimization, and feed back the adjustment result to the management and control system. The management and control system determines whether the result meets the objective and whether to adjust it again.

The management and control system is capable of machine learning and has built-in optical optimization knowledge base, lab optical optimization supervised learning knowledge base, and online optical enhanced learning module, which can calibrate optical optimization policy in real time. Both the optical optimization knowledge base and the supervised learning knowledge base come

from ZTE's huge online OTN data model base, and can be updated periodically to provide abundant learning samples for machine learning in the management and control system. The online optical enhanced learning module can calculate the optimal policy for the current system based on real-time network data.

Typical Application Scenarios

The SDON solution enables the system to automatically deal with network emergencies and maintain service stability without human intervention. Its typical application scenarios are as follows:

Optical Performance Degradation

Optical performance degradation includes aging of optical cable and substandard cleanliness of fiber pigtail joint. These factors cause optical cross-section power changes or line bit errors. The SDON solution can improve optical path performance and ensure reliable service transmission through APO and optical loss compensation while keeping line rates, modulation pattern and spectrum unchanged.

The management and control system can monitor optical performance degradation and trigger optical optimization in real time. It enables the intelligent algorithm to match the optical optimization policy. The management and control components can generate a specific adjustment command set without changing the rate, code pattern, or spectrum. The management and control system delivers the adjustment command set to optical system equipment. The optical system components on the equipment optimize and adjust the optical power of service lines and compensate optical loss according to the command set. After the adjustment, they feed back the result to the management and control system. Based on the adjustment result and real-time service performance monitoring, the management and control system determines whether to perform the next optimization and adjustment. After the adjustments are completed, information about triggering reason, matching policy, and adjustment result will be put into the knowledge base, and the machine learning knowledge base will be updated iteratively.

Under the condition of optical performance degradation, the SDON solution can achieve a better OSNR and pass through more WSS cascades by adjusting optical power or compensating optical loss without changing the rate, code pattern or spectrum.

Optical Cable or Node Failure

When optical performance is degraded to a

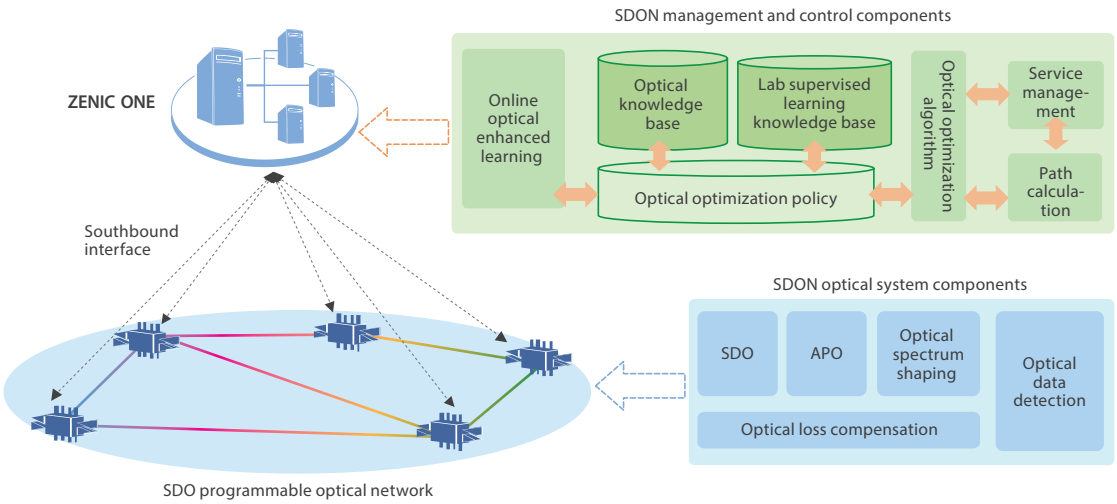

Fig. 1. SDON architecture.

certain level, optical power optimization and optical loss compensation fail to reach the goal, or optical cable is interrupted or even the node fails, the management and control system will initiate the recovery policy.

If there are paths with unchanged rates, code pattern and spectrum, the management and control system will use the algorithm and policies in the optimization policy base, calculate recovery routes, and select the optimal recovery path. After services are switched to the recovery path, the optical power is optimized to ensure optimal service performance.

If services cannot be recovered due to the limitation of physical resources such as devices and optical cables, the management and control system will first adjust the modulation code pattern under the condition of unchanged rates to ensure service transmission performance. If the modulation with unchanged rates cannot be implemented due to limited physical resources, the system will reduce transmission rates and match appropriate modulation code pattern and spectrum to ensure service connectivity.

Data Center Interconnect

As internet user traffic is bursty and unpredictable, it is difficult to completely fix the data center interconnect (DCI) model. If the OTN capacity is designed to reach the maximum traffic in a certain period of time, the bandwidth usage will be greatly reduced, and the network construction cost will be increased as well. SDON provides a solution to increase the transmission rate for DCI burst traffic.

Traffic surge can be detected and reported to the management and control system, or predicted by the traffic prediction function of the management and control system. When network traffic increases sharply, the solution for increasing optical transmission rates will be triggered. According to the current performance of the optical system, the management and control system will calculate the optimal modulation code pattern and spectrum that can meet the transmission requirements, and generate a modulation command set. After receiving the modulation command set, the optical system components adjust the optical modulation code pattern and spectrum and increase transmission rates to ensure the transmission of burst traffic. They also adjust and optimize the optical power to ensure transmission performance.

Whether in line performance degradation, optic cable interruption, node failure, or optical layer adjustment caused by traffic burst, information about triggering reason, adjustment policy, and optimization result will enter into the knowledge base for system machine learning, so that the algorithm can be optimized continuously.

Customer Value

ZTE's SDON solution can achieve a better OSNR through optical power optimization and optical loss compensation and guarantee service bandwidth and performance while keeping line rates, spectrum interval and modulation mode unchanged. In the case of limited resources, the solution can implement flexible spectrum modulation and line rate control, and improve the space for path selection. In the event of a failure, the solution can make full use of existing physical resources to ensure the service connectivity. The SDON solution can also automatically adjust the code pattern and rate to handle sudden increase in service bandwidth.

With the accumulated optical data, growing SDON knowledge base, and rich optimization policies, the management and control system enhances its machine learning capabilities and can rapidly make the optimization policy that is most suitable for the current network and accurately predict the optimization results when an OTN network fails. It can be predicted that with the further development of AI, ZTE's SDON solution will provide the best guarantee for optical network reliability and customer service performance. ZTE TECHNOLOGIES

ZENIC ONE: An Intent-Based Intelligent Product

Xiao Hongyun

ZTE BN Product Solution Planning Manager

The advent of 5G combined with AI has led to widespread enthusiasm for innovations to improve the productivity of telecom networks and achieve network automation. The concept of intent-based networking (IBN) put forth by Gartner in 2017 is getting a lot of attention in the industry. Standard bodies like 3GPP, ETSI and CCSA have initiated research on IBN. It is gradually becoming clear that the future network should be self-planning, self-adjusting, self-optimizing, self-managing, and allocate on-demand resources so as to align itself with the intent without human involvement.

Based on its deep understanding of network development and rich accumulation in ICT technologies, ZTE launches the ZENIC ONE, an IBN-oriented intelligent product. The product covers the full lifecycle of the network and provides such intelligent services as network planning, rapid network deployment, automatic service provisioning, automatic service recovery, quick fault diagnosis, network simulation, network prediction and network optimization, which effectively reduce network Capex and Opex, improve the level of intelligence as well as the efficiency of network construction and O&M.

Architecture

The ZENIC ONE consists of intent, automation and perception engines (Fig. 1). The intent engine, at the core of the ZENIC ONE, receives the user intent, drives the automation engine to orchestrate and control the network, and provides proactive intent assurance according to the analysis of the perception engine, thus building an intelligent closed-loop lifecycle.

The intent engine includes three components: translation, perception, and assurance (Fig. 2). The intent engine offers a web interface and third-party northbound interfaces. After users express their intents by voice, text or other modes through the web interface, the translation component interacts with them to ensure the integrity and clarity of the intent. The translation component also ensures that intent is implemented consistently. An intent,

whether it is user's input or remediation/optimization inside the network, is converted into a unified network intent expression model, goes through the processes of solution design, network orchestration, and pre-verification, and then is translated into configurations and sent to the automation engine. The perception component analyzes the network data reported by the perception engine against the intent, and sends the analysis results to both the management component (intent status) and the assurance component. The assurance component performs bandwidth adjustment, path adjustment, and protection recovery based on set policies to ensure the quality of the user intent.

The automation engine provides network control and management services. The network control service supports the control of IP, IPRAN, SPN/PTN and OTN networks, and works closely with the network management service to implement the unified management and control of various networks. The automation engine receives the configuration issued by the intent engine, processes it internally, and sends it to the actual devices to create the corresponding service. In a cross-network or cross-domain scenario, the automation engine may have multiple instances to manage multiple networks or multiple domains.

The perception engine collects and stores massive data in the entire network, and uses machine learning algorithms for association analysis, data mining and prediction, and then sends network analysis results to the perception component in the intent engine.

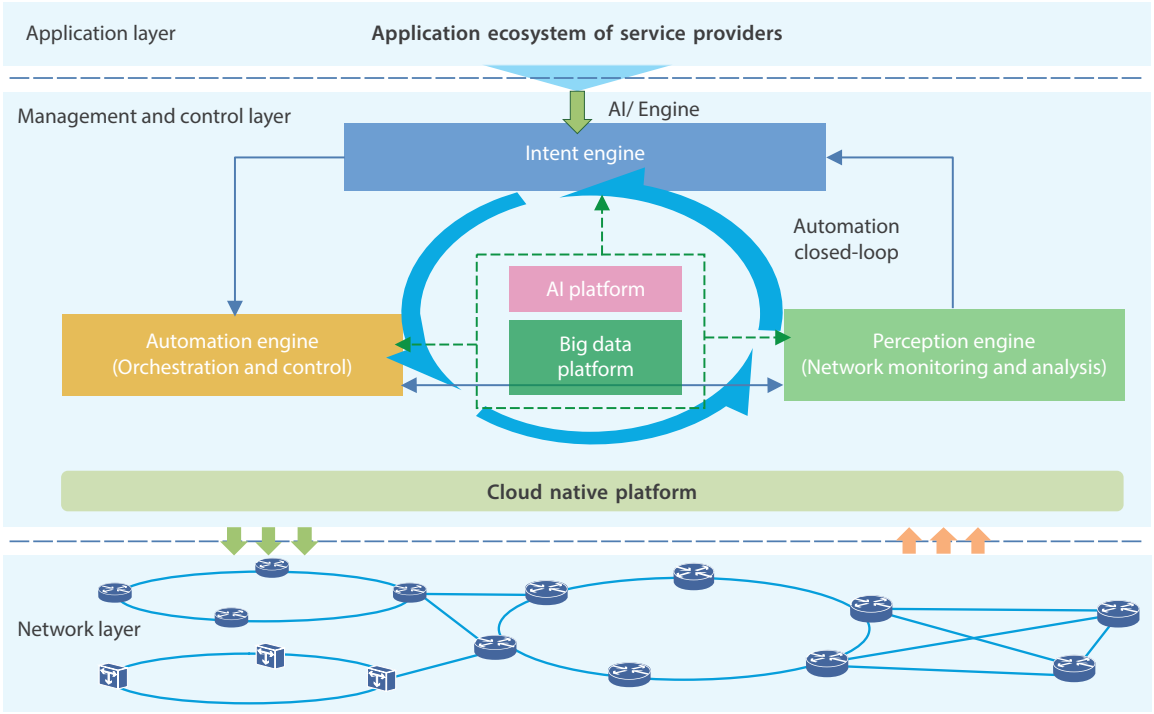

Fig. 1. ZENIC ONE architecture.

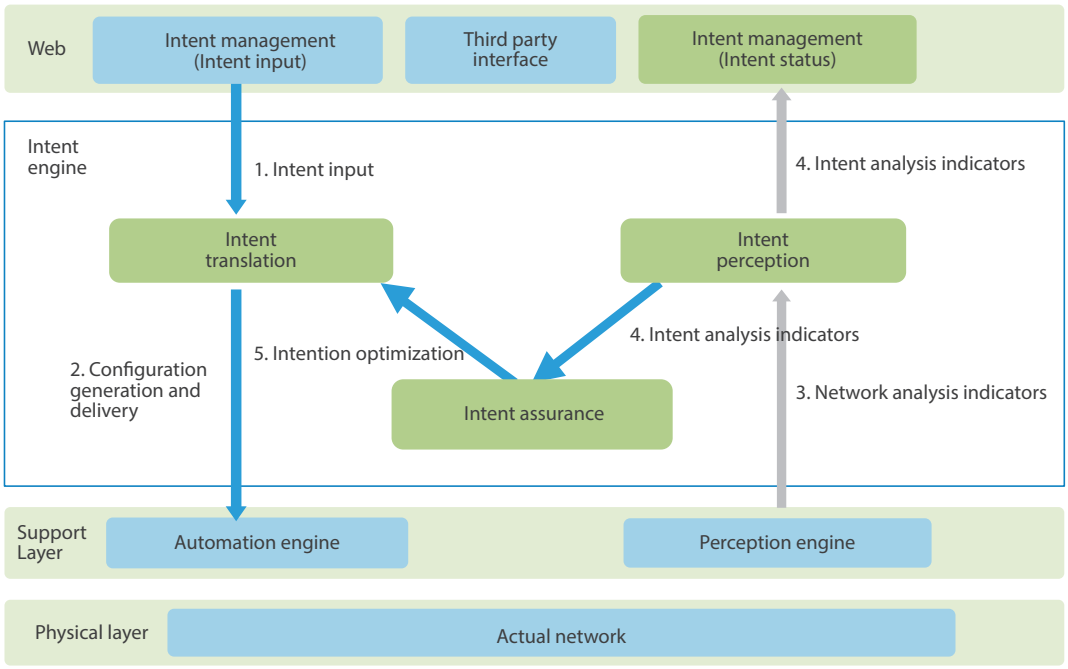

Fig. 2. Process flow of the intent engine.

The third-party northbound service is interconnected with the operator's upper-layer system, and they together implement automatic provisioning of services. It supports smooth evolution of the operator and rapidly meets new service requirements.

Features

The ZENIC ONE is an open, intelligent system with the following features:

- **Leading architecture:** The integrated management and control system is based on the cloud-native and micro-service architecture, which greatly improves the management capability, increasing the number of managed equivalent NEs from 30,000 to more than 300,000.
- **Closed-loop O&M:** Through the closed-loop operation of three engines, it offers full life cycle of intent creation, perception, and assurance.
- **Various scenarios:** It supports various network scenarios, including basic network deployment, multi-service provisioning and key network O&M services (e.g. key service assurance, network optimization).
- **Smart applications:** It achieves real-time perception of network and service based on the advanced data collection technology, network/service/resource analysis, detection and prediction using AI and big data, and assurance of network and service quality as well as intents through network and service optimization, protection, and restoration.
- **Open interfaces:** Open interfaces enable it to collaborate with other systems to meet user requirements more flexibly.

Typical Application Scenarios

Intent-Based Service Provisioning

The traditional service provisioning requires users to enter the function window of the network management and

control system and accomplish complex service parameter configurations. It has three major problems: dependant on manual configuration, resulting in heavy workload and long service provisioning time; high requirements for skills, increasing the chances of errors and lowering the solution success rates; and point-by-point configurations, leading to large manpower investment and high O&M costs.

The ZENIC ONE's intent-based service provisioning is simple and fast. Users only need to select the service scenario (e.g. a mobile service scenario, a group customer scenario). The system makes automatic judgment according to the operator and the selected scenario, and only displays the information that must be selected for this scenario, which mainly includes the equipment and ports for service adding/dropping. For QoS definition (e.g. bandwidth, protection, and automatic recovery), the system provides default recommended data based on the selected scenario and historical inputs. With the above information selected, the system will automatically formulate multiple solutions in line with the intent. The solution includes the service types (e.g. L3VPN, VPWS and VPLS), service typologies (e.g. HoVPN, FullMesh and HubSpoke), and tunnel types (e.g. LDP, TE, and MPLS-TP) with the corresponding route calculation results. If users want to explicitly confirm the solution, the system will display all service solutions and identify the best one. If not, users can directly select delivering the default solution recommended by the system. The system converts the solution into device configuration, and sends the information to the automation engine, which then performs necessary checks and verification, and pushes the information to related device to complete service provisioning.

It can be seen that the intent-based service provisioning offers clear benefits in four major areas:

- Easy configuration and automatic service provisioning greatly shorten service provisioning time and improve the efficiency by 80%.
- Automatic verification reduces the error rate, lowers the requirements for personnel and improves the success rate of service provisioning.
- End-to-end service provisioning reduces manpower investment and O&M costs.
- Service configuration is visually represented, improving the user experience.

Intent Management

The system can effectively manage the intents after intent-based services are successfully provisioned. All intents are managed in a unified way, with their names, types, and status clearly shown in a list. To view the details, users just need to click the selected intent. To modify or delete an intent, users can click the corresponding action button, and then click modify to go to a page for adding, deleting, or modifying devices, ports, and bandwidth information contained in an intent.

Through centralized intent management, users can operate and maintain the full lifecycle of an intent.

At present, ZENIC ONE has been put into commercial use by many domestic and overseas operators including China Mobile, China Unicom, China Telecom, A1 Belarus and Telefonica Columbia, and has won extensive recognition. It will play a greater role in facilitating 5G network development and accelerating network autonomy. ZTE TECHNOLOGIES

Intelligent Fault Diagnosis Based on Knowledge Graph and Machine Learning

Han Junhua

Pre-research Engineer of BN Software Platform, ZTE

The traditional fault diagnosis solution has the disadvantages of long fault diagnosis procedure, low fault location efficiency, relying on expert ability, large manpower investment, and high O&M cost. Its diagnosis rules and procedures are hard-coded, which cannot flexibly and quickly deal with various fault diagnosis scenarios.

ZTE has launched its intelligent fault location solution based on knowledge graph and machine learning. The solution not only uses machine learning to improve the intelligence of fault diagnosis and shorten the fault diagnosis time, but also adopts knowledge graph and data mining in combination with manual confirmation and summary to form fault knowledge graph. All this helps to accumulate and inherit the knowledge and experience in O&M and reduce its cost.

Intelligent Fault Diagnosis Framework

The overall framework of the intelligent fault diagnosis solution is illustrated in Fig. 1. Fault location involves fault location module, fault knowledge graph generation module, online and offline model training module, fault labeling module, fault knowledge graph module, and AI model.

- **Fault location module:** It is the core module responsible for fault location based on the trained AI model and the generated fault knowledge graph.
- **Fault knowledge graph generation module:** It uses multi-dimensional data mining technology to mine the labeled fault data such as alarms, abnormal performance, abnormal logs and abnormal configurations, and generates a complete fault knowledge graph for fault diagnosis in combination with manual confirmation and summary.
- **Online and offline model training module:** It is responsible for data cleaning and feature processing based on labeled fault data, generating training sample sets, and training AI models. During the implementation, the labeled fault data on the existing network can be collected regularly and concentrated in the data lake for offline training. Online training can also be performed directly based on the labeled fault data.
- **Fault labeling module:** It labels the restored faults in the existing network to form the labeled fault data for follow-up model training and system self-learning.

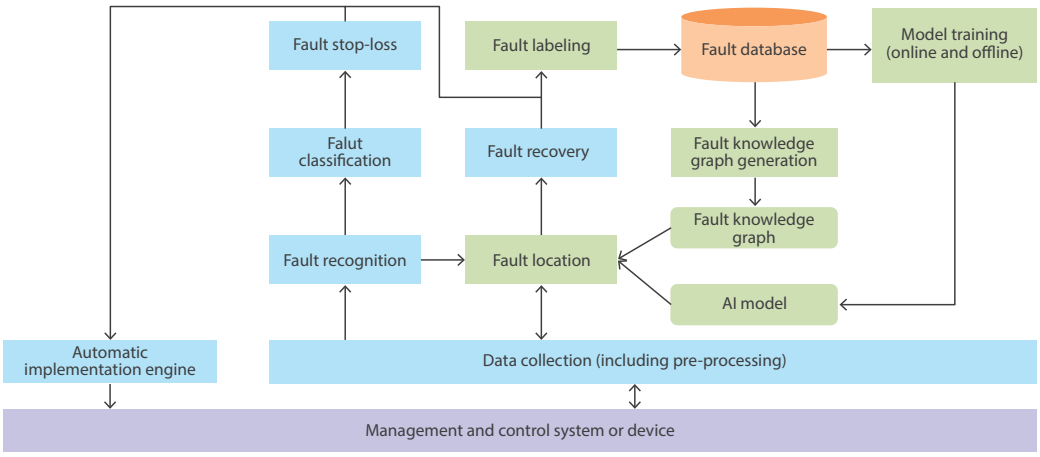

Fig. 1. Overall framework of intelligent fault diagnosis.

- **Fault knowledge graph module:** It represents and stores fault knowledge using the knowledge graph technology, which can be used for fault location, recognition, classification, recovery and stop-loss.
- **AI model:** It is used for fault location. The machine learning algorithms can be selected as desired to establish the corresponding AI model. This solution selects a Bayesian network and sets up the Bayesian AI model. Other machine learning algorithms can also be selected.

Intelligent Fault Location Solution

Before fault location, it is necessary to generate a fault knowledge graph. Specifically, with the help of knowledge graph and graph database, the multi-dimensional data mining technology is used to mine the labeled fault data such as alarms, abnormal performance, abnormal logs and abnormal configurations and to generate a complete fault knowledge graph in combination with manual confirmation and summary. The fault knowledge graph includes fault mode, symptom and propagation relationship, object, diagnosis, impacts, root cause, stoploss, recovery, and other related knowledge, which can be used for intelligent fault diagnosis. It is also necessary to select and determine an AI model, and use the training data to complete offline training of the AI model. In this solution, Bayesian network is selected as the AI model.

The Bayesian network model is automatically generated based on its generation algorithm and also the fault mode, symptom and propagation relationship, and root cause in the fault knowledge graph. The generated Bayesian network model uses the collected labeled fault data for data cleaning and feature processing, generates the corresponding training sample sets, and completes the offline training.

The primary goal of fault location is to find the fault location. For a transport network, it is to find the location of the faulty NE. Considering the characteristics of the transport network, during the actual fault location process, it is also necessary to find the faulty service path according to existing configuration data and to narrow the scope of fault location. The fault is then located based on the data provided in the fault knowledge graph. The knowledge included in the fault knowledge graph such as fault mode, symptom and propagation relationship, and root cause can be used to find the network nodes with fault symptoms and take them as suspected fault nodes.

Another goal of fault location is to further find the root cause. All possible suspected root causes can be found using graph searching algorithm based on the fault mode, symptom and propagation relationship, and root cause included in the fault knowledge graph. With the fault symptom data, the trained Bayesian network model can be then used to deduce the probability of suspected root causes.

The last step is automatic fault diagnosis. Since only the suspected fault nodes and corresponding suspected root causes and probabilities were found before, it is also necessary to automatically diagnose the root cause and give the final diagnosis result based on diagnosis rules corresponding to the fault root cause in the fault knowledge graph. For the root causes that cannot be diagnosed automatically or must be diagnosed by people, processing suggestions and probabilities are given directly.

After fault recovery, fault labeling is carried out where the results of intelligent fault diagnosis are modified and labeled with correct fault labels, and the fault data is automatically saved to the fault database for subsequent online training. Fault labeling is to continuously form training sample sets for subsequent model training and system self-learning.

To improve the accuracy of fault location, it is also necessary to train the Bayesian network online regularly based on the labeled fault data. The way of online training is similar to that of offline training. The labeled fault data needs to be cleaned and processed first to generate standard training sample sets, and then the Bayesian network is trained. Through the online model training, the system has the ability of self-learning, and its accuracy of fault location is getting higher and higher.

ZTE's intelligent fault diagnosis solution based on fault knowledge graph and AI model provides automatic fault diagnosis, and accumulates and inherits knowledge and experience in O&M. The solution significantly improves the efficiency of fault diagnosis efficiency, reduces O&M costs, and helps operators build quality transport networks. ZTE TECHNOLOGIES

Intelligent Configuration Check Based on Role Fingerprint

Wu Zhengguang

Marketing Manager of ZTE Transport Management and Control Products

With the rapid development of emerging services and the continuous expansion of network scale in the 5G era, the network architecture presents multi-dimensional complexity. Operators will face a large amount of new network construction and old network transformation, resulting in huge work of infrastructure configuration. Due to the complexity of 5G network route management and the increasing difficulty in multi-layer logical network operation, there will be an exponential growth in network O&M. It is therefore urgent to introduce AI technologies and algorithms such as big data and machine learning to improve the automation of network O&M and address its difficult issues.

ZTE and the Guangdong branch of China Unicom (Guangdong Unicom) have jointly launched the role fingerprint-based intelligent configuration check. This function uses AI technologies and algorithms for big data analysis to quickly discover abnormal network configurations and potential risks.

Functional Mechanism

Each network has different size, topology and service combination. There are differences in the configuration of each network element (NE) and each service, which makes the configuration work huge and easy to make mistakes. However, the internal network substructures such as NE roles and service types are very similar. If the general substructure model inside the network can be extracted and used for abnormal experience analysis, the operating cost can be greatly reduced. This solution uses the knowledge graph technology to extract the configuration features of devices from the existing network to form role fingerprints, identify abnormal configurations, and provide guidance for deployment and maintenance of new networks.

What's Role Fingerprint

Role fingerprint is actually synonymous with data features, which was first put forward by ZTE and Guangdong Unicom. For example, a person's voice has certain voiceprint features. We use machine learning to extract the frequency, waveform and other features from the voiceprint to build a model. This data model is called the role fingerprint. With the role fingerprint, the next time the person speaks, the system can identify the person. Similarly, you can build a role fingerprint for a device based on data characteristics of the device configuration.

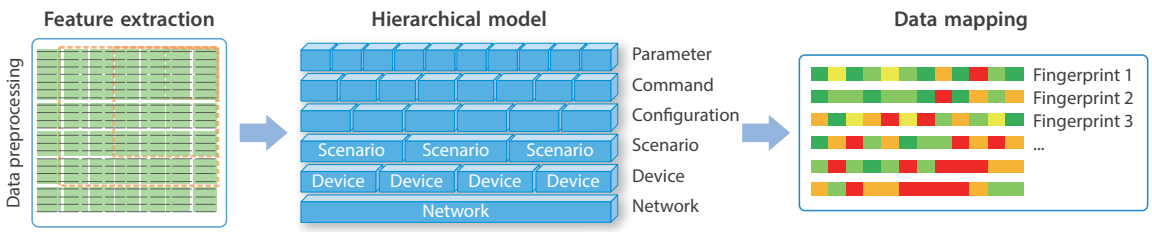

Fig. 1. Building fingerprint library.

How Does Configuration Check Work

The configuration parameters of a device are determined by its type, services it carries, topology and connectivity features in the network. Role fingerprint represents particular features of a set of configuration parameters for a particular type of device.

The principle of intelligent configuration check is as it follows: First, extract massive configuration data from existing network devices and use the natural language processing (NLP) technology to build a hierarchical model of devices (Fig. 1). Second, mine association rules at different levels based on the association analysis theory and automatically build the configuration knowledge graph to form the role fingerprint for the same type of devices. Third, mark and check the device model that is determined to be abnormal by machine. A configuration model that is finally determined to be normal is stored in the case database for role fingerprint update.

Which Abnormal Configuration Can Be Checked

The configuration check function is integrated in the intelligent transport control and management system ZENIC ONE. It supports all ZTE IPRAN equipment types in the existing SDN network. The abnormal types that can be checked include parameters, sub-commands, and command combinations. At present, the faults that can be checked are mainly caused by incorrect configuration, missing configuration, and configuration conflict. Incorrect and missing configurations can be pre-checked through the role configuration knowledge graph. Configuration conflict can be avoided by actively checking network architecture through the reasoning knowledge graph generated from the inspection rules.

Application

The traditional way of configuration check depends on the manual operation of engineers. They find problems according to their expert

Fig. 2. Best Network Intelligence Award at BBWF.

experience. ZTE and Guangdong Unicom have innovatively applied AI technologies including the knowledge graph to the transport network and have proposed a new concept of role fingerprint for intelligent configuration check. At the MWC Shanghai in June 2019, ZTE and Guangdong Unicom jointly demonstrated the role fingerprint-based intelligent configuration check for the first time. This application won the Best Network Intelligence Award at the Broadband World Forum (BBWF) held in Amsterdam, Netherlands in October 2019.

According to Guangdong Unicom O&M team who tested the role fingerprint-based intelligent configuration check on their IPRAN data from typical cities in Guangdong province such as Shenzhen, Foshan, and Dongguan, it took only one person in less than 10 minutes to check the configurations of nearly 1000 devices in the IPRAN networks, and the accuracy of abnormality check rate reached 85%.

The application is also tested and verified in the 5G network of Shenzhen Unicom. It helps Guangdong Unicom check 5 million configurations for 5000 devices in a new 5G network. Compared with the traditional check solution that needs several O&M personnel to work for several days to deal with the data in one city, the role fingerprint-based intelligent configuration check solution drastically reduces labor cost and significantly improves network O&M efficiency.

The role fingerprint-based intelligent configuration check solution has been deployed by operators in their existing networks. It improves the efficiency of configuration check and the identification rate of configuration risk, which ensure the quality of network operation. Also, it significantly saves manpower in O&M through machine computing, thus reducing Opex and meeting operators' needs for low-cost, high-speed, and highly reliable 5G networks. ZTE TECHNOLOGIES

Transport Network Simulation: A Key to Network Quality Improvement

Lv Shun

Market Manager of Transport SDN M&C Products, ZTE

As a 5G network is large and complex, it is of great value to identify and optimize the potential failure risk in advance to improve the quality of the network. Network simulation is to simulate the actual network, restore real network topology and protocols, and build a virtual network. It studies network operation rules and response mechanisms in virtual network scenarios, analyzes the change of network processing capability and network quality under normal and abnormal situations, and thus evaluate the impact of network adjustments on the existing network. This provides decision-making basis for network planning, construction, maintenance and optimization. Network optimization is implemented based on the results of several sand table deductions, which avoids frequent adjustments and improves network O&M efficiency while ensuring network stability.

ZTE's transport network simulation solution involves IP/IPRAN, PTN/SPN and OTN scenarios, and provides various simulation types such as fault simulation, traffic simulation, quality simulation and protocol simulation. A typical network simulation process is generally divided into three steps (Fig. 1):

- **Mirror network:** Receive the input from the management and control system, construct a mirror network model based on the network topology, configuration, and traffic data, and reflect the real network status through the mirror network.
- **Alteration simulation:** Make various alterations under the mirror network, simulate the alterations in the internal and external environment that may occur in the real network, and output the results.
- **Simulation analysis:** Analyze the impact of various alterations to the network based on the simulation results, identify risk points and levels, and display them visually to help O&M personnel make the best decision.

Network simulation uses the evaluation method of hypothesis analysis that allows O&M personnel to have a clearer understanding of the fault scope, traffic change, and network quality, so it has wide application value and commercial prospects.

Mirror Network

The mirror network provides a simulation network that synchronizes current network status in real-time for simulation operations, which makes the simulation more real and achieves the effect of online simulation and real-time simulation. According to the requirements

of simulation operations, the mirror network consists of three parts:

- Physical pipe, that is, the basic physical network composed of equipment and links, based on which all other work is carried out.
- Logical pipe, that is, dynamic or static paths divided by various tunnel, VPN or routing technologies on the basis of physical pipes.
- Traffic mirroring, that is, to simulate the flow law of data in the logical pipes based on physical and logical pipe models. It helps to build a complete network simulation test environment.

Network simulation is based on the corresponding traffic mirroring. Studying the traffic alteration trend is also the main goal of network simulation.

Alteration Simulation

After the construction, a mirror network simulates network alterations by triggering events around its three basic features (physical pipe, logical pipe, and traffic mirroring), that is, to carry out the simulation operation. Network alterations include fault simulation, traffic or quality simulation, physical pipe simulation (physical topology planning), and logical pipe simulation (protocol simulation).

Fault simulation refers to the simulation of the situation after one or more faults occur in the network, such as IP network L3 link or TE tunnel failure, board or chip fault, and OTN link disconnection. Based on the results of network self-adjustment, it analyzes changes of traffic distribution and network quality deterioration before and after a fault occurs.

Traffic or quality simulation aims to simulate network traffic alterations caused by external or expected traffic events, and to add them to traffic mirroring. By observing the forwarding distribution and changes of network traffic, it can find the possibility, time, and location of network congestion. Moreover, network quality indexes such as delay and jitter are simulated and altered to analyze network quality.

Physical pipe simulation is to simulate physical topology alterations such as capacity expansion or shrink to trigger the change simulation calculation. Based on the results processed by the network itself such as tunnel and service path changes, it analyzes the changes to network traffic or quality.

Logical pipe simulation does not change physical topology of the network, but adjusts the device protocol parameters such as bandwidth, protection path, and priority to affect traffic forwarding rules. Based on the results processed by the network itself, it analyzes the changes to network traffic or quality before and after the protocol alteration. The link fault simulation is illustrated in Fig. 2. In a mirror network, the SDN management and control (M&C) system finds that when the simulation link a fails, simulation links b and c will have the congestion risk. Therefore, the system will output a feasibility report and suggest that

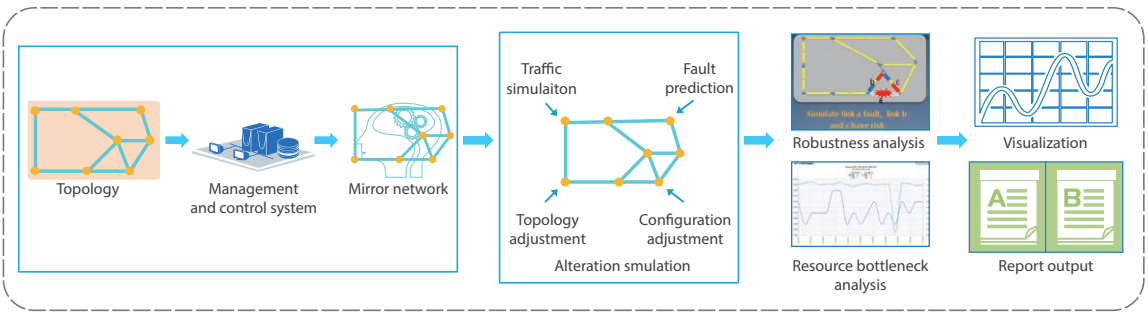

Fig. 1. Typical network simulation process.

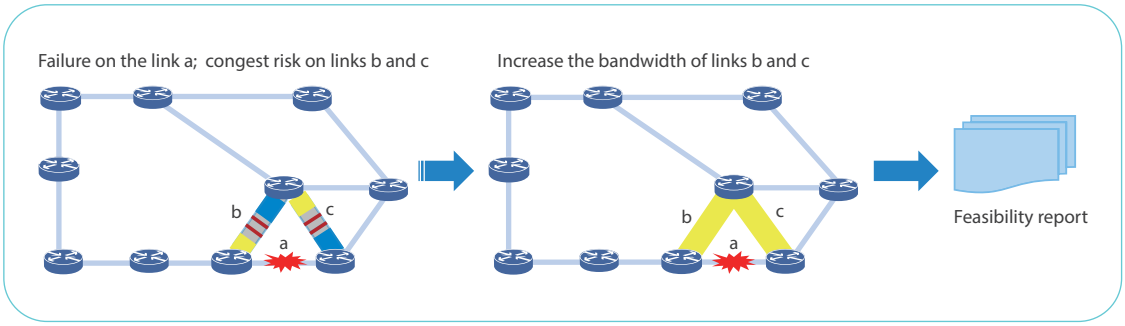

Fig. 2. An example of link fault simulation.

users should increase the bandwidth of links b and c to avoid potential risks. The network is optimized in advance to improve reliability when it is normal.

Users can simulate network alterations to meet different requirements. Different alteration simulations can also be coordinated to better identify potential risks in the network.

Simulation Analysis

The purpose of simulation is to improve network quality and make the network better serve users. It is therefore of great value to judge the results of simulation alternations, analyze the impact of the alternations to local or global network, analyze existing network traffic or quality bottlenecks, and provide guidance for network optimization.

The impact of network alterations can be analyzed from the service level, tunnel level, link level, and network level. At the service level, alternations to the network may trigger rerouting and other actions, thus affecting L2VPN and L3VPN services. Therefore, simulation analysis at the service level focuses on the alternations to service state, service path, service tunnel attached, and traffic flow. Similarly, simulation analysis at the tunnel level involves the changes in tunnel state, tunnel path, tunnel services, and tunnel flow. The impact of alterations on the link level is reflected in the changes of total traffic. The simulation module can judge the network bottleneck by analyzing the accumulative value of tunnel traffic overlapped on physical link. Simulation analysis at the network level evaluates the quality of the whole network. Global network quality indicators (NQI) or customized NQI are established to analyze the impact of network simulation on the whole network. Survivability analysis (robustness analysis) is another method of simulation analysis that studies the anti-attack capability of the network, that is, evaluates the quality of the simulated network in the case of primary failure, secondary failure or even multiple failures. The survivability analysis can also be used to find out the nodes and links that exceed the threshold, so that potential risks can be rapidly located.

Whether it is the analysis of simulation alternations at the service, tunnel, link and network levels or the survivability analysis, the purpose of simulation analysis is to help customers understand the overall quality of the network in a more rapid, intuitive and convenient manner and to give optimization suggestions to help with O&M and improve O&M efficiency.

ZTE's simulation module integrated in ZENIC ONE (ZTE SDN M&C system) has the characteristics of global network simulation and visualization and can support full coverage of 4G and 5G transport network scenarios such as IP/IPRAN, PTN/SPN, and OTN as well as online simulation of tens of thousands of physical network elements. ZTE's transport network simulation solution has been verified in China Unicom, TRUE, and other global markets, helping operators worldwide improve their network quality and O&M efficiency. ZTE TECHNOLOGIES

ZTE: Strong Partnerships Are at the Heart of Digital Transformation

Source: Telecom Review Asia

With 5G deployment fast becoming a reality in many parts of the world, mobile operators are scrambling to get their hands on the latest products and solutions that will catapult their businesses to greater heights. Advancing right alongside this 21st century digital phenomenon is ZTE, who is not only leading the way towards a 100% software-based, end-to-end mobile network infrastructure solutions, but also smashing through traditional telco methods and welcoming a new generation of continued innovation and market proliferation.

Telecom Review Asia Pacific sat down with Mr Bai Yang, Vice President of ZTE Corporation, Leader of Global Marketing & Solution Department in Pan-Asia Pacific Region to discuss his vision for a 5G future.

What is unique about ZTE's approach to 5G deployment?

ZTE is one of only two equipment manufacturers in the world that can provide 5G end-to-end solutions and commercial products. In the Asia Pacific region, ZTE has assisted operators in China to achieve 5G scale commercial use and conducted 5G network test and new business exploration with mainstream operators in Malaysia, Myanmar, Indonesia, Thailand and many other countries.

Through these practices, ZTE has accumulated rich experience and put forward a mature 5G rapid network construction scheme. The first is to "simplify" the technical solution, including the whole scene minimalist site solution based on multi-mode multi-frequency multi-architecture and full mode maximum capacity BBU platform, the Common Core scheme which supports 2G, 3G, 4G, 5G and the fixed network access at the same time, and the Flexhaul bearing network which can effectively reduce power consumption and configuration complexity; the second is to "add intelligence" to the network: add AI and MEC functions; the third is to "separate" the network, virtualize a physical network into multiple virtual networks, build a core open platform, shorten business online time and reduce operation and maintenance costs; the last is to multiply 5G features and massive vertical industries, leading to the matrix revolution of 5G business model.

Seeing that the region is made up of socio-economically diverse countries, what types of solutions have been introduced to cater to these specifications?

Firstly, 5G mainstream band 3.5 GHz has been

Mr Bai Yang, Vice President of ZTE Corporation

ZTE is willing to work closely with Asia Pacific operators to provide the best solution for customer' digital transformation based on its own accumulation of video capabilities, AI capabilities, basic software and equipment development.

used in many countries in the Asia Pacific region. For the countries where 3.5 GHz cannot be obtained, ZTE has launched a series of customized 5G AAU products, which can meet the network construction needs of different operators in 700 MHz, 2.6 GHz and other frequency bands.

Secondly, the Asia Pacific region is densely populated and the demand for network capacity is growing explosively. ZTE's Massive MIMO products have been deployed for many years, and have been proved to provide 6-8 times the throughput of 4G network cell. This brings users the ultimate experience.

Additionally, some operators also have a large demand for 4G expansion. ZTE's wireless and core network products can support 2G, 3G, 4G, 5G access at the same time, and support NSA/SA dual-mode. The dynamic spectrum sharing scheme can support the flexible allocation of spectrum in 4G and 5G networks, realize the smooth evolution of 4G networks to 5G, and protect the investment of operators.

In order to save 5G investment, operators try to share infrastructure such as co-built transmission and site, or further seek M&A to reduce market competition. ZTE's RAN sharing scheme has been commercially validated by China Telecom and China Unicom, and it is a practical solution that can significantly reduce Capex and Opex in the process of network infrastructure sharing and network consolidation.

Lastly, many traditional operators are transforming to full-service operators to improve profitability. ZTE's 5G core and 5G optical access product TITAN can be compatible with wireless broadband and fixed broadband access at the same time, support seamless switching of user equipment at the network level, and realize fixed mobile integration.

What kinds of challenges can you foresee when it comes to driving digital transformation in Asia Pacific?

The digital transformation of operators is not only to provide digital communication services, but also to build and integrate into a new digital ecosystem and become an enabler of the future digital economic society. In the process of transformation, operators not only need to overcome the shortcomings of the traditional

business model, but also need to meet new challenges, such as the repositioning of the ecosystem, operational organization change, talent transformation and so on.

In order to better serve the digital transformation of customers, operators must first solve the problem of insufficient network agility, resource scheduling needs to be more flexible, and the network is easier to expand, so as to support diversified and personalized business innovation. ZTE can provide SDN/NFV network products based on mainstream technology, with communication level reliability and high performance, to help operators with agile network transformation.

Operators in the Asia Pacific region are in different stages of digital transformation. Some operators have not completed the digital transformation of their own operation, so they have some challenges to deal with the digital transformation of the society. ZTE has rich experience in its own digital transformation. It can provide large-scale operators with national data center, ICT PaaS, distributed database and other basic software, which can help operators cope with their own digital transformation.

In the process of business development, operators need to constantly accumulate experience and improve the ability to integrate the ecological chain, so as to provide customers with the best technology, the lowest cost and the best delivery solutions. ZTE, as a long-term strategic partner of operators, is willing to work closely with Asia Pacific operators to provide the best solution for customer' digital transformation based on its own accumulation of video capabilities, AI capabilities, basic software and equipment development.

How closely do you work with customers in order to bring 5G to the respective markets?

5G has been integrated into the key capabilities in the industrial field at the beginning of its definition. On the basis of building ubiquitous communication, it is built with AI enhancement, evolutionary perception and control intelligence to comprehensively improve the collection, transmission, processing and application level of information, laying a solid foundation for the continuous optimization cycle of operation innovation, product service innovation and mode innovation of enterprises and society.

In the age of 5G, customers' demands are characterized by individuation, customization and polymorphism. Operators and equipment manufacturers are trying to explore the industry rules and demand characteristics. It is expected that in the future, operators will build an open and powerful middle platform, integrate resources, and provide relevant capabilities to ecological partners and markets.

We have many 5G partners in the Pan-Asia Pacific Region, such as Smartfren, Telkom and Telkomsel in Indonesia, U Mobile, Webe and Digi in Malaysia, Ooredoo and Mytel in Myanmar, Kivystar in Ukraine, True and AIS in Thailand, Bharti Airtel and VIL in India, TP in Pakistan, Megafon in Russia and A1 in Belarus. Our role as we see it is to verify new technologies and from that develop new business through strong partnerships.

ZTE has formed in-depth collaborations with more than 70 operators around the world. With its extensive experiences in the field of Massive MIMO and continuous innovation in 5G algorithms, ZTE has been improving 5G commercial network performance and building quality networks for users to enjoy the uninterrupted high-speed and low-latency internet experience.

As a proactive and leading contributor to new 5G applications, ZTE has been collaborating with global operators to optimize the 5G vertical industry with its end-to-end 5G SA solutions. Moving forward, ZTE will continue leveraging its end-to-end NSA & SA dual-mode products and leading Massive MIMO technology to help operators build the best networks with ultimate user experience and services. ZTE TECHNOLOGIES

ZTE Says End-to-End Network Slicing Is Crucial in the 5G Era

Source: RCR Wireless

End-to-end network slicing is key to enabling net neutrality in the 5G era, according to Chinese telecom vendor ZTE.

ZTE proposes that operators can use the technology of network slicing to work as virtual private network (VPN) for different types of terminals. In one network slicing, net neutrality access policy can be adopted for the same type of terminals. However, operators can use a predefined policy to dynamically adjust the resource allocation between network slices for different types of terminals, so as to ensure those terminals for public interest or human beings can have priority network access in case of network congestion.

In the past, the only way for the enterprises to have a private mobile network was to build a physical network and set up a professional network operation team. "Only the super large enterprises, army and government could afford to build such a private mobile network," said Jiashun Tu, Chief Scientist of NFV/SDN, ZTE. "On the other hand, due to the regulation of frequency, normally such a physical mobile network has to be a national wide network, which is not suitable for some regional and small-scale enterprises. 5G end-to-end network slicing will meet the demand for private networks, while bringing more competitiveness to thousands of 5G services because of more affordable costs and better end-to-end user experience."

The executive also highlighted that network slicing provides a way to divide a physical network into multiple virtual networks with different service-level agreement (SLA). Operators can adjust the dynamic resource proportion of different network slice to define the SLA dynamically. In fact, this provides SLA for users in different network slice, which is contrary to the existing net neutrality principle. But such a dynamically adjusted classified net neutrality principle will actually better promote network equality and improve the utilization efficiency of frequency resources, when the network transforms to ubiquitous 5G network with hundreds of millions of human, robots and IoT terminals.

Although 5G claims to provide ten times network performance compared with 4G, 5G will still have to face the scene of resource conflict due to the access of more terminals of IoT. Some typical 5G applications, such as industrial control, autonomous driving and telesurgery, need absolute SLA assurance from the network, otherwise it will bring huge economic losses and even casualties. While other typical 5G applications, such as online video, do not have too many requirements for reliability, but are more sensitive to the economy of network services. Thus, the traditional sense of network neutrality needs to be extended to adapt to the new 5G scenario. With

Jiashun Tu, Chief Scientist of NFV/SDN, ZTE

5G end-to-end network slicing integrates SDN/NFV, cloud, orchestration and related technologies to help enterprises of different types and sizes have their own SLA guaranteed VPN/slice at an affordable price.

the development of 5G network, the limitation of resource such as frequency, transmission and base station site space for tens of billions of things and human will lead to the bottleneck of the development of human society. So the only solution is to use 5G network slicing as VPN with high resource utilization to replace the physical private network gradually. It is the best solution to give as many resources as possible for the operator to run a public telco network, and then use network slicing technology to provide VPN for different 5G services.

ZTE also highlighted that cloud capabilities closer to the end user can provide a faster response to the service. "Usually, automatic control service, autonomous driving requires a low-latency and reliable network (uRLLC). Compared with the normal central cloud, MEC avoids transmitting a large amount of information to the central cloud. First, this saves backhaul resources," Jiashun Tu said. "Secondly, it avoids security risks caused by long-distance multi-hop transmission. Thirdly, the reduction of processing points is also conducive to improving reliability," the executive added.

For 5G, cloud technology and virtualization technology have completely changed the core network. Virtualization technology makes the core network more flexible and economical. Compared with 4G, 5G requires more sites and more flexible network access modes. Therefore, virtualization of RAN is also a trend. Currently, the CU defined by 3GPP can be a virtualized network element. MEC will be a platform to support the smooth evolution of virtualized RAN. It can be imagined that in the future, with the popularization of MEC, it will form a ubiquitous cloud infrastructure together with centre cloud, and 5G itself will evolve into an application on this ubiquitous cloud.

ZTE also explained the concept of Cloudify 5G and what are the main benefits of this for telecom operators. Cloudify 5G is composed of a virtualized core network, software defined network (SDN) transmission, and virtualized RAN. At present, the core network already supports softwarization, the transmission network also supports software definition, and the newly introduced MEC needs to support future RAN evolution. "When the RAN evolves into a virtualized RAN on the MEC platform in the future, Cloudify 5G will become a typical service and capability on the cloud (PaaS and SaaS). Operators will realize the transformation from a communication service provider (CSP) to a digital service provider (DSP). The challenge is that existing cloud providers are also transitioning in this direction through another path (adding 5G to their existing clouds). ZTE TECHNOLOGIES

ZTE Pushes Ahead with 5G to Fight Coronavirus

Liu Xinyang

Brand Manager of ZTE Wireless Products

The coronavirus is accelerating the remote collaboration in various industries such as education, medical care, industrial manufacturing, and logistics. The government will also deepen and widely promote the intelligent management. This puts forward higher requirements on collection, transmission, processing, and application of information in the entire society. The demand and investment of 5G applications in the ICT industry will be further expanded.

Speedy Construction of 5G Network

ZTE works with operators to ensure the construction of the communication network. At the same time, it works with industry partners to deploy innovative applications such as new media, telemedicine, distance education, and security in the 5G industry to fight against COVID-19.

ZTE and the operators jointly completed the communication network construction of the emergency specialty field hospitals across the country, established 5G remote consultation and other emergency network guarantees, built and secured 4G/5G networks at 68 hospitals in 23 provinces across the country, such as Wuhan's Leishenshan Hospital, Huoshenshan Hospital, Huanggang Dabieshan Regional Medical Center. In 24 hours, the construction of high-definition video conference systems at three key hospitals in Wuhan and 26 designated hospitals was completed. ZTE also cooperated with CCTV and Xinhua News Agency's live broadcast channel to achieve 24 hours of continuous live broadcast at Wuhan LeiShenshan Hospital.

ZTE 5G Is Widely Used in Telemedicine, Monitoring, Distance Education

5G telemedicine has played an important role. ZTE cooperates with local operators in Hubei, Chongqing, Sichuan, Guizhou, Jiangxi and other places to open 5G remote consultation and mobile diagnosis and treatment services. On January 26, the first 5G remote consultation in three locations across the country was realized. In addition to disease treatment, daily psychological counseling services can also be provided.

Based on ZTE's big data technology, the three major domestic operators can provide itineraries for mass mobile phone users.

ZTE uses temperature measurement equipment that integrates intelligent video, AI, and thermal imaging to release an intelligent video cloud epidemic prevention and control solution. It installs intelligent sensing equipment at key locations for epidemic prevention inspection, reducing manual investment, infection risks and related costs.

The 5G network combines AI, robotics and other technologies to support the indoor distribution of infectious disease rooms and reduce the risk of infection. Unmanned distribution in cities can also be a way for the closed management residents.

Affected by the coronavirus, schools and educational institutions have launched online courses and implemented distance education. ZTE helped China Mobile launch the home cloud classroom business quickly, and introduces massive and high-quality educational resources.

5G Roll-out Will Be Speeded Up

The existing 5G network cannot meet some special applications, and the customization capabilities for different industries are insufficient. To solve these problems, both the construction of 5G networks and the layout of infrastructure such as edge computing must be accelerated. At the same time, it is also necessary to accelerate the construction of 5G SA core networks, supporting network slicing capabilities, network customization and capability opening for applications in different industries.

In addition to the 5G network itself, the basic technology and equipment capabilities related to 5G applications, such as terminals, robots, and AI algorithms, need to be further improved by the whole industry.

Due to the coronavirus, the communication industry will be affected in the short term, but the overall goals will not change or even be accelerated in the long term. ZTE has the confidence and ability to support operators to accelerate the construction of 5G networks. The coronavirus outbreak has tested the anti-risk capabilities of Chinese communication vendors and operators. ZTE has demonstrated its overall 5G technical capabilities, product capabilities, and capabilities in network interaction and security. ZTE TECHNOLOGIES

China Mobile Neimenggu Deploys Cloud-Based OMC

Guo Fei

Marketing Manager of ZTE Transport NMS

With the accelerated 5G deployment and the advent of mobile internet, transport network operations will face bigger challenges and pressures in reducing costs, improving resource utilization, and rapidly launching services. Emerging technologies including software defined network (SDN), network function virtualization (NFV), cloud computing, big data and artificial intelligent (AI) continue to drive telecom operators to start a new round of network and IT infrastructure transformation. Cloud operations based on SDN/NFV/cloud computing are quite different from traditional physical network operations that focus on localized operations and make plans by location-based layers. Cloud operations that focus on intensive operations can build DC-centric elastic networks and make planning by cloud-network synergy to achieve open network operations.

China Mobile Neimenggu adopted localized operations in its transport network, and each city operates the network independently. To adapt to future development, China Mobile Neimenggu has introduced ZTE's ElasticNet unified management expert (UME) system to gradually realize cloud-based intensive operations.

Challenges and Requirements

Due to continuous network expansion, China Mobile Neimenggu's network becomes more and more complex. This brings great pressure on OTN management and maintenance. The original network management system (NMS) is restricted by non-distributed architecture that can not elastically extend its management capability to meet the needs of future network operations.

China Mobile Neimenggu hopes that their operation and maintenance center (OMC) will use distributed cloud architecture based on cloud infrastructure. The OMC can be deployed on their private cloud resource pool and has cloud capabilities such as elastic expansion, load balance, and high reliability. China Mobile Neimenggu also hopes that their OMC system will be open, intensive and intelligent, capable of providing powerful management and access capabilities as well as high-grade security and disaster tolerance.

China Mobile Neimenggu used to deploy ZTE's OTN devices in three league cities such as Hulun Buir, Hinggan and Tongliao as well as Xiganerping branch. The OTN devices were independently managed by their own NMSs in the area. A total of five NMSs were deployed, with two NMSs in Hulun Buir branch, one NMS in Hinggan and Tongliao respectively, and one NMS in Xiganerping.

To have a clear understanding of network resources, simplify service deployment and provide intelligent fault handling and visualized QoS, it is necessary to change the mode of operating one NMS in each city into the mode of using a unified NMS in the whole region. Through the distributed domain control function, the local branch can operate devices in their own local area while the regional branch can manage devices in the whole region.

Deploying Cloud-Based OMC

To meet the needs of centralized OMC deployment on a provincial basis and future service growth by China Mobile, China Mobile Neimenggu has deployed ZTE's ElasticNet UME system on the cloud resource pool.

The ElasticNet UME system provides powerful network management and control capabilities as well as high-grade security and disaster tolerance. In August 2019, the ElasticNet UME system implemented management and control of local network elements in Hinggan League and completed an access test of managing OTN devices. The access test involves OMC cloud architecture, OMC basic functions, security management, and north bound interface. All the test items have been verified and passed successfully with the ElasticNet UME system.

The ElasticNet UME system based on distributed B/S microservice architecture integrates the capabilities of management domain and control domain. It can provide elastic expansion, load balance, high reliability, capability exposure, as well as central, automatic and intelligent operations.

After the deployment, the ElasticNet UME system has brought operational benefits to China Mobile Neimenggu.

- **Standardized operations:** The operational authority can be set through the domain control function. Each prefecture and city operates its local network. The regional branch manages network devices in the whole region and works out the unified rules for operations.
- **Cloud microservice architecture:** The management and control capabilities can be elastically expanded. Resources are allocated on demand based on the network scale, and servers can be utilized efficiently.
- **SDN intelligence:** Integrated management of backbone and local networks are supported. The SDN intelligence is introduced for fast service provisioning and fast fault recovery throughout the whole region. The capabilities of end-to-end network coordination and cross-city service guarantee can also be improved.

Using ZTE's ElasticNet UME system, China Mobile Neimenggu has implemented elastic and intelligent cloud-based centralized operation and management. "We are very satisfied with ZTE's ElasticNet UME products and services and hope to have more extensive cooperation with ZTE in the future," said a manager at the OMC of China Mobile Neimenggu. ZTE TECHNOLOGIES

To enable connectivity and trust everywhere