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Cover Figure | *Khurrum Ashfaque, CTO of Telenor Pakistan*

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ZTE Launches Its Cyber-Security Lab Europe in Brussels

10 July 2019, Shenzhen, China — ZTE has furthered its commitment to improving security for the ICT industry by opening its Cybersecurity Lab Europe in Brussels, Belgium.

Located in the administrative and political heart of the EU, the Cybersecurity Lab Europe will provide a much wider range of access to the external security verification of ZTE's products, services and processes, and will facilitate the external cooperation in security field with stakeholders.

The opening of the lab is another important part of a transparency initiative of ZTE. Under such an initiative, the company has launched two other cybersecurity labs in Nanjing, China and Rome, Italy in May.

As the platform for transparency and cooperation, the lab provides four essential functions including source code review, document review, black box testing and penetration testing. In addition, ZTE will conduct in-depth researches of the security field in the lab, in partnerships with industry-leading security organizations. Moreover, the lab will play a significant role of guaranteeing the security of the company's 5G solutions in 5G era.

ZTE and Telkom Indonesia Sign Business Cooperation MoU in 5G

21 June 2019, Shenzhen, China — ZTE has signed a memorandum of understanding in 5G cooperation with PT Telkom Indonesia, the largest digital telecom operator in Indonesia. This memorandum of understanding showcases ZTE and Telkom Indonesia's commitment to building 5G network and exploring new 5G fields in Indonesia.

Joddy Hernady, Senior Vice President of Media and Digital Business Department at Telkom Indonesia, and Wu Yao, Sales Director of ZTE Indonesia signed the memorandum of understanding. This ceremony was also witnessed by Li Zixue, Chairman of ZTE Corporation, Xiao Ming, Senior Vice President and President of Global Sales at ZTE Corporation, Mei Zhonghua, Senior Vice President and President of Asia Pacific & CIS at ZTE Corporation, Richard Liang, Vice President at ZTE Corporation and President Director at ZTE Indonesia, Ririek Adriansyah, President Director at Telkom Indonesia, and Faizal R. Djoemadi, Director of Digital Business at Telkom Indonesia.

It is hoped that the collaboration can provide benefits, especially for the development of digital ecosystems in Indonesia. ZTE and Telkom Indonesia have long term partnership in various fields such as fixed access, bearer transmission, core network and other technologies. By virtue of the 5G cooperation MoU, ZTE and Telkom have been well poised for the upcoming 5G era.

ZTE Secures 25 5G Commercial Contracts

25 June 2019, Shenzhen, China — ZTE announced that it has secured 25 5G commercial contracts globally and has been committed to partnerships in the 5G arena with over 60 operators across the globe.

ZTE has made 5G its core development strategy and is a major contributor and participant in global 5G technology research and standardization. According to IPlytics, a market intelligence tool to analyze technology trends, market developments and a company's competitive position, as of June 15, ZTE had declared 1,424 families of 5G standard-essential patents and patent applications to the ETSI, ranking global top 3 in terms of the number of such families.

ZTE has filed more than 3,500 5G patent applications, with over 30 experts at the company taking the key positions, such as president and reporter, in international standardization organizations. They have submitted more than 45,000 papers to the organizations, including more than 7,000 proposals for 5G NR/NexGenCore international standards.

ZTE Launches the First 5G Smartphone in Austria

13 June 2019, Vienna, Austria — ZTE has launched its latest flagship smartphone series ZTE Axon 10 Pro in Austria. In addition to the 4G version, ZTE will also introduce ZTE Axon 10 Pro 5G to Austria, providing local consumers with ultimate 5G experience in partnership with the leading carrier Hutchison Drei Austria.

The ZTE Axon 10 Pro 5G series features various technological advantages, such as device miniaturization, electromagnetic compatibility, antenna design, power consumption and heat dissipation. Powered by Qualcomm® Snapdragon™ 855 mobile platform and the Snapdragon™ X50 5G modem, as well as the AI acceleration engine, the flagship smartphone delivers a smoother using experience of no lagging within 20 months. Moreover, the AI triple camera can provide an impressive shooting experience.

With an attractive price-performance ratio, the ZTE Axon 10 Pro 5G series also features a curved design with the 6.47-inch 3D Quad curved AMOLED display, high-quality sound, great vision, 4000 mAh battery, Near Field Communication (NFC), and wireless charging.

ZTE Wins Best Mobile Service for Connected Living in Asia Award

28 June 2019, Shenzhen, China — ZTE has won Best Mobile Service for Connected Living in Asia Award at MWC Shanghai 2019 by virtue of its air to ground (ATG) air broadband solution.

The solution uses mature land mobile communication technology to construct a three-dimensional ATG broadband coverage network, providing on-board entertainment, on-board office, customized services and extensive industrial application services.

ZTE and China Mobile Showcase Leading MU-MIMO Performance at MWC Shanghai 2019

28 June 2019, Shenzhen, China — ZTE, in partnership with China Mobile, has demonstrated a 5G multi-user multiple-input multiple-output (MU-MIMO) performance test based on 5G commercial base stations and smart phones at Mobile World Congress Shanghai 2019. The demonstration showcases both companies' leading positions in commercial performance.

The MU-MIMO makes full use of multi-antenna features to maximize the utilization of spectrum resources, creating much greater revenue for users. It is the core technology of 5G to realize ultra-wide bandwidth.

This MU-MIMO test was carried out in China Mobile's Guangzhou 5G field, employing ZTE's industry-leading 160M full-band 4G/5G dual-mode commercial base station. The base station supports dynamic spectrum sharing, achieving dual-network integration at 2.6 GHz, and 16 ZTE commercial Axon10 Pro mobile phones.

The test result showcased that a 5G single cell throughput is over 3.7 Gbps, while a single EU downlink data rate is more than 200 Mbps. The result is also a four-time increase in network system capacity than that of the SU-MIMO technology. The test footage and data were also transmitted back to China Mobile's booth at MWC Shanghai in real time from Guangzhou.

ZTE Chief Hails 5G Potential to Lower Complexity

Source: Mobile World Live

ZTE CEO Xu Ziyang

ZTE president Xu Ziyang explains how operators can tap 5G capabilities to reduce network complexity, which will not only lower costs but give them increased flexibility in catering to the demands of vertical industries.

At MWC19 Shanghai, you outlined a simple equation for figuring out how best to deploy a 5G network. Can you share that with us?

The equation details what an ideal 5G network will look like. It needs to be very simple, so capex can be reduced, and needs to be smart to reduce

opex. The network also should be very flexible, to adapt to uncertain requirements and challenges, as well as efficient in order to reuse resources.

This is an ideal network. Unfortunately, a traditional hardware-defined network cannot offer all of these capabilities.

However, with new technologies, 5G can achieve these because it's virtualised and software-defined.

I think the ideal 5G network can be achieved in four ways. First, simplify the network by subtracting unnecessary elements in the network to make it more competitive.

Second, improve network intelligence by adding critical features, such as AI, mobile edge computing (MEC) and big data analysis.

Third, by slicing a physical network and dividing it into several virtual parts, it is enabled to serve multiple vertical customers simultaneously. This reduces the cost of building, operating and maintaining a network. The logic is very simple: a one-dollar budget can meet ten-dollar requirements.

Finally, based on the above steps, we can combine the three major 5G use case scenarios (eMBB, uRLLC and mMTC) to do multiplication, or apply 5G to vertical industries. With hundreds of vertical markets, a 5G network can create thousands of opportunities.

With operators dealing with multiple spectrum bands and standards, how is ZTE enabling them to reduce complexity in their network configurations?

From an equipment perspective, we recommend using converged equipment. For example, in the RAN, the 2G, 3G and 4G modules can be converged into a unified RAN. In the core network, try to use a common core to provide service across all mobile generations at the same time. 5G transport can be adopted as well.

From the management perspective, they need to automate the network. I suggest using AI and other technologies to achieve 'zero touch' operation and maintenance to minimise risks.

In addition, use a centralised system for the architecture. For example, reduce network layers and nodes, involve software defined network (SDN) technology and a regional data centre in the network, which may reduce costs.

Last but not least, select open technologies. For example, IT, open source and white-box technology; with that we can easily access expertise from the market.

How important are end-to-end capabilities when considering investing in 5G?

They are very important. Everyone knows end-to-end solutions can be deployed quickly and provide more resources and capabilities for customers. It is important for us to make additional contributions to our customers' networks.

End-to-end solutions, however, bring some challenges, for example the possibility of vendor lock-in. Fortunately, we can minimise the risk by adopting virtualisation, decoupling hardware and software, and using IT technologies.

So end-to-end solutions give our customers a comprehensive view to analyse and balance the end-to-end benefits. Customers are then free to select the most valuable solutions in the value chain. I believe operators and partners can work more closely to embrace the uncertain future for mobile operators.

What about MEC, what route are you advising your customers to take?

The essence of MEC is to bring the network close to the customer. It is totally different from a distant cloud solution.

An ideal MEC network should be easy to maintain, provide dedicated services, guarantee 100 per cent security and have very low latency.

The simple logic is that if an operator can provide a similar service like a private IT network, why would an enterprise CIO spend a lot of budget in building a private IT network? ZTE TECHNOLOGIES

Khurrum Ashfaque, CTO of Telenor Pakistan

Telenor Pakistan: Serving Pakistan Better

Reporter: Muhammad Rizwan

Serving Pakistan better has been our key driving force and all our products and services carry this very imprint, said Khurrum Ashfaque, CTO of Telenor Pakistan, who spoke to *ZTE Technologies* about the business motivation, achievements and expectations of Telenor Pakistan. He also shared with us what makes the company one of the best places to work in Pakistan.

With a footprint spanning throughout the country, Telenor Pakistan is the second largest cellular and digital services provider in Pakistan. The company is renowned for its innovative moves like commercial deployment of Dynamic Spectrum Assignment and disruptive solutions like the financial service 'Easypaisa'.

How does it feel to be in the pivotal position in one of the industry leaders? What impact does it have on your personal as well as professional life?

The feeling is a mix of responsibility and fulfillment. Working with a tech leader in a developing market like Pakistan gives you the chance to turn challenges into opportunities. With Telenor Pakistan, it becomes all the more fulfilling as we remain driven by our purpose of connecting people to what matters most and our vision of empowering the people of Pakistan, which means that every service or product we offer has a direct impact on the country's economy and society apart from anticipating and delivering on the needs of our consumers. I feel very proud of the fact that Telenor Pakistan's work is bringing a positive change in the country by reducing inequalities. This is something that keeps me motivated in my personal life as much as it does in the professional one.

When did Telenor Pakistan start its business and what was the primary motivation behind it?

We began operations in Pakistan in 2005 and recently completed 14 years of our commercial operations in Pakistan. The primary motivation behind everything we do is to empower the people of Pakistan through provision of affordable and integrated digital solutions. Since the beginning, we have been sensitive to everyday challenges that a common citizen is faced with and have successfully sought innovative solutions in communications technology to facilitate the public. Serving Pakistan better has been our key driving force and all our products and services carry this very imprint.

Digital and financial inclusion in order to reduce social disparity has been high on the Government's agenda for a long time. We at Telenor Pakistan, being key proponents of digital transformation in the country, continue to support the national agenda using disruptive digital solutions catering to such important sectors as financial services, agriculture, and social inclusion. We see a mobile phone in every

hand as an opportunity to deliver innovative solutions to a common Pakistani to improve lives and livelihoods.

Recently Telenor Pakistan shifted its HQ to this newly built state of the art facility, how does this impact the employees and what do they say about it?

Our aim for the new HQ was to make it a comfortable workplace that enables innovation and helps us serve people better. We strongly believe there's a powerful link between happy employees and happy customers, that is why we have made '345' a state-of-the-art facility where every employee feels at home and gives their best towards collective progress. Facilitating employee creativity was a key prerequisite for the design and combined with an enabling workplace culture, the new HQ is supporting us in reaching greater milestones. The building features a multitude of big and small meeting and conference rooms, silent and social zones, and latest available technology to get things going seamlessly.

This is in addition to the on-site facilities all our employees enjoy including cafeterias, fitness center, and a daycare center to name a few. The campus is very welcoming to the differently-abled employees too who can contribute their best without feeling disadvantaged at any step of their career progression. The building's architecture perfectly complements our employee-friendly HR practices that have inclusion, diversity, and innovation at their heart. Programs like Open Mind Pakistan and Naya Aghaz are ensuring true inclusion at the workplace, while initiatives like Startup Garage and Activate are enabling innovation from within the organization. All these steps are a testament to our long-term commitment in Pakistan which not only impacts our own employees but the whole nation at large.

It's pertinent to note here that '345' recently won several international accolades

Telenor Pakistan, a pioneer in launch of Pre 5G LAA Site

for its architecture.

Telenor Pakistan has continuously been ranked as one of the best places to work in Pakistan which is very appreciable. Could you tell the main reasons behind it? How many employees does Telenor Pakistan have?

Telenor is an organization which is built around people and we consider our employees our biggest asset. Our comprehensive, employee-friendly HR policies have played a pivotal role in establishing us as a top employer. The equal opportunity that all our employees— men, women, and differently-abled included— enjoy at Telenor Pakistan is hard to match in the industry. Similarly, facilities and benefits like a flat six-month paid maternity leave, flexible working hours, ability to work from home, and on-site facilities like daycare center, fitness

center etc. attract quality human resource from across Pakistan.

We currently have 1,600 direct employees; however Telenor Pakistan provides livelihood to over 200,000 people indirectly. Developing an enabling workplace culture is a continuous job and the coveted status didn't come overnight. Using internal employee surveys, industry trends, and global benchmarks, we are constantly working to make Telenor Pakistan a more dynamic, productive, and friendly place of work for people of all backgrounds.

The year 2018 has passed, is there anything you would like to express?

2018 was the year of continued commitment to serving our customers better. While expanding the reach and portfolio of our network and services, we made progress on our

digital interventions for agriculture and social inclusion namely Khushaal Zamindar/Khushaal Aangan, and Digital Birth Registration. The DBR project was also nominated for the GSMA Global Mobile Awards (GLOMO) 2018 in the 'Outstanding Mobile Contribution to the UN SDGs' category.

Some other key achievements in 2018 included launch of state-of-the-art self-service booths. It was also the year when we launched Telenor Pakistan's Hybrid Cloud and evolved to Network Function Virtualization. We have modernized our transport network to 100G DWDM backbone and IP-MPLS metro aggregation. These developments are vital steps to cater to the rapidly growing cellular data in Pakistan, to support our transformation and 5G readiness. Data analytics driven personalized products from Telenor were an interesting highlight in Pakistan's telecom market.

Telenor Pakistan also has a mature software development team that adopted agile development, DevOps and API first approach to keep up with the pace of change & innovation in industry. We developed applications and complex business services for some of Telenor Pakistan's customers as well as other Telenor business units.

Telenor Pakistan is known well by its principles of empowering and connecting societies with innovative solutions like Easypaisa & Internet for All. Would you like to share your expectations for 2019?

Our vision of empowering a common Pakistani coupled with our passion for the country has manifested into ground-breaking solutions for financial, digital, and social inclusion of the marginalized Pakistani masses. By connecting the previously unconnected and bringing mobile-based solutions to everyday challenges, we have and will continue to elevate the standard of life for millions of Pakistanis.

Telenor Pakistan has been a technology leader in the country and would continue to

New HQ of Telenor Pakistan

strive for customer centric, zero-touch operations through extensive use of RPA, ML & AI along with actionable analytics.

Our expectations for 2019 are to innovate with a greater focus on reducing inequalities by leveraging the latest available technologies. In 2019 we foresee further increase in mobile and broadband uptake and advancements in mAgri, DBR, and similar initiatives. We also expect to play a bigger part in our customers' lives as their preferred digital lifestyle partners by offering more products and services to match their evolving connectivity needs. 2019 may also bring some progress in innovative solutions based on emerging technologies like IoT and AI.

In the coming years what do you classify as major growth areas for the Telecom Industry in Pakistan and what are the major challenges associated with them?

The digital transformation we are aiming for calls for reducing gaps that still exist in teledensity and NGMS penetration. With GSMA's estimates of nearly half of Pakistan's population still being unconnected, both basic telephony and mobile broadband penetration are the areas of focus without which our dream of a digital Pakistan and a knowledge economy will not materialize. At Telenor Pakistan, we are playing our part to expedite teledensity and digital penetration through better network coverage, superior service, and affordable hardware including handsets and internet devices.

Financial inclusion gaps in Pakistan have also been a major challenge which digital interventions like Pakistan's first and foremost mobile banking service Easypaisa are working to reduce. Following the National Financial Inclusion Strategy (NFIS), launched in 2015 to connect at least 50% adult population to banks, 23% of the adult population has been provided with access to formal financing services compared to 13% in 2014. Mobile financial services are and will continue to play a pivotal role in getting closer to the inclusion targets. Some other growth areas include IoT and emerging technologies.

One of the most exciting claims coming out of CES 2019 is that we're on the brink of the 4th industrial revolution. With 5G and IoT being the main backbones of cyber-physical systems, how promising do you think these two are and how soon can we see these making their way and contributing towards advancement in Pakistan's economy?

Talk of 5G has been circulating in the industry for a long time now but it may still be a while till the technology sees a full-scale global roll-out. For Pakistan to prepare for and get the most of 5G, IoT, and other futuristic technologies, it's imperative to strengthen the local telecom sector further through more forward-looking policies, spectrum roadmap, and conducive regulatory environment.

Telenor Pakistan has contributed majorly to developing and promoting the country's digital ecosystem including our recent launch of the country's first and only 4.5G service and numerous IoT initiatives including exhibitions and device roll-outs. As part of Telenor's global priorities we have recently started working on 5G readiness, the work we are doing for radio network modernization and Telenor Hybrid Cloud (THC) are all part of this agenda. These developments, and the ones to come, will surely have a deep impact on the country's socioeconomic development as it is headed towards a knowledge economy with an aim to make ICT a top contributor to Pakistan's exports and job creation. Telecom-intensive sectors, such as financial services, education, health, retail trade, wholesale trade, and transport will see immediate boost with other sectors fast becoming telecom-intensive. **ZTE TECHNOLOGIES**
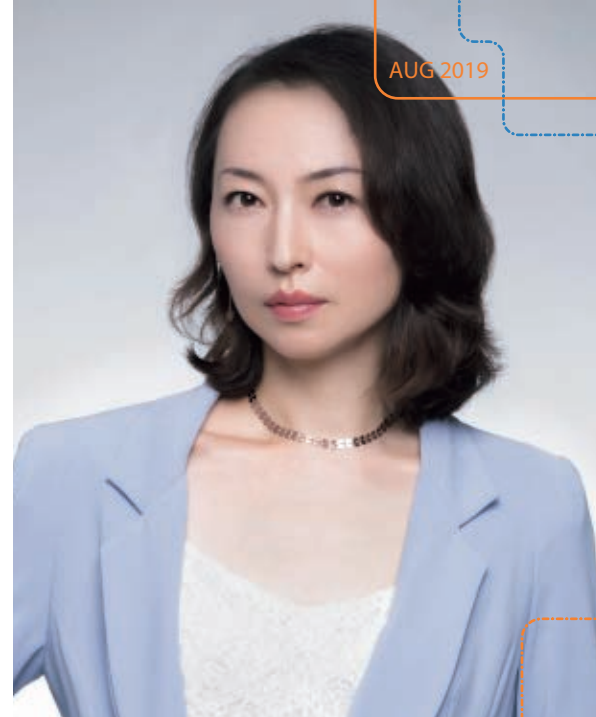
Supreme Network Promotes Win-Win Development in 5G Era

Cui Li
Vice President at ZTE

2018 was a year of rapid growth for 5G, as 5G standards were frozen, network products were ready to be launched, commercial terminals were released, and industrial and ecosystem cooperation was deepened. Statistics from GSMA in December 2018 showed that 201 operators in 83 countries around the world were testing or commissioning 5G networks. Among them, 86 operators in at least 46 countries have clearly defined that their 5G network deployment time and plans are mostly concentrated in 2019 and 2020. 2019 will be the first year of 5G scale deployment.

To meet the challenges of 5G deployment, ZTE helps operators provide supreme simplified 5G deployment, supreme intelligent 5G operations, and supreme user experience. ZTE's 5G solutions focus on 5G precise seamless coverage, multi-band multi-mode network collaborative development, operation efficiency enhancement, and vertical industry expansion. The 5G solutions cover technical issues ranging from chips, core technologies, end-to-end series products, to network convergence and long-term evolution, ubiquitous artificial intelligence (AI) applications, and 5G application exploration, fully empowering operators to enter the 5G era.

Supreme Simplified 5G Deployment

When deploying 5G networks, most operators will face the co-existence of 2G, 3G, 4G and 5G sites. Site resource reuse, multi-band multi-mode coordination, economical convenience, and long-term evolution are the core issues to be considered. ZTE's Unisite helps operators address their issues of commercial 5G site deployment. The highly integrated, high-performance multi-band multi-mode base station series make site deployment simple, economical and efficient.

Unisite provides differentiated solutions for diverse scenarios such as hotspots in dense urban areas, general urban areas, remote suburbs, and special indoor rooms. Among them, ultra-band radio unit (UBR) integrates three mainstream bands: 900 MHz, 1800 MHz, and 2100 Mhz, thus reducing the number of sites by two-thirds. With the innovative built-in combiner RRU, UBR enables all 2G, 3G, 4G and 5G sites at the bands below sub-3 GHz to use one antenna. 5G AAU commercial series have implemented full spectrum, full scenario, full range of macrocells with different specifications. Microcells such as Pad AAU/BBU have zero
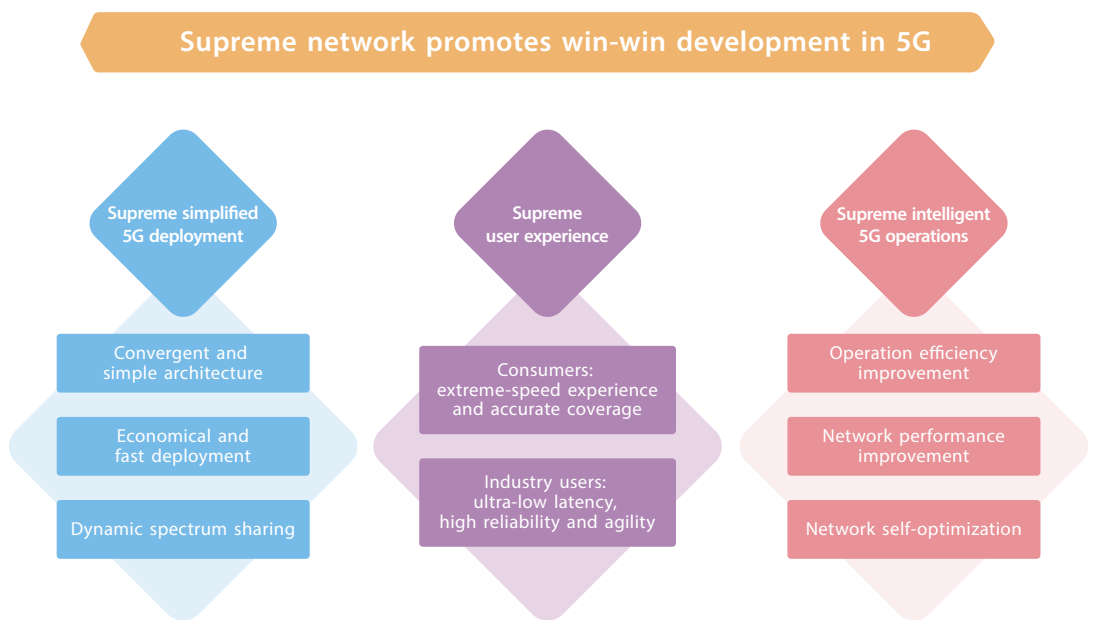
footprint and can be commissioned quickly and conveniently, helping operators cover hotspot and blindspot areas in a flexible and rapid manner. Multi-band multi-mode microcells and QCell support seamless indoor coverage under different conditions, with the most economical investment to ensure seamless coverage in all 5G scenarios and good network performance.

From the perspective of overall network architecture, convergence with simplicity is an inevitable trend. ZTE's IT-BBU supports 2G, 3G, 4G and 5G, multiple networking modes such as CRAN and DRAN, as well as multi-mode network convergence and long-term evolution. The industry-first commercial 5G Common Core based on service-based architecture (SBA) supports full wireless (2G/3G/4G/5G) access and convergence, and also supports 3GPP R15 SA and NSA. The commercial 5G Common Core enables target architecture in one-step, flexible introduction of functions, and a reduction of investment cost by 40%.

Supreme Intelligent 5G Operations

In the 5G era, the wide application of new technologies such as multi-mode network and Massive MIMO will multiply the complexity of network operation and maintenance. The development of vertical industry will also bring about the needs for fragmented services, raising extremely high requirements on network capability, response speed and resource sharing. Therefore, the introduction of AI is imperative.

AI can better help operators improve operational efficiency, reduce operating costs, improve network performance, and thus achieve a self-evolution network. The AI engine self-developed by ZTE has implemented ubiquitous intelligence applications in full 5G scenarios, including optimal network management based on RF fingerprint, Massive MIMO weight adaption, mobility load balance to increase capacity, and intelligent shutdown to save energy and reduce consumption. Take the application of ZTE's wireless solution in China Telecom as an example. It took about six months to optimize the 1700 cells. After the AI solution is introduced, the optimization period

Supreme network promotes win-win development in 5G

Supreme simplified 5G deployment
- Convergent and simple architecture
- Economical and fast deployment
- Dynamic spectrum sharing

Supreme user experience
- Consumers: extreme-speed experience and accurate coverage
- Industry users: ultra-low latency, high reliability and agility

Supreme intelligent 5G operations
- Operation efficiency improvement
- Network performance improvement
- Network self-optimization

> *To meet the challenges of 5G deployment, ZTE helps operators provide supreme simplified 5G deployment, supreme intelligent 5G operations, and supreme user experience.*

will be reduced to three weeks and the efficiency will be improved by 88%.

ZTE launched its CloudStudio, the AI-based commercial 5G network operation system at the MWC2019 Barcelona. The CloudStudio has built-in 8000+ root cause analysis (RCA) rules based on machine learning that can fully support agile deployment, intelligent analysis and rapid self-healing and improve network operations efficiency by more than 30%. The CloudStudio can also provide end-to-end network slicing capability to fully meet the needs for fragmented services in the internet of everything (IoE) era.

ZTE also released ZTE ES600S MEC server with Intel to push AI to the network edge, significantly improving the edge computing and processing capability, reducing network latency and optimizing TCO.

Supreme User Experience

Supreme user experience comes from the supreme performance and seamless coverage of the network. ZTE offers solutions ranging from chipsets, key technologies to full-range products, while ensuring the performance of 2C and 2B businesses. With industry-leading, high-performance and highly integrated self-developed chips, ZTE is able to provide IT-BBU with the strongest performance and the

smallest 5G AAU in the industry. ZTE has more than five years of experience in commercial use of Massive MIMO, one of the core technologies of eMBB services. ZTE not only continuously optimizes product performance, but also delivers targeted commercial performance optimization solutions for various typical application scenarios such as CBD and stadium, providing users with optimal experience.

For vertical industries and low-latency applications, ZTE has released the industry's first AI-based commercial 5G slicing operation system, lightweight edge cloud, and intelligent acceleration solutions, fully meeting the needs of consumers and vertical industry customers. The 5G service with supreme user experience will help operators survive the market competition.

The world's first wave of 5G scale commercial deployment is about to start. With extensive 5G pre-commercial experience, rich product series and sophisticated network construction solutions, ZTE will be fully involved in 5G commercial deployment and continue to maintain its technological leadership. Also, ZTE will work with upstream and downstream partners in the industry to promote 5G commercialization and achieve a win-win development with its supreme 5G network. **ZTE TECHNOLOGIES**

Promoting 5G Commercialization From Three Aspects

Wang Weibin
CTO of NFV/SDN Products at ZTE

2019 is recognized as the first year of 5G. SK Telecom, KT and LG U+ from South Korea officially launched 5G commercial services for ordinary consumers on 5th April 2019. This was followed by the Federal Communications Commission (FCC) who announced its third millimeter-wave spectrum auction on April 16th, promising to invest more than $20 billion to deploy 5G in rural areas. China Unicom announced the launch of a 5G network trial in 40 cities at the Shanghai Partner Conference on April 23rd. Although the wave of 5G commercialization has gradually started all over the world, it is still necessary to further improve the commercial capabilities in terms of 5G industrial technology maturity, service development and business model, and efficient network O&M, to expand the commercial scene and scale of 5G networks, and to promote the continuous deepening of 5G commercialization.

5G Industrial Technology Maturity

In June 2018, the 3GPP Plenary Meeting (TSG#80) approved the freeze of 5G standalone (SA) networking function, marking the official release of the truly complete international 5G standards. Different from the 4G standards, 5G standards are characterized by multiple application scenarios, diverse networking modes, and core network re-architecture. Specifically, 5G standards not only support enhanced mobile broadband (eMBB) scenarios, but also support ultra-reliable and low latency communications (uRLLC) and massive machine type of communication (mMTC) scenarios. 5G standard network architecture is divided into

two categories: non-standalone (NSA) and standalone (SA). NSA is subdivided into Option 3/3a/3x, Option 4/4a, and Option 7/7a/7x, while SA is subdivided into Option 2 and Option 5. 5GC also introduces virtualization, service-based architecture, stateless design and HTTP protocol, and reconstructs the 5G core network with IT technology. So far, 5G standards for eMMB scenarios, whether NSA or SA, have been frozen, uRLLC will be frozen in 2020, NB-IoT and eMTC are defined as 5G features, and mMTC will be completed in R17.

In terms of industrial chain maturity, NSA smart phones have been commercialized, and NSA/SA dual-mode chips and smart phones are expected to be mass-produced in Q3–Q4 2019. Mainstream equipment vendors have long been waiting for 5G commercialization. NSA/SA dual-mode base stations as well as NSA/SA converged core networks have been tested and verified, and will have large-scale commercial capacity in the second half of 2019.

According to the mobile trend report released by GSMA, South Korea and the United States have launched 5G services, and China and the United Arab Emirates will also launch 5G commercial services in 2019. There will be 100,000 5G base stations deployed in China, and 5G services will cover dozens of cities in 2019. More than 10 countries and regions in Canada, Mexico, Australia, Japan and the Asia-Pacific region (except China, Japan and Korea) and more than 20 countries in Europe will also launch 5G commercial services in 2020. By 2025, the number of 5G users worldwide is expected to reach 1.36 billion.

On the whole, 5G industrial technologies are ready for commercial use in eMBB scenarios and still need to be improved for applications in uRLLC and mMTC scenarios.

5G Service Development and Business Model

When 5G was born, technologies such as AI, IoT, cloud computing, big data and edge computing were also booming. The 5G network

that combines these technologies is no longer comparable to traditional ones. 5G is highly regarded not only by the industry but also by the whole society. 5G network can provide large bandwidth, low latency, massive connections, and high reliability. These performances and features are either ten or tens of times higher than 4G or are not available on 4G. 4G changes life, while 5G changes society. 5G not only upgrades existing 4G services, enhances personal digital experience, but also creates new services (Fig. 1). Typical new services, such as cloud AR/VR, cloud gaming, personal video live broadcast and other immersive real-time video services are only the first wave of 5G applications and are the natural evolution from 4G MBB to 5G eMBB to address the capacity requirements of large bandwidth services at a lower bit cost. With the introduction of uRLLC and mMTC, 5G will also bring about industrial change in the internet of everything. It provides industry applications such as auto-driving based on internet of vehicles, intelligent manufacturing based on drones and industrial robots, and telemedicine, smart city, and smart agriculture based on low-latency connections.

Although the cost per bit for mobile broadband has been reduced in the 5G phase, competition and policy have also made it more difficult to monetize traffic. The vertical industry has a beautiful scene and huge space, but the current standards and industrial maturity are still relatively low. Therefore, the existing business model of mobile networks can no longer support sustainable development of 5G. Do operators need to introduce a variety of billing methods such as charge by traffic, by rates, by number of connections, by time latency, by slice, or by slice plus SaaS for different scenarios to support new business models including traffic value, rate value, connection value, latency value, and slice
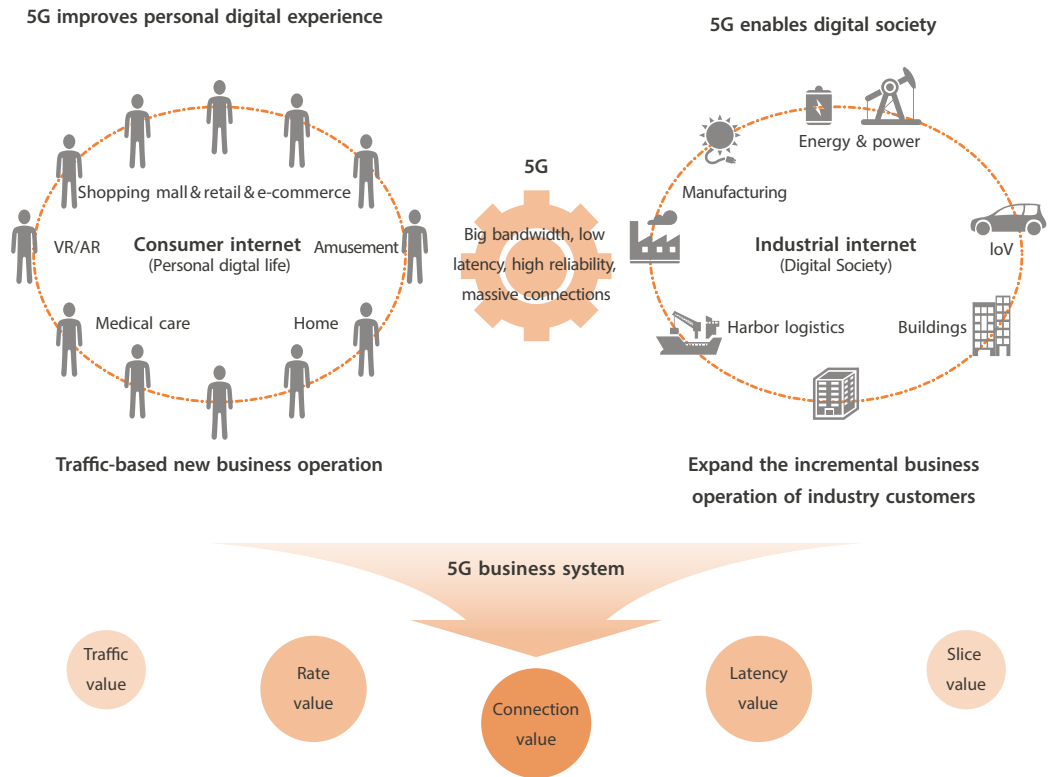
5G improves personal digital experience

Shopping mall & retail & e-commerce

VR/AR **Consumer internet** (Personal digtal life) Amusement

Medical care Home

Traffic-based new business operation

5G

Big bandwidth, low latency, high reliability, massive connections

5G enables digital society

Energy & power

Manufacturing

Industrial internet (Digital Society) IoV

Harbor logistics Buildings

Expand the incremental business operation of industry customers

5G business system

Traffic value

Rate value

Connection value

Latency value

Slice value

value? All these need to be explored in advance and nurtured for a long time.

Multi-access edge computing (MEC) and network slicing are hot topics in the 5G field. The ultra-low latency, high bandwidth, and high-speed mobility of 5G services have given birth to local services. The determination of latency and continuity of local services and the need for ultra-high computing power need to achieve the organic combination of connectivity and computing power at the edge of the network, otherwise it is difficult to meet the requirements of local services. It is worth noting that only by effectively utilizing the connection ability can the edge computing power distributed at one or more points be effectively coordinated to realize sharing of data and capacity and improve automation and intelligent efficiency at a lower cost. Accordingly, is the business model of edge computing a simple monetization of connectivity, or a monetization of computing power, or a monetization of the combination of connectivity and computing power? These also need to be further explored.

Network slicing is similar to logical network or virtual private network. With the introduction of NFV/SDN, network slicing can generate an almost unlimited number of end-to-end logical networks on a physical network any time, anywhere and can provide multiple slices for the same user to achieve a variety of bandwidth, latency, number of connections and security isolation services under different resource requirements. Although the virtualized 4G network can implement some similar functions through DeCore/e-DeCore, the slicing of 5G network is native and end-to-end. From terminal to network, the slicing capability is more flexible and complete. Similarly, the business model of 5G slicing is also vague. The major concern is how to effectively use 5G slicing to serve the vertical industry and whether to act as an e-commerce and settlement platform for online sales of many businesses and become an interconnected business platform for many enterprise users to achieve digital and intelligent transformation.

5G is not only a pipeline, but also the innovation of business model, the change of service mode and the innovation of vertical business integration. The commercial scale of 5G network needs to explore possible new business models in advance, and push 5G onto the benign track of sustainable development through both quantitative and qualitative change.

5G Network O&M

The goal of 5G network is to achieve the service provisioning time in minutes and realize transmission latency within tens of milliseconds for 90% of areas, providing users with a visual, optional and self-service network experience. In the 5G era, the traditional way of network O&M has become inadequate.

First, due to the introduction of SDN/NFV, network devices are virtualized, and service functions and connections can be dynamically loaded and orchestrated. The network will no longer be a simple sub-domain, but horizontal sub-domain, vertical hierarchical cloud-network synergy. The difficulties of automatic deployment,

testing, upgrade, monitoring, optimization, and cross-layer cross-domain fault location of network elements and services will increase significantly.
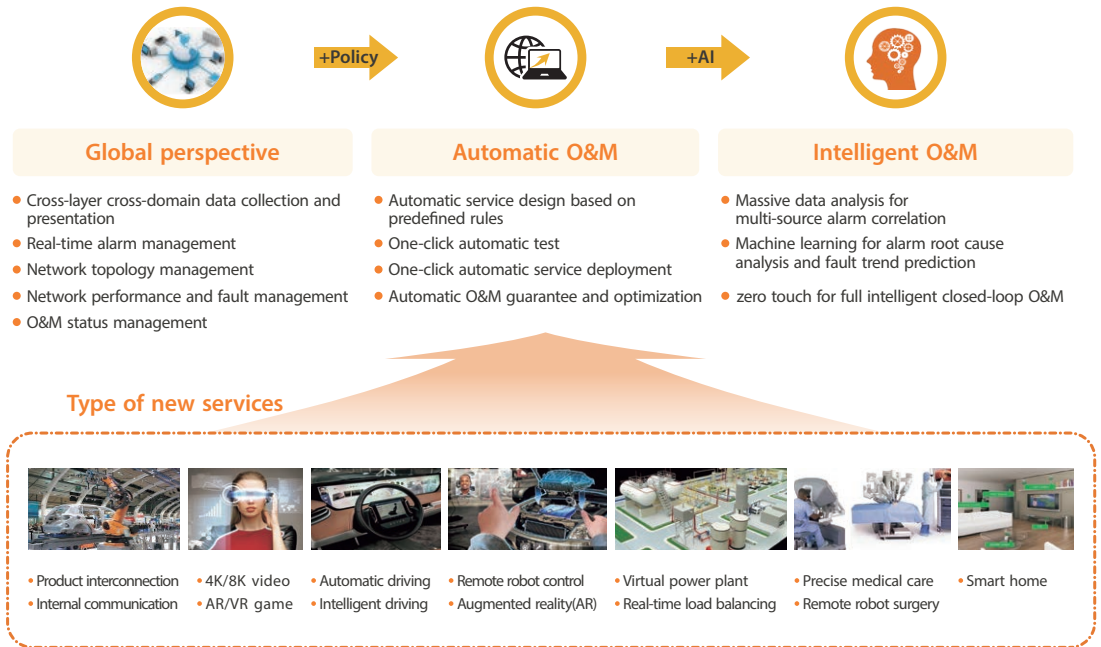
Second, 5G network is a distributed network with separate control plane and forwarding plane. To improve resource utilization, O&M efficiency, and the speed of service delivery, centralized deployment of control plane in a big area will become a trend. Both centralized deployment and centralized O&M will inevitably pose challenges to the existing structure, O&M process, and BOSS system.

Third, existing networks are probably in a multi-vendor equipment environment. The urgent problem to be solved is how to implement unified management and automatic end-to-end orchestration of multi-vendor equipment including access, transmission, and core network, and how to unify network capability API to realize open network capability and end-to-end slicing operation.

5G network must introduce new technologies to achieve automatic and intelligent network O&M. Global perspective, automatic O&M, and

Fig. 2. Key capabilities of ▶ 5G network O&M.

Global perspective
- Cross-layer cross-domain data collection and presentation
- Real-time alarm management
- Network topology management
- Network performance and fault management
- O&M status management

+Policy

Automatic O&M
- Automatic service design based on predefined rules
- One-click automatic test
- One-click automatic service deployment
- Automatic O&M guarantee and optimization

+AI

Intelligent O&M
- Massive data analysis for multi-source alarm correlation
- Machine learning for alarm root cause analysis and fault trend prediction
- zero touch for full intelligent closed-loop O&M

Type of new services

- Product interconnection
- Internal communication
- 4K/8K video
- AR/VR game
- Automatic driving
- Intelligent driving
- Remote robot control
- Augmented reality(AR)
- Virtual power plant
- Real-time load balancing
- Precise medical care
- Remote robot surgery
- Smart home

intelligent O&M are three key capabilities of 5G network O&M (Fig. 2). The global perspective capability involves cross-layer cross-domain data collection and presentation, real-time alarm management, network topology management, network performance and fault management, and O&M state management. The automatic O&M capability includes automatic service design based on predefined rules, one-click automatic test, one-click automatic service deployment, automatic O&M guarantee and optimization. The intelligent O&M capability contains massive data intelligent analysis for multi-source alarm correlation, machine learning for alarm root cause analysis (RCA) and fault trend prediction, and zero touch for full intelligent closed-loop O&M.

The automation of 5G network O&M is still in the stage of end-to-end automatic deployment and orchestration for single-vendor equipment, and the end-to-end

automation for multiple-vendor equipment is being explored. The intelligence of network O&M has just started, and it is still far from the 5G network to realize zero touch closed-loop intelligent O&M and intend-driving network. However, the more confused you are, the more you have to look into the distance, and the more you can see the future ahead.

Internet was born in 1969, and this year marks its 50th anniversary. In the past 50 years, internet has developed at an amazing speed and penetrated into various industries of human society, which not only brings about great social changes, but also brings some bubbles and problems. This year is the first year of 5G. When the "50th anniversary of internet" meets "the first year of 5G", let us jointly promote the continuation of 5G commercialization from three aspects: industrial technology maturity, service development and business model, and network O&M. **ZTE TECHNOLOGIES**

5G Commercial Network Needs "Worry-Free" Core

2019 is the first year of 5G commercial use. Major operators worldwide are gearing up to deploy 5G networks. Because of the difference of market strategy and spectrum, 5G commercial networks at the early stage are fragmented in the following three aspects:

- **Fragmentation of network deployment mode:**
  The 3GPP standard defines five deployment modes for 5G networks such as Option 2, Option 3, Option 4, Option 5, and Option 7. Based on their own characteristics and needs and the maturity of the industry chain, operators mainly choose Option 2 and Option 3 as their deployment modes for 5G commercialization at the early stage.

- **Fragmentation of network architecture:**
  As the basic technology of 5G network, NFV helps operators better adapt to service deployment and innovation in the internet era and meet the needs of evolving network architecture to 5G. However, during the virtualization of traditional core networks, some operators have completed the virtualization of traditional EPC and some have not yet begun commercial deployment because of the differences in decoupling mode, user-plane software and hardware acceleration mode, and virtualization products.

Operators therefore have a quite different 5G commercial network architecture due to the difference in the virtualization process.

- **Fragmentation of network objective:**
  The objective of 5G network is to connect all things and meet the ever-changing needs of internet of everything (IoE). In the initial stage of 5G network construction, domestic and foreign operators can choose different network objectives to gradually transition to the ultimate IoE objective according to existing network needs, brand strategy and industrial chain maturity. Different network objectives have different requirements for 5G network deployment and functions.

The core network in the 5G era plays an increasingly important role. In particular, 5G introduces network slicing to fully help operators transform their business models, providing a fertile soil for extending the telecom industry chain and creating new profit models. As the fragmented 5G commercial network faces many challenges such as diverse requirements, complex architecture, and difficult evolution, it is necessary to build a "worry-free" core for the network control center, which is the key for operators to face many challenges and ensure competitive advantages. How is the "worry-free" core built up?

Lu Guanghui
Chief Engineer of ZTE 5G CN Products
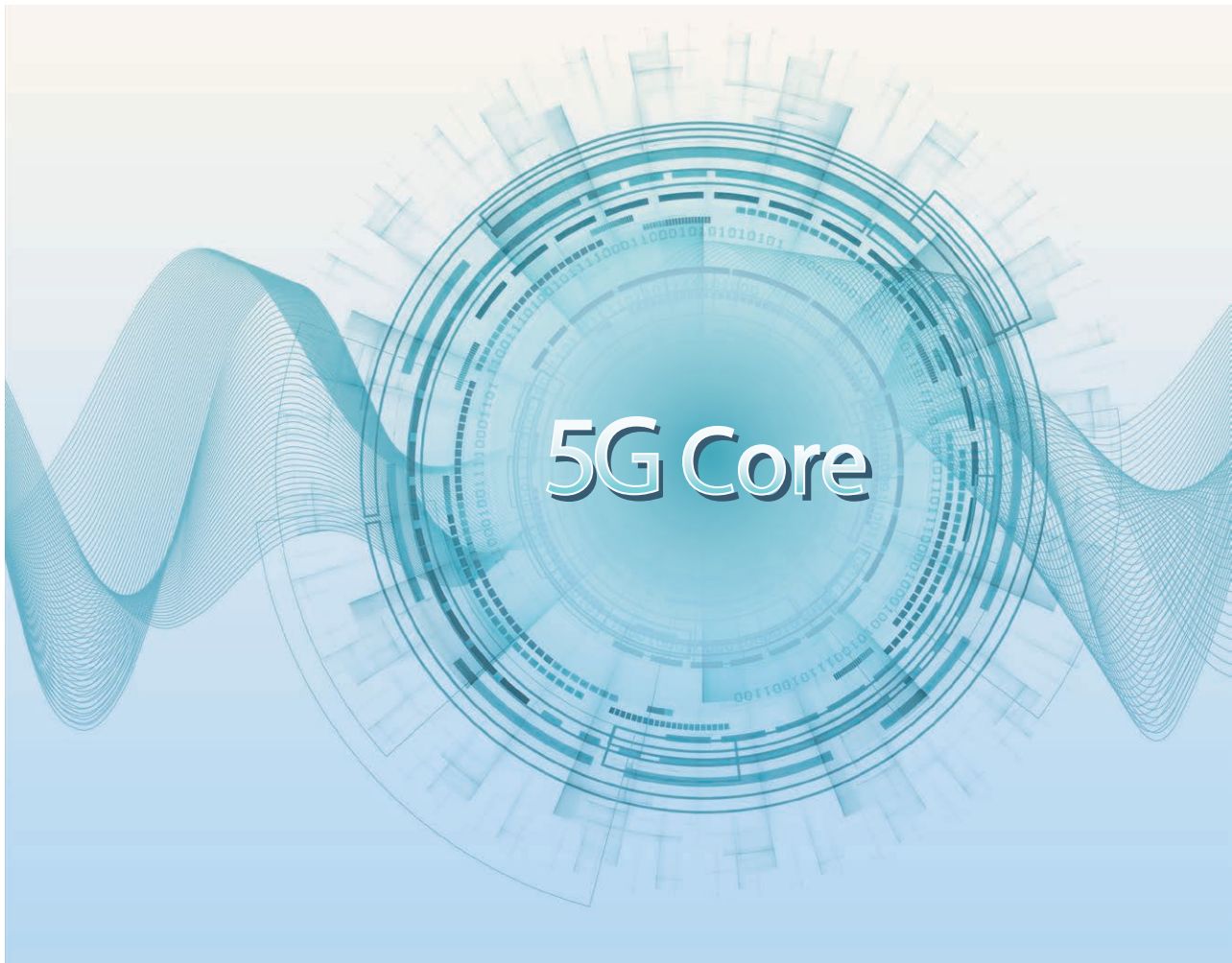
5G Core

Ultra-Agile Architecture

In the initial stage of 5G construction, the core network adopts an ultra-agile architecture to meet the needs of fragmented 5G network. The core network based on SBA+ independent service, independent configuration, independent upgrade, and independent elasticity provides more flexible plug-and-play of network services than traditional NFV and forms the basis for building a custom-made network. The ultra-agile architecture has the following attractions:

- Convergence enhancement: 5G Core (5GC) supports 2G/3G/4G converged access and totally re-architects its software. In this way, access convergence, data convergence, policy convergence, and forwarding convergence can be implemented. Also, 5GC is compatible with the existing network O&M system and billing system, and provides a supreme simplified network to meet the need of rapid 5G commercial use at the initial stage.
- Carrier-class microservice architecture: 5GC adopts the microservice

architecture to build software and enhances key component features such as communication reliability and efficiency to meet carrier-class requirements. A variety of public microservices are abstracted, such as signaling, route control and LB. The key features of microservices such as ISSU and grayscale upgrade can be used to significantly shorten the time to market for new services and greatly reduce Opex for operators.

- Smooth backward evolution: Based on the services defined by 3GPP, self-defined services with finer granularity are provided to meet the requirement of long-term network evolution. The infrastructure is independent and can be quickly deployed in virtual machines (VMs), containers or bare metal resource pools.

Ultra-Wide Forwarding

In the initial stage of 5G network construction, ultra-wide forwarding capability is required in different deployment modes or network architectures. The virtualized forwarding plane is designed in distributed mode and can be linearly expanded to meet the needs of 5G explosive traffic growth. Hardware or software acceleration solutions can be used flexibly to meet large bandwidth needs of user planes for different mainstream operators.

Hardware Acceleration Solution

Based on the standard network interface card (NIC) or universal intelligent NIC, a single computing node supports single or multiple 10GE/25GE standard NICs or 40GE/100GE intelligent acceleration NICs. Large-size VMs are configured to fully utilize the NIC forwarding capabilities and maximize the use of CPUs and network resources. In the subsequent evolution, NIC can be swapped without changing the server. The maximum bandwidth can be increased by four times, and the latency can be reduced from 100 to

10 microseconds, meeting the needs of OpenFlow idea to subdivide the flow. The action is executed high-speed and low-latency services.

Software Acceleration Solution

Based on the standard NIC, the DPDK or SR-IOV acceleration technology is adopted to reduce the cost gap with traditional hardware. The software flow offloading technology, that is, the VPP design concept is used in combination with the according to the flow characteristics to achieve high-speed packet forwarding. In this way, the performance can be improved by 20% and the cost can be saved by 10%.

Highly Reliable Network

5G network provides the eMBB service in its initial stage, and the subsequent evolution needs to provide uRLLC and mMTC services. It is therefore necessary to provide a large-capacity network, a highly reliable network, and zero-interruption user experience. The following aspects are involved:

- Highly reliable service processing: The stateless cloud architecture adopts unified data storage to separate service processing from data. The service processing uses N+M load sharing mode to replace the original 1+1 active/standby mode, thus reducing the cost and improving resource utilization. Second-level elasticity is also implemented to improve user experience and operational reliability.
- Highly reliable data storage: Unified storage and management is used for online data sharing. The flexible synchronization mechanism ensures data consistency. When the network QoS is good, synchronous replication

is used. Asynchronous replication is used when the network QoS is poor. Level-4 backup and recovery ensures data security and reliability. The memory, disk array, local hard disk, and external storage devices are all secured. Users' dynamic and static data are saved in real time.

- Various disaster recovery networks: Data storage supports N+K geographic disaster recovery to meet different application scenarios. Access network elements (NEs) take over services flexibly in the Set according to the weight. In a hybrid network with multiple user planes and multiple control planes, users can still access the network even if any NE is faulty.

Automatic O&M

To meet the needs of fragmented 5G network construction, the core network must be designed, deployed, and secured to completely improve automatic full lifecycle operations capability. Design tools, end-to-end deployment, automatic service configuration and test, gray upgrade, cross-layer alarm correlation RCA are used to improve engineering and front-line operations efficiency, reduce Opex, and speed up service launch.

Fast Service Launch

Design tools are used to automatically generate the deployment script, including HLD/LLD design and generation of DC resources, networks, VNFs, and slices, providing end-to-end automatic deployment of hardware, cloud platform, MANO, VNF, and slices. The service configuration and test are completed automatically, and the

service launch time is reduced from several weeks to one day.

Gray Upgrade

Old and new versions are smoothly upgraded and rolled back to ensure service continuity. Through flexible gray policies, users and services are gradually swapped over by user group, APN, and link. The A/B test is made to discover or reduce the impact of failures on the commercial environment in advance.

Cross-Layer Alarm Correlation RCA

Both fuzzy match and precise match are supported, and alarms at the resource layer are abstracted. VNF only needs to concern about the resource attribute causes that trigger the alarms, such as network, memory, CPU, host, and cloud disk. The correlation rules between the VNF and the resource layer are established through abstract resource attributes, facilitating the decoupling between VNF and NFVI.

5G core network is the key to 5G network construction and service transport. Facing the needs of mainstream operators around the world for 5G core network construction in a fragmented manner, ZTE has put its core network products into practice. Through the "worry-free" core, ZTE can provide operators with a fast deployment channel for 5G construction, helping them build "worry-free" networks and head up into the era of 5G IoE. **ZTE TECHNOLOGIES**

The Rise of 5G-Oriented Edge Computing

5G signifies a shift in communication from man-to-man to man-to-machine and machine-to-machine. It would enable a wide range of services, including AR/VR, IoT, industrial automation and autonomous driving. This creates the requirements for high bandwidth, low latency and massive connections, which are the three major usage scenarios defined for 5G by 3GPP.

Edge Cloud Features

In order to meet the requirements of 5G services, more and more NEs start to separate the control plane from the forwarding plane, allowing for hierarchical deployment. The control plane is centralized and provides centralized scheduling while the user plane NEs are distributed close to the users, which helps strike a balance between management costs and user experience. Meanwhile, in order to effectively move service anchors towards the edge, shorten service response time and expose the communication capabilities of traditional mobile networks, mobile/multi-access edge computing (MEC) is fully introduced. To adapt to distributed NE deployment and MEC deployment, it is necessary to use cloudification technologies to transform a centralized telecom cloud into a distributed telecom cloud on the infrastructure level.

The distributed cloud (Fig. 1) is composed of central cloud and edge cloud (which can be subdivided into city, county and access levels). The central cloud, as the brain and center, mainly controls/manages centralized media-plane NEs. The edge cloud mainly bears distributed user plane/media plane NEs for fast traffic offloading as well as NEs with strict real-time requirements to develop a better user experience for services such as HD video, vehicle networking and VR/AR.

The edge cloud has the following features due to its particularity in location, scale and environment.

- Limited by the environment (e.g. air conditioners, bearing capacity and power), the edge cloud deployed in cities, counties and base stations usually adopt customized multi-node servers or hardware that integrates computing, storage and network. Such hardware, based on the universal X86 architecture, has high environmental adaptability and allows a cabinet to have the minimum height and depth. It features front maintenance, high integration and low power consumption, which matches existing equipment room conditions and reduces the room reconstruction requirements.
- With the arrival of 5G services, the edge cloud resource pool will evolve from a single resource pool type (VM/bare metal) to co-existence of multiple types (VM/bare metal and container). OpenStack and Kubernetes are two key technologies that unify the underlying network/storage/security technologies and enable unified orchestration and management of VM/container resources, greatly improving resource allocation flexibility and resource utilization ratio.

Zhu Kun
Chief Engineer of ZTE MEC Product

- The edge cloud, based on X86, usually introduces co-processors (accelerators) such as FPGAs and GPUs to meet the network's high-speed forwarding requirements. The latest ETSI NFV architecture uses hardware acceleration. It adds acceleration resource virtualization capability, which abstracts accelerators, presents them as logical acceleration resources, and uniformly provides comprehensive acceleration services.

- Due to the small storage scale, the edge cloud adopts an independent resource pool, resulting in high costs and low resource utilization ratio. Therefore, the converged compute and storage solution is widely used, with distributed storage deployed in the compute nodes. The unification of compute and storage nodes greatly enhances resource utilization ratio. Meanwhile, VMs/containers on the local nodes can directly access the local storage through policy configuration and allow replication to other nodes, which greatly enhances storage performance while guaranteeing the reliability.

- Since the edge cloud has a small scale, it is necessary to reduce the resources occupied by the management module. It is viable to either deploy the lightweight management module or to centrally deploy the management module in the upper-layer cloud and only deploy compute nodes in the edge cloud. Both types of deployments can be chosen flexibly according to the scenarios.
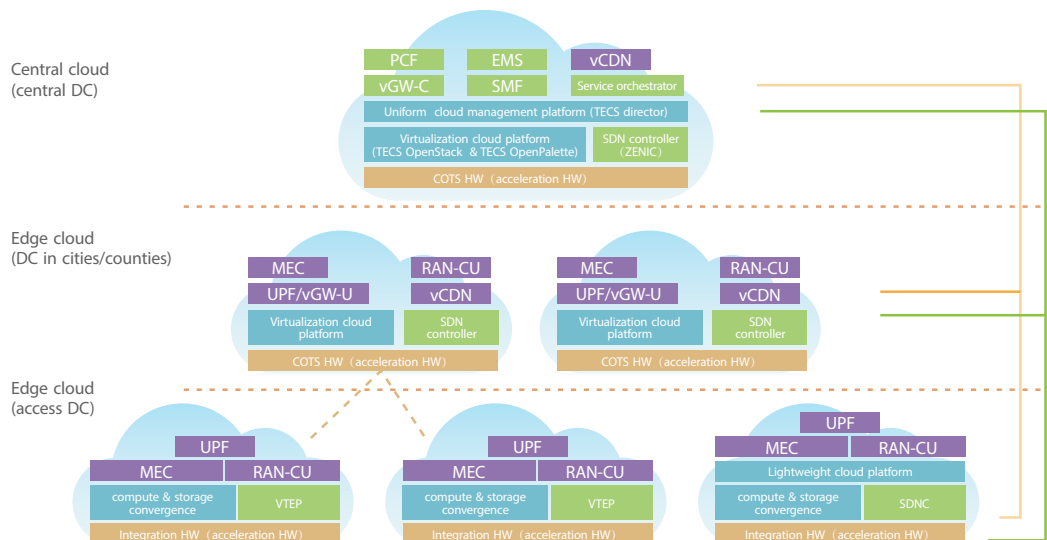
- The distributed cloud usually adopts hierarchical deployment. Data centers are distributed at different locations and have multiple resource types, which requires a uniform management platform to hide the heterogeneity of resource pools and perform global O&M to improve Q&M efficiency.
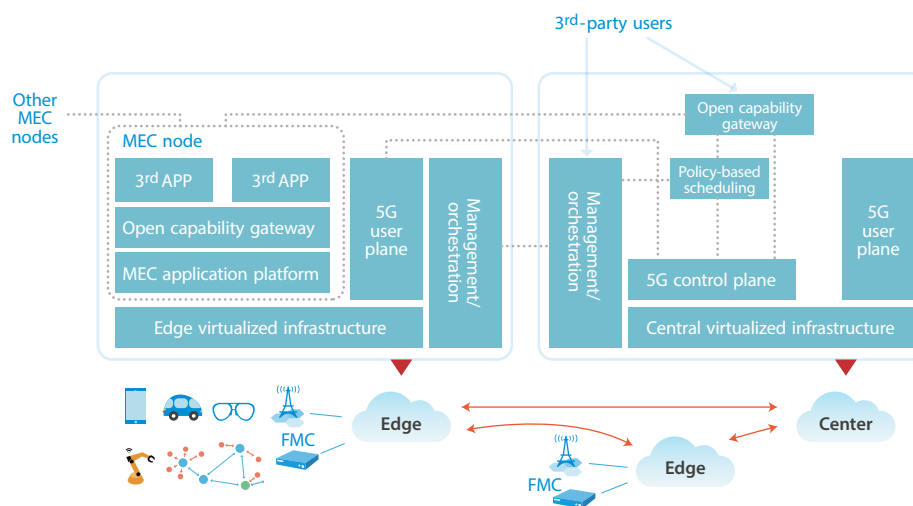
MEC Scenarios and Architecture

As the technology for enabling the edge cloud, MEC extends IT and cloud computing capabilities to the edge of the network by deploying universal servers close to the access side. It allows distributed deployment and localization of applications, services and contents, makes low latency and high bandwidth transmission possible, and reduces the amount of backhaul bandwidth required and operation costs. Meanwhile, MEC defines a two-way API communication mechanism of network and third-party applications. For example, a wireless network can expose contextual information (e.g. location, network load, and wireless resources utilization ratio) to third-party applications via APIs, which effectively enhances the network's intelligence and promotes deep convergence of network and services.

According to the features of different services, MEC application scenarios are divided into two types: one is localized services (e.g. local caching

▶ *Fig. 1. Distributed cloud architecture.*

and integration of services) with typical application scenarios including enterprise park networks and extended AR/VR services; and the other is vertical market expansion with typical application scenarios including IoV and industrial internet. In order to better support new services and explore the existing network's capabilities, MEC needs to address issues such as more precise indoor navigation, platform development and application integration.

Taking into consideration the MEC system architecture features specified by ETSI and 3GPP and requirements of 5G MEC scenarios, ZTE has designed an MEC architecture (Fig. 2).

Based on 5G distributed cloud infrastructure, 5G user planes and 5G MEC nodes are deployed in the edge cloud. The 5G MEC nodes provide an MEC application platform, which enables third-party applications and provides public services for third-party applications. MEC nodes cooperate with each other to support context transfers to guarantee service continuity during UE mobility.

The central side exposes network capabilities to third-party users and applications. Policy-based scheduling, according to application, load and network conditions, dynamically creates/deletes a third-party application instance, and dynamically provides policies for edge user plane function selection, achieving great coordination of network and services.

The architecture adopts a hierarchical management/orchestration structure. The management/orchestration function on the

central side is the uniform entrance to the management and orchestration of third-party applications, which selects one or more edge locations to deploy applications. The management/orchestration on the edge side manages actual resources allocation and application deployment.

Summary

We should be prepared for the ICT-based convergence trend and 5G era. Different from the pipe provider in 4G era, the operator in 5G era stands a greater chance in exploring value-added services and transforming into an E2E service provider. As the new technology of ICT convergence, edge computing brings high bandwidth, low latency and localized services closer to the edge of the network. It provides uniform telecom infrastructure support for mobile and fixed convergence and will play an important role in digital transformation and industrial structure upgrade. However, it still needs to be supported by a strong business model. The industry has lots of expectation for various application scenarios of the edge service platform. ZTE hopes to join hands with more partners to discuss about the cooperation mode of MEC, build the ecosystem for 5G network edge, and promote the prosperous development of the edge service. ZTE TECHNOLOGIES

5G Network Slicing: Key to Digital Transformation of Industries

Zhang Qiang

IPR Director of ZTE's Core Network Products
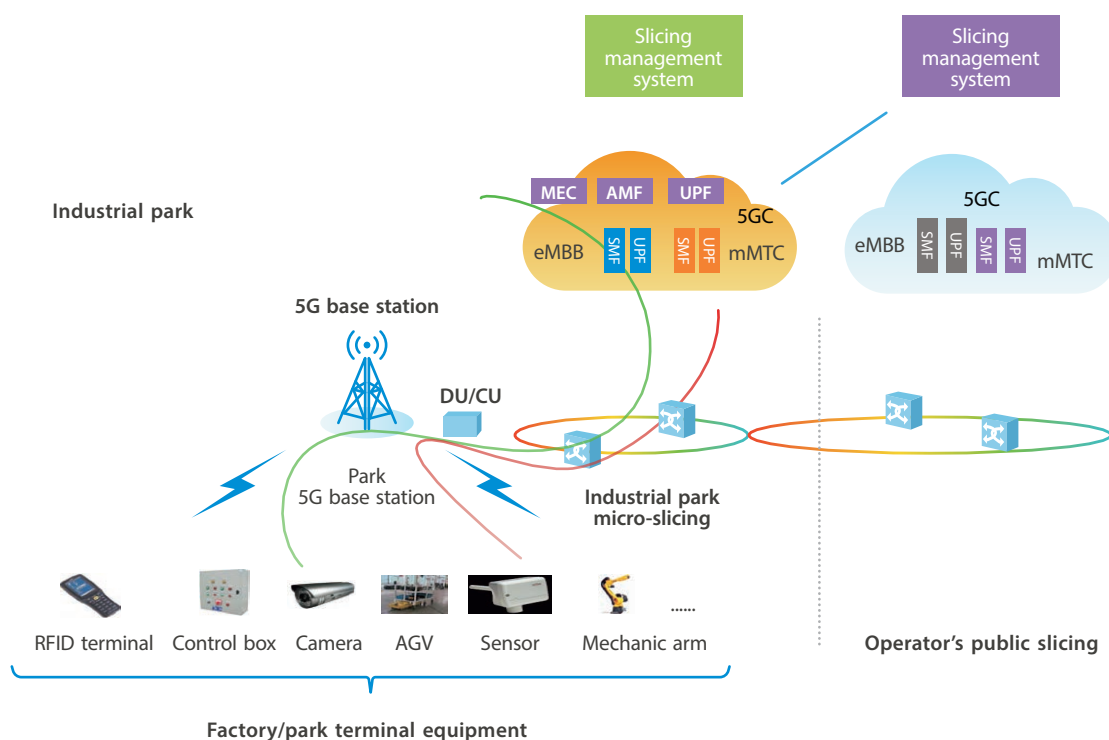
Industrial Digital Transformation Scenarios

Digital transformation is the way in which enterprises apply digital technology to their production, operations or management. In the 5G era, operators are presenting exemplary applications in many different domains including medical care, transportation, manufacturing, energy, municipal administration, education, and video, driving the digital transformation of various industries through 5G technology (Table 1).

Slicing-Based Industrial Digital Transformation Solution

In the digital transformation of industries, different services have different requirements for latency, bandwidth, and security, and it is difficult for a single network to meet all the requirements. ZTE's 5G network slicing supports key technologies and solutions including flexible networking, slice online migration, slice capability exposure and 5G LAN/TSN. This, when combined with MEC, can meet various needs of digital transformation of different industries.

Table 1. Typical industrial application scenarios of 5G. ▶

Industry	Service	Scenario
Energy	5G smart grid	Differential protection, remote power distribution (remote signaling, telemetering and remote control), accurate load control (demand-side response), advanced metering, robotic inspection, emergency communication
Manufacturing	5G smart factory	Flexible manufacturing, VR-supported transparent factory, smart toolbox, collaborative control of robots, vision-based robotic quality control, cloudified MES, intelligent inspection, production environment monitoring
Transportation	5G smart transportation	V2V (collision warning, vehicle formation), V2I (traffic information broadcasting, signal warning), V2P for pedestrian warning, in-vehicle entertainment based on V2N communication (high-definition video, map navigation)
Medical care	5G remote medical care	Mobile medical vehicles, remote medical consultation, emergency rescue, remote robotic ultrasound, remote robotic inspections of wards
Education	5G smart park	Remote interaction, holographic projection, virtual education, intelligent recognition
Municipal administration	5G public services and society governance	Comprehensive management of safety, environmental protection and sanitation monitoring
Video	5G video integrated application	4K/8K HD video, remote monitoring, VR/AR live broadcasting

Flexible Slice Deployment Scenarios to Meet Diverse Networking Needs of Industrial Digital Transformation

According to the coverage and security isolation requirements of different industrial applications, ZTE provides slice deployment solutions for closed scenarios, semi-closed scenarios and open scenarios. Closed scenarios include industrial parks and production workshops; open scenarios include internet of vehicles and smart grid; and semi-closed scenarios means that the same terminal may simultaneously access the internal or external slices of a park. Flexible networking is enabled by 5G slicing to cater to different scenarios.

Take a closed scenario for an example (Fig. 1). In an industrial park, the entire 5GC will be deployed, which is composed of AMF, SMF, UPF and UDM. At the same time, micro-slices can be constructed according to different business needs, such as eMBB (video surveillance), mMTC (sensor) and URLLC (flexible manufacturing). The slicing management system can be deployed in the industrial park where the enterprise operates the slice itself, or deployed in an operator's data center with the slice Q&M provided by the operator.

5G LAN/TSN with Support for Point-to-Point and Point-to-Multipoint Communication in Industrial Applications

ZTE provides 5G LAN-based slices (e.g. URLLC slices for grid differential protection), which realizes UE-to-UE communication through UPF for data interaction, service unloading, and

transmission latency reduction (Fig. 2). The 5G LAN terminal group management technology is provided to automatically adapt to the changing typologies of the industrial control terminals. This technology supports direct communication between service terminals in a power grid, collaboration between robots in the manufacturing industry, as well as rapid interconnection and wirelessization of devices (e.g. printers and notebook computers) in an office area.

Online Migration of Slices to Support Differentiated Operations of Industries

ZTE offers a slice online migration solution that allows users to dynamically join or exit from their own slice, or migrate from one slice to another. With the slice migration technology, differentiated operations or VIP rights operations can be carried out for applications such as online games and HD theaters. The same service can run on slices of different SLA levels, for example, normal slices and high-quality slices (ultra-low latency slices or high bandwidth slices). Ordinary users can access services through normal slices by default whereas high-end industrial users can subscribe to the acceleration service online through an online mall or an industrial application portal,

dynamically migrating to a higher quality slice for a better experience.

**Slice Capability Exposure to Enable Visibility and Controllability of Vertical Slices**

The slice capability exposure solution allows a slice to be visible, controllable and customizable, thereby supporting terminal management, QoS control of users in a slice and slice monitoring.

Terminal management refers to getting the status and location of a terminal (e.g. robot and sensor) in a slice through slice capability exposure so as to develop new services and functions such as vehicle formation management and availability detection of power grid terminals.

QoS control means modifying the QoS package of users in a slice through PFC capability exposure so as to improve the user experience. For example, for the VIP player of a game, the acceleration service can be subscribed to; and for the differential protection of the power grid, the latency policy can be modified for guaranteed reliability.

Slice monitoring allows the status of a slice to be obtained through slice capability exposure, which helps detect whether the latency and bandwidth of the actually-running slice meets the SLA requirements submitted when the slice is subscribed.

Fig. 2. Direct communication between UEs.
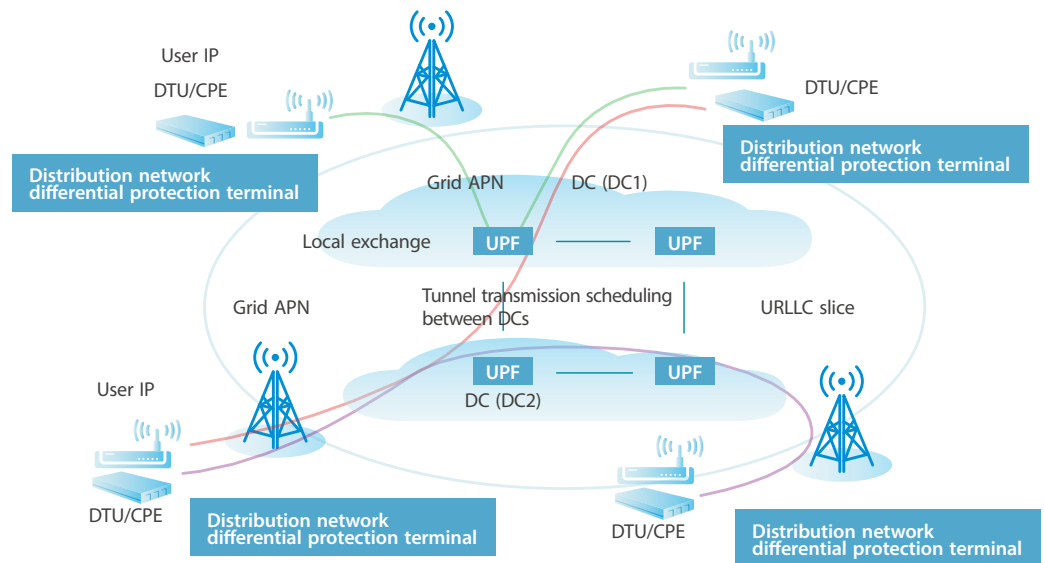
5G Slicing + MEC to Support Development of Industrial Applications

In industries like smart manufacturing, there are a large number of mass-storage and high-performance computing services such as image recognition, video analysis and VR rendering. These services are characterized by a large amount of data, which does not leave the park. MEC brings the computing closer to the user, and also supports software acceleration (DPDK) and hardware acceleration (e.g. GPU and FPGA). ZTE offers a solution that combines the high-performance computing capability of MEC with the low latency features of slices to help many industries carry out digital transformation.

VR-supported transparent factory is an example. The 5G eMBB slice + MEC solution facilitates low latency and high bandwidth communication of VR. Through local traffic offloading of slices, MEC GPU acceleration, and image rendering, the assembly process is fully digitized, thus creating a digital twin and a immersive user experience.

Unmanned aerial vehicle (UAV)-based quality inspection is another example. The drone can be used in the aircraft manufacturing industry to inspect the paint quality on the exteriors (especially the tops) of the aircraft. Videos can be transmitted back in real time. The 5G eMBB slice + MEC solution solves such problems as capturing 360-degree videos/photos, transmission, and analysis.

The Outlook

Slicing is an important digital technology in 5G that integrates advanced technologies such as cloudification/virtualization, security isolation, automation, AI, and hardware/software acceleration. With the advancement of 5G, slicing will be gradually applied to various vertical industries, promoting the development of smart manufacturing, smart grid, internet of vehicles, smart city, smart park and other domains. It will drive digital transformation across industries and aid the comprehensive development of the information society. ZTE TECHNOLOGIES

ZTE 5G Common Core Accelerates 5G Commercialization

Liu Rui

Planning Director of ZTE CCN Products

ZTE 5G Common Core based on 3GPP R15 SBA provides key features such as cloud native, network slicing, CUPS, stateless design, and containers to meet the requirements of operators in various application scenarios such as eMBB, mMTC, and URLLC. It makes full use of advanced technologies including NFV, SDN, cloud computing, and big data to create a 5G core network (5GC) that leads in architecture, test and technology. With its substantial improvement in technological innovation, market progress, industrial evolution, openness and cooperation, ZTE has established a leading image in the global telecom field.

Technological Innovation

Compared with traditional networks, 5GC construction faces four major challenges: new architecture, multi-networking, multi-system coexistence, and complex network operations. ZTE 5G Common Core is based on SDN/NFV that enables operators to re-architect their networks. It adopts 3GPP R15 SBA and cloud native architecture that enables agile network function. It uses end-to-end network slicing technology for the development of vertical industry. It also builds zero touch through DevOps and AI, enabling automatic network operations.

ZTE 5G Common Core can meet the full access and full convergence requirements of 2G/3G/4G/5G/Fixed and support 3GPP R15 SA and NSA deployment modes. Operators can flexibly deploy SA, NSA or dual SA and NSA modes in the same network as needed. By building a network with Common Core, resources can be reused and the target 5G architecture is built in one step to avoid multiple network upgrades and reconstructions. The investment cost can be reduced by 40%.

ZTE 5G Common Core is also based on micro-service software architecture. Software delivery is changed from NE-based large granularity to micro-service small granularity. It supports fast release and gray upgrade. Based on DevOps CI and CD, new services are put online quickly. The software release period is shortened from the traditional half year to less than one month.

Moreover, ZTE CloudStudio intelligent operation solution based on AI implements automatic design, automatic deployment, automatic service provisioning, automatic test, automatic inspection, and automatic attendance. By introducing AI-based closed-loop self-healing and self-optimization, the solution monitors network status in real time, analyzes fault root cause,

adjusts resources intelligently, adjusts network topology dynamically, and thus implements self-management, self-organization, self-optimization, and self-recovery to build an intelligent network. By simplifying network operations, the solution improves operational efficiency by more than two times.

ZTE is committed to helping operators build 5G networks comprehensively from center to edge, from underlying hardware to orchestration management, and from network element to service.

Market Progress

ZTE cloud core products have been highly recognized by major operators worldwide. They have been deployed in more than 450 NFV commercial/PoC projects around the world by the second quarter of 2019. ZTE has been working with more than 60 global operators to carry out 5G cooperation and tests (Fig. 1). Its 5G commercial deployment will also focus on key countries and mainstream multinational operators and provide them with 5G products and services.

1st 5G SA call in Europe
5G holographic call

5G service demo
4K video conferencing, VR,
low-latency cloud storage...

1st 5G first call | 2.6 GHz

1st 4G/5G network interworking

1st Performance stability test
1 million users 100G traffic

◀ *Fig. 1. ZTE establishes extensive cooperation to promote 5G commercialization.*

- In June 2019, 5G holographic call with the transmission of voice and images in real time, was powered by ZTE and Orange at Global 5G Event and EuCNC2019.
- In June 2019, ZTE partnered with Telefonica and Bank of Santander to announce Europe's first 5G banking services in Spain. The project can provide 4K Video conference, 5G low latency cloud storage, and virtual visiting, etc.
- In April 2019, Orange and ZTE reached an important milestone on mobile network evolution. The two companies joined hands in Valencia to implement Europe's first complete 5G call including voice and data by using standalone (SA) architecture. This is the first show of 5G SA mode in Europe. The architecture used in this deploymenttest complies with 3GPP R15 SA standards and uses ZTE's end-to-end 5G commercial products.
- In February 2019, China Unicom and ZTE finished the interoperability test of 5G smart phones (like ZTE) in Zhengzhou Data Center. In January 2019, ZTE and China Unicom (Guangdong) jointly made the first call based on 5G smart phone in Shenzhen 5G field and completed the verification of multiple services such as WeChat multi-party voice call, online video, and web browsing.
- In February 2019, ZTE was the first to complete the IoT test of its 5G core network based on R15 SA standard organized by China Telecom. In September 2018, ZTE helped China Telecom implement the first 3.5-GHz 5G SA end-to-end VoNR in Xiong'an field.
- In December 2018, ZTE took the lead in completing IMT2020's Phase-3 5G core network tests including performance stability test and security test. This is another breakthrough after ZTE successfully completed the SA 5G core function test at the end of September 2018, fully verifying the maturity of ZTE's 5G core network system.
- In November 2018, China Mobile and ZTE took the lead in completing the first phase infield test of 5G core based on SA architecture.

Honors

In June 2019, ZTE won the "Leading Contribution to Network Slicing" award at the 5G World Summit for its 5G slicing wholesale solution.
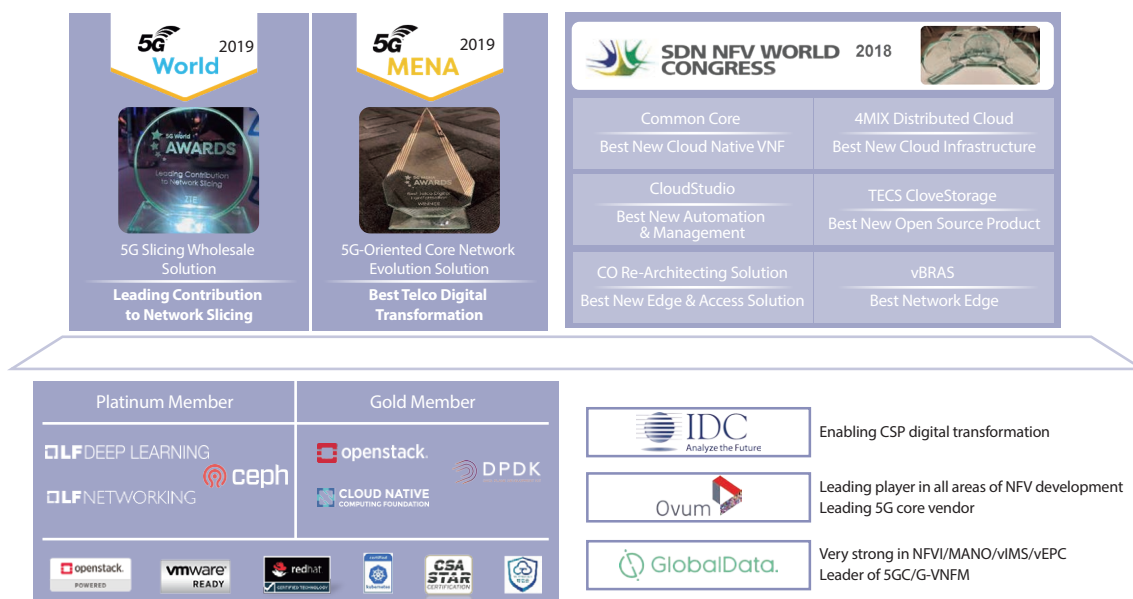
In April 2019, ZTE won the "Best Telco Digital Transformation" award at the 5G MENA Forum held in Dubai for its 5G-oriented core network evolution solution (Africa).

At the end of 2018, the annual ICT List launched by Communication World once again brought the ICT industry chain to the center stage. With its outstanding performance in 5G and SDN/NFV, ZTE 5G Common Core Solution won the "2018 5G Core Network Excellent Solution" award and ZTE 5GC Automated Integration Service Solution won the "2018 SDN/NFV Best Practice" award.

In October 2018, ZTE won six awards at the SDN NFV World Congress held in the Hague, Netherlands, including the "Best New Cloud-Native VNF", "Best New Open Source Product", "Best New Cloud Infrastructure", "Best New Automation and Management", "Best Network Edge", and "Best Edge & Access Solution" for its Common Core solution, TECS CloveStorage, 4MIX distributed cloud solution, CloudStudio solution, vBRAS solution and CO re-architecting solution respectively. These awards demonstrate the industry's recognition of the technical and commercial capabilities of ZTE's SDN/NFV products.

Industry Evaluation

In October 2018, the world-renowned consulting firm GlobalData officially

released the 5G report: *5G: Review of 5G Technology Readiness and Commercialization.* The report introduces in detail the development of 5G standards and the global 5G commercial process, and makes multi-dimensional comparative analysis of mainstream vendors in the telecom industry. ZTE's 5G core, RAN, and transport are all rated as leaders, keeping the leading position in the industry.

In February 2019, ZTE was evaluated as a leading supplier in the white paper *ZTE Accelerates Carriers' Migration to the 5G Core Network officially* released by OVUM, a global research and consulting firm. The white paper describes how operators can build an agile, automated 5GC to improve operational efficiency and business revenue in response to the 5G network transformation in the telecom industry. It also shares ZTE 5G Common Core solution and highly recognizes ZTE's leading innovation capabilities and competitive strength in 5GC standard, technology,

and commercial practice.

Openness and Cooperation

So far, ZTE has joined more than 50 open source communities and standardization organizations such as ETSI, 3GPP, and IETF. As a platinum member of LF Networking, LF Deep Learning and Ceph, and a gold member of Openstack and CNCF, ZTE has cooperated with mainstream manufacturers in the industry, has been deeply involved in open source communities, and has been committed to building an open and win-win ecosystem (Fig. 2).

Conclusion

ZTE, a leading international provider of integrated telecom solutions, has been focusing on the 5G field to be a pioneer in 5G. It has been committed to working with mainstream operators around the world to promote the development of 5G technologies and standards, and accelerate the process of 5G technological innovation and commercialization. **ZTE TECHNOLOGIES**

5G Operations Get Smarter When AI and Slicing Combine

Yan Liang
MANO System Architect at ZTE

Trends and Challenges of Digital Operations

4G changes the life, while 5G changes the society. 5G network needs to support ultra-large bandwidth, ultra-low latency and massive connection scenarios, and can serve a variety of vertical industry applications such as automatic driving, industrial control, smart grid, big video and AR/VR.

Diverse services, flexible deployment requirements, and complex network topology pose great challenges to 5G operations. Traditional manual or semi-automatic operations can no longer meet the requirements.

Artificial intelligence (AI) has inherent advantages in high computation data analysis, cross-domain feature mining, and dynamic strategy generation. The introduction of AI can further improve the efficiency of network deployment and operations, increase resource utilization, and reduce Opex.

Inevitability of Smart 5G Slice Operations

Network slicing is an important feature of 5G networks. Through flexible allocation of network resources and flexible combination of capabilities, multiple logical subnets with

different features can be virtualized based on a physical network to meet customized requirements in different scenarios. In essence, network slice operations provide full lifecycle management for slice instances, including design, provisioning, SLA guarantee, and termination. Network slicing not only brings great flexibility, but also increases operational complexity. It is inevitable trend to enhance automatic slice management capability based on AI.

Key Technologies of AI-Based Smart Slice Operations

When AI is introduced, the slice management system automatically executes management policies output by the AI training platform and provides smart network sensing, modeling, provisioning, analysis, judgment, and prediction capabilities to achieve a perfect balance between slicing flexibility and management complexity.

Smart Slice Provisioning

The slice management system provides smart slice provisioning that involves service customization, network planning, model design, automatic deployment, and E2E service activation.

- **Service customization:** The system uses data collection and machine learning to conduct deep mining of service features and provide customized, secure isolation of private slicing networks.
- **Network planning:** The system comprehensively analyzes available resources of the whole network, continuously trains the optimization algorithm by using AI technology, quickly transforms service requirements into network requirements, and effectively resolves the conflict between differentiated SLA and network construction costs.
- **Model design:** According to the analysis result of the AI training platform, the system smartly orchestrates and schedules virtual resources and automatically outputs templates related to slice lifecycle, policy rules, and slice optimization deployment.
- **Automatic deployment:** Combined with automated integrated deployment tools and slicing models, the system automatically instantiates resources at all levels, smartly matches test scenarios and use cases, and automatically performs slice testing. The deployment cycle is shortened from weeks to days.
- **E2E service activation:** According to the configuration template definition, the system automatically disassembles configuration parameters to each subnet, executes automatic calculation of parameters to form a batch script, and automatically activates services through the configuration channels.

Smart Slice SLA Guarantee

Network slice guarantee is essential to guarantee the SLA required by users. With the smart QoS service capability, the system can smartly analyze service requirements, network capabilities and user features, make multi-standard decisions, and introduce QoS monitoring feedback to form an SLA guarantee closed loop.

- **QoS guarantee:** The system collects massive traffic data (such as service types and time requirements), network data (such as the number of connections, load, speed, and delay), and user data (such as user levels, communication habits, time, and locations). Through smart analysis and judgment, the system evaluates current service experience in real time, and forms one or more optimal QoS parameter sets to make the best decision and control.
- **QoS differentiated services:** Based on smart judgment of time, location, access service, user communication habits, user subscription requirements and network real-time load pressure, the system forms the best matched QoS control parameters to provide users with real-time differentiated services.
- **QoS prediction and early warning:** Based on massive data collection, modeling, and analysis, the system implements QoS prediction and gives QoS early warning in extreme cases, providing reference for O&M guarantee actions such as early service termination and service change. For example, based on the neural network and linear regression algorithm, the system can predict the growth rate of the same period, analyze the peak or average traffic, and predict network congestion for operations involving dynamic scheduling and traffic acceleration.
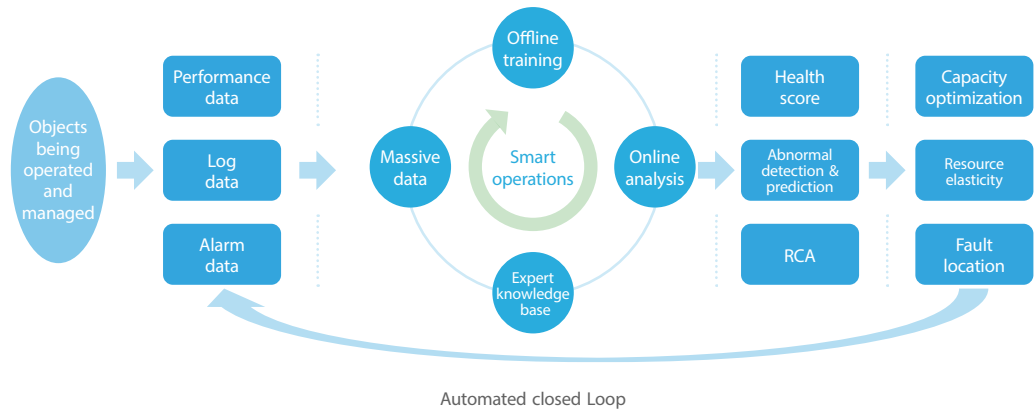
Smart Slice Closed-loop Operations

To efficiently manage network slices and reduce the complexity and costs in operations, the slice management system must provide smart slice closed-loop operations guarantee such as network self-sensing and self-adjustment (Fig. 1).

At present, the network policy is still based on manual static configuration and ignores actual network conditions. After the AI technology is introduced, the system can smartly analyze and determine the traffic, congestion level, and load status based on the time, location,

Fig. 1. 5G smart slice closed-loop operations. ▶

Automated closed Loop

and mobility characteristics. Through the dynamic slice management policies output by the AI training platform, it also implements smart scheduling.

Moreover, real-time or historical smart analysis provides reference data such as health score, abnormal detection and prediction, and root cause analysis. Based on such data, the system performs capacity optimization, configuration optimization, resource elasticity, and fault location operations to implement closed-loop slice optimization.

Smart Slice Fault Location

The system analyzes the time, location, and event description of slice alarms and identifies the alarm clue relations based on historical frequency data, cross-NE data, intra- or cross-private network data, and service-related data. It also reasons about the relations based on the current alarms, statistics, logs, and the rules obtained through training, and obtains the matched alarm root causes. Smart slice fault location includes training, reasoning, and closed-loop optimization.

The training process includes data extraction, data cleaning, data formatting and segmentation, algorithm execution, and results analysis. The reasoning process contains real-time monitoring of alarms, scheduled sampling of resources, and data configuration. The system uses the learned rules to comprehensively determine alarm data, resource data, service bearer relationship, and time sequence of the existing network and to find out the root cause for automatic repair or

prompting the operation and maintenance personnel to repair the fault. The closed-loop optimization involves updating, modifying, and improving the rule library in accordance with the actual rule application or expert judgment.

The effect of smart fault location is measured by the number of effective alarm root cause rules and the alarm compression ratio, or evaluated indirectly through the reduction rate of the number of work orders. AI-based smart alarm location can reduce the number of work orders by over 60%.

5G smart slicing network will experience three phases: intra-domain exploration, cross-domain integration, and high autonomy. First, sub-domains of the 5G network shall be integrated with AI to provide preliminary intelligence in network resource allocation based on big data and machine learning. Second, with the development of technologies, AI will be able to learn big data of the 5G network across domains, and integrated intelligence will emerge in some sub-domains to achieve intermediate intelligence. Finally, with the rapid development of 5G and AI technologies, network-wide coordination and high autonomy will be realized. This will greatly improve the efficiency of full-lifecycle network management and achieve advanced intelligence based on the intentions of human control networks.

It is foreseeable that the combination of AI and 5G slicing network will produce dazzling sparks and promote the rapid development and evolution of networks. ZTE TECHNOLOGIES

velcom Leads the Wireless Market in Belarus with SDR Base Stations

Located in the heart of Europe, Belarus is a landlocked country bordering Russia, Latvia, Poland, Lithuania and Ukraine, with a total area of 207,600 square kilometers. Belarus has a stable political situation and a good economic base. velcom is a branch of Telekom Austria, with 4.86 million subscribers. It has the same market share as MTS (5 million subscribers) and much higher than the third one Life (1.6 million subscribers).

Weakness of velcom's Network

The wireless market in Belarus is mature, and the competition between velcom and MTS is fierce. As velcom's 2G and 3G base stations belong to three different vendors, the interoperability between these devices leads to complex networking and high equipment O&M cost. Each year velcom's Opex is high. Moreover, some vendors do not support the evolution of new technologies such as LTE and NB-IoT.

velcom's strategic vision is to deploy LTE, create a minimalist network, provide the best network experience, and reduce Capex and Opex to become the leader in Belarus' wireless market. The above-mentioned problems seriously restrict the realization of velcom's vision.

Rebuilding the Network with SDR Solution

velcom wanted to be supplied by a single vendor, whose base stations would support both 2G, 3G and 4G, so that it could attract customers and take a leading position in the fierce market competition through the best network quality and service. ZTE found favor with velcom for its small-size, large-capacity, and low-power consumption multi-mode base stations, as well as rich experience in project implementation, and velcom selected ZTE as a single vendor in its wireless SRAN project.

Lu Yi
Wireless Product Marketing Manager of CIS Region at ZTE

"The success in cooperation and the excellent performance of ZTE equipment and service, was one of the key reasons why velcom has taken the decision to change their whole radio network strategy towards a single SRAN supplier," said Christian Laque, velcom CTO.

Christian Laque, velcom CTO

ZTE's wireless SDR solution based on the industry-leading MicroTCA standard hardware platform supports GUFTN multi-mode deep integration, high-capacity multi-mode baseband boards, and unified EMS. The solution can meet velcom's needs and perfectly solve its pain points.

In 2016, ZTE completed the replacement of velcom's network equipment in a short period of 11 months. "Due to the excellent cooperation between velcom and ZTE project team, we were able to achieve an average site swap number of over 80 sites per week, and during the hot phase even more than 110 sites per week have been swapped. Finally all works on site were

conducted effeciently, with required quality and safety. I would like to express my high appreciation to ZTE local team and R&D's efforts and the support of ZTE Austria, dedication and contribution to such challenging and complicated missions," said velcom CTO Christian Laque. After the replacement, the network could provide better KPIs and support LTE. Since then, velcom started to work ambitiously on the LTE market.

Failure to Acquire LTE License

In 2016, Becloud, a newcomer to the wireless market in Belarus, had the only LTE

Fig. 1. Comparison of FTP mean user download rates of velcom, MTS and Life. ▶

	velcom	MTS	Life
Average (kbps)	**9452**	**6046**	**8573**
Maximum (kbps)	24701	25664	21098
Minimum (kbps)	531	246	121
Confidence Interval	254.85	235.94	246.16
FDTT FTP Mean User Data Rate DL > 1 Mbps (%)	**99.90**	**98.11**	**99.04**
Confidence Interval	0.19	0.84	0.59
FDTT FTP Mean User Data Rate DL > 2.5 Mbps (%)	**97.28**	**83.42**	**95.60**
Confidence Interval	0.99	2.30	1.24
Sample Count	1029	1007	1045

	MTS	Life
Average (kbps)	**8902**	**3320**
Maximum (kbps)	85177	29134
Minimum (kbps)	257	75
Confidence Interval	487.47	194.88
FDTT FTP Mean User Data Rate DL > 1 Mbps (%)	**98.58**	**88.84**
Confidence Interval	0.71	1.99
FDTT FTP Mean User Data Rate DL > 2.5 Mbps (%)	**88.55**	**49.32**
Confidence Interval	1.92	3.16
Sample count	1057	959

◀ *Fig. 2. Comparison of FTP average user download rates of MTS and Life (LTE only).*

licence in Belarus, and MTS and Life chose to rent Becloud's LTE network. Though velcom built its own LTE network, it has not obtained the LTE license for a long time. Taking advantage of this time window, MTS and Life launched LTE advertisements all over the place, and adopted the strategy of low-fee LTE traffic packages, which attracted a large number of users in a short period of time and made velcom very passive. In the face of customer churn, falling revenue, and possible waste of investment in the LTE network, velcom was under enormous pressure.

Leading Wireless Market with Flexible Multi-Mode Base Stations

velcom was not knocked down by the failure in acquiring LTE license, but shifted its focus to the development of UMTS network. ZTE's SDR platform and GUFTN multi-mode base stations can achieve flexible configuration of 2G, 3G and 4G baseband resources. The conversion of 2G, 3G and 4G baseband resources can be implemented quickly only through the configuration of unified network management system. This not only avoids the waste of investment in the LTE network, but also leaves sufficient resources for

the UMTS network. With its large-capacity UMTS network, velcom launched low-fee traffic packages and received excellent feedback from the market, resulting in a sharp rise in velcom's PS data traffic. In 2017 and 2018, velcom's revenue, profit and ARPU from the wireless market were ahead of MTS and became the market leader in Belarus. Without an LTE license, the average user download rate of velcom's UMTS network in 2018 according to the third party dmtel was still higher than that of MTS/Life's LTE networks (Fig. 1 and Fig. 2). Velcom provided excellent user experience.

New Technology Innovation

To strengthen its leading position in the wireless market, velcom has begun to explore new services. With ZTE's SDR multi-mode base stations, velcom launched Belarus' first commercial NB-IoT network at the end of 2017 and began the development of NB-IoT services. The introduction of NB-IoT technology will bring brand-new service experience to the Belarusian people. It will also drive the development of NB-IoT design and integration industry, promote social innovation and create more employment opportunities in Belarus. ZTE TECHNOLOGIES

Exciting Time for 5G Has Only Just Started

Source: telecoms.com   June 21, 2019   By Wang Weibin

To say that the buzz about 5G has created excitement in the telecoms world would be an understatement. After the first commercial networks switched on in North America and Asia, Europe is also catching up quickly. More recently, four 5G licences were awarded in China, the world's largest mobile market, well ahead of the schedule that has been broadly anticipated. But the world has only seen the beginning of the true 5G, with much more excitement to come in the next few years. I used my recent interview by Telecoms.com to explain why.

Telecoms.com: There is no doubt that 5G rollout is accelerating. However, the commercial networks switched on so far have only offered enhanced mobile broadband (eMBB) services and used data speed as the key selling point. Isn't that a disappointment? How do you see the industry move from here?

Wang: No, it's by no means a disappointment. As a matter of fact, I see in the 5G services being offered now the beginning of a long exciting time for the telecom industry. We all know 5G can offer much more than broadband access, but to start with broadband access has its advantages.

To start with, in addition to the fact that broadband access is easier for consumers to understand, it is also a good way for the telecom industry to gain experience. 5G is a watershed opportunity for the telecom industry to directly participate in the digitalisation of other industries. Telecom operators will find in offering high-speed internet access a valuable and reassuring starting point to deepen their understanding of other vertical industries.

Another advantage of starting with enhanced broadband access is that the eMBB scenarios for all Option modes have been frozen in the R19 Late Drop version of Q1 in 2019. Therefore, with

a more mature technology, despite its being new too, the success rate will be higher. In comparison, although the technologies are ready for other 5G use case implementations, including low latency and massive IoT, the standardisation for ultra reliable low latency communications (URLLC) will only be finalised in March 2020 with Release 16, and the standards of massive machine type communications (mMTC) for NR won't be frozen until Release 17. 3GPP schedule for Release 17 is still open though we expect it to be completed in the first half of 2021.

Telecoms.com: That explains why some operators choose to launch 5G early by adopting the NSA mode, some would rather wait till the technologies are more mature and go directly to SA mode. What would be your advice to the operators on their options?

Wang: Technologically, the 5G base stations can handle both NSA and SA modes, but the key difference is in the core. NSA Option 3 is built on LTE evolved packet core (EPC), but SA Option 2 is built on the new 5G core that is organised around services, i.e. using service-based architecture (SBA). Therefore, to unleash the full potential of 5G, especially the B2B potential, going for NSA mode will make more sense. This is also meaningful in a business sense for the telecom operators who would expect to generate more value from 5G service offerings to business customers.

A fundamental difference between serving consumers and serving business customers is that, consumers are generally more price sensitive, and tend to treat personalised offers as a bonus, while business customers are much more demanding in time to market (TTM) and customisation capabilities. Some current hotspot technologies, including network slicing and virtualization, integration with the cloud, edge computing, and full adoption of AI, machine learning

and automation, can be better implemented in a 5G environment.

However, this doesn't have to be an "either-or" choice. Operators may choose to adopt the NSA mode now, so that they don't have to wait till all the standards are frozen or SA mode devices are broadly available. They can then transit to the SA mode at their choice of time. Technologies from companies like ZTE are making the transition straightforward and cost-efficient, because we are facilitating the convergence of different technologies and business operations.

Telecoms.com: This leads me to the next question. We have heard industry professionals talk about convergence for many years. What is so unique about the convergence in 5G era? And what is ZTE's answer to it?

Wang: One of our technology answers to the convergence demand is the industry's first Common Core. This architecture level innovation serves networks from 2G to 5G and, in the case of 5G, it is equipped with NSA and SA dual-stack capability. Therefore, operators using the Common Core can choose to deploy SA, or NSA, or even SA/NSA dual-mode networks based on their own business needs. The architecture is modular, so it does not only save resources and cost, but also vastly simplifies the network architecture, and fully supports the strong demand for edge computing and low latency in an end-to-end 5G environment.

What we offer are clearly welcomed by our customers. That's why, so far, ZTE has cooperated with more than 40 operators worldwide in the 5G field. As we speak, we are testing and demonstrating end-to-end 5G services, including automatic cars, real-time robotics, and hologram video calls, in partnership with Telefonica and Orange in Spain. These use cases are driving more excitement for 5G, which has just started by the live 5G networks switched on. ZTE TECHNOLOGIES

To enable connectivity and trust everywhere