ZTE TECHNOLOGIES

VIP Voices

POST Luxembourg:
Positioning Itself in the Digital Era

SVP View

Jointly Embracing a Better Connected Future with 5G

Special Topic: 5G Innovations

Claude Strasser, CEO of POST Luxembourg

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ZTE TECHNOLOGIES FEB 2018

ZTE and velcom Jointly Announce Belarus' First NB-IoT Commercial Deployment

14 December 2017, Shenzhen, China — ZTE and velcom, a branch of A1 Telekom Austria Group, jointly announced the deployment of the first commercial NB-IoT network in Belarus. The network was deployed in Minsk city first and then in other regions as scheduled. So far, velcom has verified smart metering and smart city solutions in the network.

The cooperation of NB-IoT between velcom and ZTE has started since the end of 2016. In the Tibo exhibition, the end-to-end gas metering service demo was successfully demonstrated. Following that, more lab tests and field tests were carried out.

velcom has highly appreciated ZTE's commitment in this market. "We are very excited that, with ZTE, we have provided abundant services to our customers. Within the project, we installed equipment that will allow us to implement NB-IoT technology. This is an incredible breakthrough in the field of telecom, and we are happy to complete it together. We are sincerely glad to have such a partnership and looking forward to further cooperation," said Christian Laque, CTO of velcom. "ZTE is very proud to work with velcom to release the first NB-IoT commercial deployment overseas. The achievement signifies ZTE's capabilities of providing operators with the smooth evolution solution towards 5G," said Pu Yingchun, Vice President of ZTE and General Manager of FDD Products.

ZTE Combo PON Solution & Smart Parking System Win Total Telecom Innovation Awards

1 December 2017, Shenzhen, China — ZTE won two innovation awards for its Combo PON solution and smart parking system at the World Communication Awards (WCA) 2017 held by Total Telecom, a renowned telecom publication, in London, the U.K.

The ZTE Combo PON solution earned the "Highly Commended" award in the "Innovation Award: Vendor" category. ZTE is the first vendor to innovate a 3-in-1 Combo PON solution. Integrating GPON and 10G GPON into a single optical module through a built-in WDM1, and processing signals separately based on different MAC addresses, the solution is able to simultaneously deliver GPON and 10G GPON services over one PON port.

The ZTE smart parking system won the "Most Innovative IoT Solution" award. The system is the industry's first NB-IoT based smart parking solution ever used in pilot deployments. It innovatively integrates IoT, wireless communications and GIS to enable data collection, management, query, reservation and navigation of parking spaces; thereby realizing efficient allocation of parking resources. The system has been commercially trialed in over 40 cities globally, including the Xiongan New Area, Tianjin, Shenzhen, Brussels, and Madrid.

ZTE Joins IEEE-SA Standard Board

27 December 2017, Shenzhen, China — ZTE announced that its 5G standard director Mr. Jingyi Zhou joined IEEE-SA Standards Association Standards Board (SASB) for the term of 2018.

Meanwhile, Zhou also joins SASB Industry Connections Committee (ICCom) and returns to SASB New Standard Committee (NesCom) for 2018.

IEEE-SA is a leading standard organization globally. ZTE has been working with IEEE for years on various technologies and standardization including wireless LAN, WAN, Ethernet, Front-haul, Advanced Fog/Edge computing, and Blockchain etc. ZTE experts are holding leadership positions in P1934 and P802.11ax PHY Ad-Hoc Working Groups (WG) as well as SASB Board and Committees. ZTE is working together with IEEE to extend its influence and contribute to the industry with its advanced 5G wireless technologies.

ZTE Releases IoT Cloud Platform Product — ZTE ThingxCloud

12 December 2017, Shenzhen, China — ZTE released a new generation of ZTE's ThingxCloud IoT platform products in Shanghai IOT summit.

ZTE's ThingxCloud, a basic IoT cloud platform with advanced technology architecture and a wealth of basic capabilities, can well connect APPs and devices while generating data internally. Meanwhile, it features great capabilities of enabling IoT and IoT ecology development, and opening a co-construction, co-sharing and win-win situation in IoT arena.

Based on oneM2M's technology architecture and ICT PaaS/AI & Big Data, ZTE's ThingxCloud includes IoT devices, connection management and application enabling management. It adapts to various bearer networks, and shields differences among different bearer network technologies so as to make the upper applications transparent on the underlying bearer network.

The software development kit (SDK) /API makes the massive terminals access to IoT simplified, data sharing secure, and the upper IoT application and public foundational capabilities controllable for all kinds of applications. Therefore, varieties of IoT applications can be greatly optimized in the architecture, difficulty of its development and construction be reduced, costs of construction and operation saved while new intelligence being generated for upper-level applications with rich AI & Big Data capabilities.

ZTE First Completes Ultra-High-Precision Time Source Test in Cooperation with NTSC, Boosting IoE in 5G

7 December 2017, Shenzhen, China — ZTE announced its completion of the test for the high-precision time source device based on the principle of satellite common view in National Time Service Center (NTSC), Chinese Academy of Sciences (CAS).

The time source test based on common view technology is the first that achieves the time precision of +/−10 ns. The completion of this test marks that ZTE has introduced the satellite common view technology from scientific research on astronomical navigation to communication industry application for the first time, boosting internet of everything (IoE) in 5G.

ZTE and China Telecom Complete Pre5G FDD Massive MIMO Testing

8 January 2018, Shenzhen, China — ZTE declared that its CloudStudio (formerly vManager) VNFM product was ranked as Leader by GlobalData in its latest standalone VNFM survey report titled "Standalone VNF Managers: Competitive Landscape Assessment".

GlobalData, a world leading provider of data and analysis, points out that VNFM product is an important part for VNFs interfacing with MANO to complete virtualization capabilities. Operators need a generic VNFM, whether strictly ETSI-compliant or not, to deploy multiple VNFs to finish the first step to network virtualization transformation. A generic VNFM which can be sold standalone or integrated should possess powerful capabilities in decoupling or integrating with third-party APPs/VNFs and NFVO.

So far, ZTE has deployed more than 320 commercial/trial virtualization projects around the world. ZTE develops deep cooperation with mainstream operators, has joined many standards organizations and open source communities such as ETSI, 3GPP, ONAP, OPNFV, OpenStack, OpenDayLight and CNCF, and aims to build an open and win-win ecosystem together with industrial partners.

POST Luxembourg:
Positioning Itself in the Digital Era

Reporter: Liu Yang

Claude Strasser, CEO of POST Luxembourg

F ounded in 1842, POST Group, based in Luxembourg, is the country's largest provider of postal, telecommunications, philatelic and financial services. Being the incumbent operator in Luxembourg offering services to over a million customers, POST Luxembourg is in the process of consolidating its IT platforms to provide non-differentiated services for its customer base, support centralized operations for both fixed and mobile networks and ultimately improve the customer experience through proactive customer care and innovative digital service offerings. POST Luxembourg and ZTE are working together on a project which aims at realizing business convergence by deploying ZSmart BSS suite developed by ZTE's subsidiary ZTESoft. At a recent partnership signing ceremony, *ZTE Technologies* interviewed Claude Strasser, CEO of POST Luxembourg, and Pierre Zimmer, CSO of POST Luxembourg. They outlined the company's challenges, strategy, and how they are positioning themselves in the digital era.

Could you describe Luxembourg's telecom market?

Claude Strasser: Luxembourg is one of the main financial centers in Europe which results in a very high demand from the B2B community, i.e. banks, financial institutions, insurances, law firms etc. In addition the industry and technology sectors developed rapidly over the past years, thus increasing the demand for a full range of high quality ICT services and state-of-the-art products. This makes Luxembourg a very challenging and highly dynamic telecom market.

How important is the telecom business for POST?

Claude Strasser: The telecom business is by far the largest business for POST. It accounts for three quarters of our turnover and roughly two thirds of our employment.

What business challenges are you facing in the telecom market?

Claude Strasser: As the biggest operator in Luxembourg, POST is facing an increasing demand for high quality products and services from a highly diversified customer base. This is why we've taken the strategic decision to go for full fixed-mobile convergence products. For the fixed network we are deploying fiber on a national scale, and we are currently in the process of connecting every single household and every single company. On the mobile technology side, we are offering 4G plus, and we will offer the future-generation 5G to our customers in the very near future.

What's your strategy of going forward?

Claude Strasser: One element of the strategy is the full convergence of fixed and mobile for the B2C customer base, as mentioned before. On the B2B side we will broaden our product range for ICT services on top of the classical connectivity and the classic mobile and fixed telecom products. Another very important area is the M2M business, which is now broadening to IoT. This is clearly an important path of growth in the future.

Digital transformation is a priority for telecom operators. What role does IT play in POST's digital transformation?

Pierre Zimmer: IT is playing a crucial role in the digital transformation. Indeed the IT department is the central link between the different business lines of POST, which gives IT the global picture of the company's operational processes as well as the customers' needs. We are deploying every effort to deliver state-of-the-art products and services to a highly automated customer base, this with a steadily reduced time-to-market. IT has also a key role to play in order to identify synergies between the different business lines and propose technical solutions to enhance existing processes, thus boosting operational

Pierre Zimmer, CSO of POST Luxembourg

efficiency and reducing cost.

What have been your IT-related initiatives?

Pierre Zimmer: As we are striving to continuously increase our customer experience, we have launched the Möbius project with the objective to transform the legacy systems onto a unified platform to improve time-to-market, maximize process automation and provide 360 degree view portal services in real-time for both fixed and mobile services.

How can the Möbius project support POST's digital transformation efforts? What are your major concerns?

Pierre Zimmer: Möbius is a fundamental transformation project which involves IT specialists as well as business experts from the front- and back-end side. The new platform we are putting in place allows

a more agile and dynamic way of working which will improve our efficiency and enables us to deliver high quality services and products to our customers.

With the implementation of Möbius, the current operational landscape will completely change, which represents a challenge for POST's employees, as they will work in a complete new environment. **Claude Strasser:** The new platform will also enable customers to have an easier access to our products through highly flexible interfaces.

How do you ensure that user experience is unaffected during the migration process?

Pierre Zimmer: We have a product called My POST enabling customers to use our products and services via mobile devices or computers. The aim is to seamlessly move from the old system to the new environment. The new interface with the customers will offer more flexibility and in a second phase it will enable us to offer new products and services in a more efficient and faster way.

What are the services you are going to offer based on the new system?

Claude Strasser: First of all, there is the convergence of our products which we don't have today. We currently do not have one integrated system. For instance, we still have separate invoices for fixed and mobile offers, which will be merged into one single invoice. A major improvement for customers will be the advantage to have online access to nearly 100% of our products and services. Another milestone will be considerably reduced time-to-market for our product and service offerings. Every small change to a product or a service means a huge configuration change in the background. We believe that ZTE's ZSmart 8 BSS suite will enable POST Luxembourg to provide an improved customer experience for consumers and business customers with dramatically improved

service and product catalogue rollout times.

What are some of the challenges you need to tackle in your new role as CSO?

Pierre Zimmer: The first priority is to translate POST's strategy into a clear action plan with benchmarks and milestones. In order to achieve our short, medium and long term goals, we have taken the strategic approach to set up dedicated project teams of IT and business experts, acting in an agile mode in order to develop innovative products and services with a reduced time to market. One example of such a dedicated task force is the Möbius project, which will completely change POST's operating landscape as well as the interaction with our customers.

Another challenge we have to tackle results from the regulations in Luxembourg. Being a very mature market with highly automated professional players, the regulators have decided to set a stringent legal framework, what implies some constraints for market players, but also creates new business opportunities which POST is well positioned to take up.

How do you evaluate the cooperation with ZTE?

Claude Strasser: The cooperation between POST and ZTE has proven to be fruitful and efficient. In the beginning teams had to overcome some hurdles such as culture and language differences. The fact that employees from ZTE moved to Luxembourg and worked together with their colleagues from POST improved the communication and helped people to better understand each other's way of working. The cooperation between our two organizations has evolved to our entire satisfaction and we are very happy with ZTE's responsiveness to our business needs.

What do you think of the significance of the agreement signed ? What are your expectations for a future

cooperation?

Claude Strasser: The signing of the partnership agreement demonstrates the commitment of ZTE to support POST Luxembourg in its strategic IT digitalization project. There are important milestones to be met in 2018. We are confident that by joining forces the Möbius project will be a success, and that the collaboration between our two companies could be further broadened in the future.

What's your vision for POST's future?

Claude Strasser: POST's strategic vision is very clear. Being the incumbent operator in Luxembourg offering products and services to over a million customers, POST Luxembourg needs to consolidate its scattered IT platforms to provide non-differentiated services to its customer base, support centralized operations for both fixed and mobile networks and ultimately improve the customer experience through proactive customer care and innovative digital service offerings. Delivering high quality services and products with faster roll-out times, while reducing costs significantly, will be key to defend our market share. A fierce competition and the relatively small size of Luxembourg are the main challenges. For the past 25 years, we've proven that we have been able to defend our position in the market, and we are deploying every effort to stay competitive and successfully position ourselves in the digital era.

In an interview

At a signing ceremony between POST Luxembourg and ZTE

Could you tell us more about the size challenge?

Claude Strasser: Luxembourg being a relatively small country means that you have a limited customer base. Today, POST is the biggest operator in Luxembourg, and delivering value added services and high quality products to our customers differentiates us from our competitors. This becomes even more important in the future in order to stay competitive.

Any plan for expanding your market?

Claude Strasser: Growth for us is definitely not limited to the Luxembourg market. We are looking at M2M and IoT. Penetrating international markets needs to be prepared carefully, both in terms of business opportunities and financial investments.

POST has a long history. How do you balance tradition and modernity?

Claude Strasser: Founded in 1842, POST Luxembourg is the country's largest provider of postal and telecommunications services and also offers financial and philatelic services. POST's strategy is

to maintain our three historic business lines, which implies that we have to continuously enhance our service and product catalogues. Having the biggest market share in Luxembourg, POST continuously strives to satisfy the customers' demands for first-class service and state-of-the-art products.

POST Luxembourg owns its fixed and mobile infrastructure, and together with POST Telecom, offers secure, superfast broadband connectivity solutions, as well as voice and data management services to private individuals as well as professionals. POST Luxembourg also offers telecom and ICT services internationally and is a leading operator for M2M services in Europe.

For the telecom business POST has opted for ZTE as strategic partner to make the digital transformation a success. With regards to the traditional postal business, we are focusing more on the parcel business. We are collaborating with logistics providers and POST has signed partnership agreements with Chinese companies which use Luxembourg as a hub for parcels delivered to Europe. We focus on digital transformation which is the key success factor for all of our three business lines. We are looking forward to the challenges ahead. **ZTE TECHNOLOGIES**

Smartfren:
Going 4G LTE Only

Reporter: Xiong Limin

Christian Daigneault, CTO of Smartfren

I ndonesia is witnessing a rapid increase in mobile internet usage as the number of smartphone users are growing strongly. This is a huge challenge for Smartfren Telecom, which used to be a CDMA-centric operator in Indonesia. However, it forges ahead with an LTE-only strategy with a focus on network reliability and experience. This is one of our main differentiators in the market, said Christian Daigneault, CTO of Smartfren, in an interview with *ZTE Technologies* that took place in November 2017. Being the first operator to deploy 4G LTE-A and VoLTE, offering the widest coverage across Indonesia and completing the first Pre5G trial in Southeast Asia, Smartfren continues to lead the 4G market and has successfully carved a niche for itself in it.

Could you describe the mobile landscape in Indonesia and your ambitions for it?

Recently, the mobile market in Indonesia has been developing very quickly. The internet penetration has risen quickly in the last few years. It used to be all voice service with 2G, and only five years ago the networks evolved to 3G; the traditional mobile voice market is developing to data, later with 4G. Today all five mobile operators in Indonesia have deployed 4G LTE. So it is a very competitive market with five strong competitors.

Our ambition is in the next few years to become a strong No. 2 in the market. We have a relatively small market share at this point because we came from a CDMA background. At the time we launched LTE two years ago, our frequency band was not available for many devices, and the ecosystem was quite small for TDD at 2300 MHz. This has changed and now a large ecosystem supports our frequency band and VoLTE and we're seeing our growth going much faster. Continuing on this trend, we think in the next few years we can become a strong No. 2.

From your extensive telecom experience,

what philosophy do you bring to Smartfren?

The philosophy is to build a very strong network that provides the best customer experience. I am not just talking about offering the maximum speeds, which is more a marketing gimmick, but real broadband experience. We're really focusing on minimizing video buffering, having a very short latency, a very fast download, and having very strong service stability. This is the focus of the whole team—to improve customer experience and network stability.

What is your overall network strategy? How do you plan to differentiate yourself?

Firstly, the strategy for the last two years has been to deploy an LTE-only network. We are the only operator in Indonesia with an all LTE network which guarantees a consistent data experience. This is one of our main differentiators in the market. We plan to turn off completely CDMA network by the end of 2017, and refarm that spectrum to LTE.

Secondly, we were first to introduce voice over LTE (VoLTE) two years ago. Our VoLTE now is at a mature stage, which is better than 2G and 3G. So we can also be differentiated by better voice quality.

Thirdly, our customers are guaranteed to have 4G coverage nationwide in Indonesia, which means that even on the highways, in most remote areas, in tier 2 and tier 3 cities we have 4G LTE whereas in many of those areas the competitor only has 2G—a good voice network but no data.

How did you manage the migration from CDMA to LTE?

Since more than a year we have been offering our customers good incentives to move to LTE. We offered our Andromax smartphones and MiFi devices at good price, to motivate users to move to LTE. We are gradually turning off CDMA in the market where most of the customers have already migrated, and we intend to complete the migration by the end of 2017. As

Smarfren and ZTE complete a Pre5G Massive MIMO trial

soon as we shut down the CDMA network, we refarm that spectrum for LTE. And since our CDMA uses low-frequency 850 MHz band, this brings extremely good coverage for LTE. We will use the refarmed spectrum to increase the capacity and throughput of LTE. Wherever we turned off CDMA and refarmed to LTE, the customer experience has improved significantly. (Note: Smartfren's CDMA to LTE migration has already been completed.)

Smarfren launched 4G LTE-A service in Indonesia with ZTE. What do you think of ZTE as a partner?

ZTE has been a very good partner for the last 11 years for Smartfren. Earlier it was our exclusive partner to build the CDMA network nationwide in Indonesia. Three years ago we upgraded our network to LTE with the help of ZTE. So ZTE continues to be our long-term partner. I would say this is a very successful collaboration.

Smarfren and ZTE completed a Pre5G trial. What's your take on 5G? What's your next move?

The Pre5G trial with Massive MIMO antenna in the 2300 MHz TDD band was done early in 2017. Now we're planning to introduce this technology

especially to improve in-building coverage in the large cities. This technology is good for 3D propagation, ideal to radiate inside a highrise building to improve the indoor coverage without having to spend too much for an expensive distributed antenna system. We're working with ZTE to deploy several Massive MIMO sites in the large cities like Jakarta. This is a step toward 5G whereas for Indonesia, 5G is going to be some years away since the spectrum has not been allocated yet. We're building the network in such a way that it will be ready for 5G when the spectrum and regulations allow.

What trends do you expect in the global telecom market?

Globally, the trend is towards more internet usage and the need for extreme reliability since customers become more and more dependent on mobile connectivity for all their needs. As the new normal, the data demand will increase exponentially but the capacity for customers to pay for their increased consumption is very limited, Therefore, the presure to lower cost per GB is stronger than ever. Operator needs to look for new architecture such as Cloud Core and RAN, to commoditize the hardware and implement software functionalities as required. This is a huge transformation for telecom operators since it requires re-training and recruiting new type of engineers, similar to the change to IP a few years back. This is perhaps not a good news for large telco vendors, since the technology will be simplified to the point of having a multitude of new vendors. This will in turn raise competition in the market and help reduce cost; all players in the industry need to adapt to this new trend to meet future cost challenges. **ZTE TECHNOLOGIES**

Tibor Leleszi, Mayor of Kisvárda (Hungary)

Making Life More Comfortable For Citizens

Interview on Smart Cities with Tibor Leleszi, Mayor of Kisvárda

Reporter: Meng Jingjing

From September 19 to 21 in 2017, Smart City InFocus took place in Yinchuan, China's leading smart city. The event run by TM Forum in collaboration with Yinchuan and ZTE brought together over 800 C-level executives and government officials. On the second day of the event, *ZTE Technologies* interviewed Tibor Leleszi, Mayor of Kisvárda (Hungary). He shared with us his smart city aspirations.

What is the current status of smart cities in Hungary?

I come from Kisvárda, a small city in Hungary. There are ongoing studies on the subject of smart cities in Hungary. The first steps are evaluation and planning. I came here to learn more about the development of smart city solutions.

How do you feel the technological scene is currently developing in Hungary?

Regarding the technological scene I can say that the central government's initiatives brought a breath of fresh air. I mean that the Broadband Internet program as part of the European Digital Agenda 2020 has set its targets until 2020, but the Hungarian Government made a very ambitious plan to reach that goal by the end of 2018. Based on the infrastructure, every home in Hungary can have a 30 Mbps internet access. There is a "Digital Welfare" program of the Government to support under-developed areas with low-price internet subscriptions thus giving an equal chance to all people of access to the knowledge that is offered by the proper web-content. There are also programs in their initial phase for e-health and e-education, but we have still plenty of tasks to do.

Why is it important to deploy a smart city in Kisvárda?

As Mayor of Kisvárda, it is the leading concept in my election campaign—to make Kisvárda more citizen-friendly. My first priority is to make the life of the citizens of Kisvárda more comfortable, more enjoyable in order to keep young and talented people in our city and to avoid their migration to Budapest or to other bigger cities.

Do you have a smart city strategy or plan in place?

Yesterday we saw a very complex solution to deal with almost all requirements of a city. In Kisvárda, we have already studied some segments, like e-health. But after seeing yesterday's studies, I realized that we have to develop our solutions for more extensive needs and take a look at the questions in a bigger context.

A group photo of representatives from Kisvárda and ZTE

Can you paint us a big picture of your smart city? What are the important elements ?

In order to reach the aforementioned important goal, I see tasks in several

An interview

Thailand Gearing up for 5G
Interviews from ZTE 5G Summit 2017

Reporter: Sopitha Pisutthisakulchai

areas. Our city is attracting 7000 students who are travelling every day to our city mainly by bus, causing traffic jams, frustration because of time loss and pollution. We have to develop a smart solution to eliminate this problem.

A well organized traffic is also a cost-factor for our industries. The largest poultry meat processing company of Hungary is working in our city. It is our elementary interest to serve all their needs to eliminate all barriers in front of their success.

A very important field is to take care of our senior citizens. We have already implemented one initiative. We have distributed health-check watches to several hundred seniors. They have learnt the usage of the watch with the help of volunteering students and now the watches can generate alarms if the important health-indicators reach a certain critical level. With the solutions we have learnt from ZTE, we plan to develop this system towards both prevention and pro-activity.

Another important field is tourism. Kisvárda has beautiful surroundings and now we are planning to construct a spa, a kayak-canoe facility for amateurs and professional athletes. Around these facilities I see plenty of possibilities, ideas that have to be evaluated together with local entrepreneurs in order to construct a complete eco-system for sustainable and profitable development.

What challenges do you foresee in the transition to a smart city?

The most critical task is to introduce change into the minds of the people because people sometimes have difficulty in adapting to changes. Yesterday's presentation was useful in this context. It gave examples of how this difficulty can be overcome. If people feel that the changes serve the interests of the people, they will be more open to changes.

What comments would you make on ZTE's smart city solutions?

We can learn from the company, which is very professional and open to transferring knowledge and technologies to us. **ZTE TECHNOLOGIES**

Thailand is prepared to usher in the new telecommunications era of 5G as the country moves to Thailand 4.0, a new economic model based on new technology and innovation. During the ZTE 5G Summit held in Thailand in November 2017, representatives from the mobile operator True, the regulatory body NBTC and the telecom vendor ZTE talked about the challenges and opportunities arising with the 5G era. As a 5G pioneer, ZTE organized this summit to promote cooperation across the 5G industry chain and boost Thailand's 5G development.

Adisak Prasongsup, COO of TrueMove H

What do you think is ZTE's role in future 5G development?

Adisak Prasongsup: For ZTE there are currently 3G, 4G and even 4.5G network rollout which True thinks is pretty up-to-date technology. In terms of 4.5G Massive MIMO project, this is the opportunity for ZTE to continue the 5G service. We hope that 5G technology from ZTE will solve the network problems and keep up to date with service usage. 5G will need more investment in terms of R&D for building a strong network. ZTE technology should be able to support the network capability in the future in both the IoT, which has to be developed continuously, and the smart city and smart home, which are the main interests of the market at the moment. 5G technology will be needed even more in the future when all smart devices become widely used.

What's True's plan for 5G development in the coming few years?

Adisak Prasongsup: For True, we definitely have a plan to support 5G. Now we are prepared with our 4.5G network. We also have networks covering up to 90% of the country. Therefore, True is ready to install 5G services in all the targeted areas which include metropolitan areas or all other big cities. In the coming future, all the operators will have to be ready to provide 5G services.

Dr Jesada Sivaraks, Secretary to NBTC Commissioner, Thailand

Could you review the developments of the mobile telecommunications market in Thailand?

Jesada Sivaraks: In Thailand, after we had set up the NBTC, we opened the first bidding in 2012. The market started to become more competitive and developed continuously. The big operators in Thailand have also upgraded their networks to 3G. Following this, there are biddings for 900 MHz, 1800 MHz and other developments. Right now we have 4G. For the next-generation technology which is 5G, we plan to set up and open new frequencies to increase competition in the market. We hope to see all operators strengthen their competitiveness.

How does the NBTC plan to accelerate the 5G development in Thailand?

Jesada Sivaraks: For Thailand, the NBTC has a technology-neutral policy. We support all new technology by releasing suitable frequency. For 5G development, we plan to increase the amount of

spectrum available for 5G so that industry players can have sufficient frequencies to take our country to the 5G era.

How would you like ZTE to contribute to Thailand's mobile market?

Jesada Sivaraks: In the 5G ecosystem, there is no buyer-seller relationship like that in 4G. In the future, operators and vendors need to cooperate further in order to develop the market capacity because there is going to be a series of new services and new industry players. There might not only be the mobile service provider and mobile service user, but the mobile service provider of 5G, other services providers and the service users in this new ecosystem.

An Wei from ZTE CTO group

How to develop Thailand into a leader of 5G technology in Asia-Pacific?

An Wei: 5G is the whole ecosystem which includes devices, spectrum, raido network, core network, transmission network and applications. If operators want to develop 5G, the first thing is to get the 5G spectrum. As a technology and network supplier, we provide 5G terminals, radio networks, transmission networks and core networks and we also support certain 5G applications. We also need to be open-minded and be ready to have close cooperation with all the verticals. We are ready to support Thailand as a leader in 5G technology in Asia-Pacific as part of Digital Thailand or Thailand 4.0.

An interview

What is the obstacle to open the 5G technology market in Thailand or other countries?

An Wei: The first one is to get the 5G spectrum. After you get the spectrum, we need to consider the two factors: 5G service demand and the return on investment. As the technology supplier, we must make sure that the terminals are ready, including not only the smartphones but also the IoT terminals; and the network is ready, including radio, transmission and core networks. The most critical parts are transmission ready for 5G and site acquisition as both of them take longer time. Optical fiber must be ready because there are lots of small cells in 5G network which need a lot of optical transmission.

Yu Xiaolei, CTO of ZTE Thailand

Do we have any cooperation with any operators in Thailand?

Yu Xiaolei: For 3G and 4G, we have partnered with AIS and True. Currently, we are testing 5G technology Massive MIMO together with AIS and we are going to launch it with AIS. We also have the plan to conduct a 5G trial in 2018 in Thailand.

Which frequency is the most suitable for 5G?

An Wei: For 5G, there is middle band and high band. In middle band, there are two most popular spectrums. One is 3.5 GHz band used in Asia (including China) and Europe and the other is 4.7 GHz used in Japan and some other countries. For high band, there are two most popular ones: 28 GHz in US, Japan and Korea and 26 GHz in Asia (including China) and Europe.

Which frequency do we use with AIS?

Yu Xiaolei: Now we are testing 5G Massive MIMO in 1.8 GHz with AIS.

Thailand is going to have the bidding auction for 1.8 GHz in 2018. Do you think, if we use 1.8 GHz for 5G, is there going to be dropping or inefficiency in using this frequency?

An Wei: 5G will firstly focus on enhanced mobile broadband that requires wide bandwidth, like 100 MHz. This can only be available in the middle band and high band. By middle band, I'm talking about 3.5 GHz and 4.7 GHz and high band refers to 28 GHz or 26 GHz. 100 MHz bandwidth is not available in 1.8 GHz band for operators. 5G will start from the middle band and high band in the early 5G deployment stage. We will see frequency refarming, which includes 700 MHz, 900 MHz, and 1800 MHz in the later 5G deployment stage. **ZTE TECHNOLOGIES**

Jointly Embracing a Better Connected Future with 5G

Reporter: **Liu Xinyang**

5 G will be a revolutionary era in the history of telecommunications, where an internet of everything (IoE) involving man-to-man, man-to-machine, and machine-to-machine connections will be established. 5G will fully get into the society and change the life of everyone. "The best way to predict future is to create it. ZTE has been committed to creating a brighter 5G future with industrial partners through innovation, openness, cooperation and win-win," says Zhang Jianguo, Senior Vice President of ZTE, speaking to *ZTE Technologies* about the company's business philosophy. He also shares his views on 5G standardization and building the 5G ecosystem.

As the MWC 2018 draws near, what will ZTE showcase in the wireless sector of ZTE booth?

Zhang Jianguo: Focusing on the theme—Leading 5G Innovations, ZTE will highlight its three leadership advantages at the MWC 2018: commercialization leadership, performance leadership, and cost leadership.

The highlights of ZTE booth can be summarized as "One Live Broadcast", "Two Interactions", and "Three Innovative Products". "One Live Broadcast" refers to a live broadcast of the world's first inter-vendor IoDT test

based on the latest 3GPP 5G NR standards. "Two Interactions" are the world's largest 5G field test and interaction and the world's first real-time orchestrated 5G end-to-end network slicing demonstration and interaction. "Three Innovative Products" include 4G/5G dual-mode RRUs supporting convergent 4G and 5G networks, high and low-frequency commercial base stations based on the latest 3GPP 5G NR standards, and unified CN products based on the cloud platform supporting fully convergent 2G, 3G, 4G and 5G networks.

The competition in the 5G arena is getting increasingly fierce. What's the core competitiveness of ZTE?

Zhang Jianguo: I think the core competitiveness is our unique innovation gene and determination for future development. With technology accumulation and sustained high investment in the 3G and 4G eras, we have accurately identified at the early stage key 5G technologies represented by Massive MIMO. These technologies can be commercially available on 4G networks in advance to significantly improve the performance of existing networks and help

Zhang Jianguo, Senior Vice President of ZTE

operators remove their pain points. Today Massive MIMO has been commercially deployed on a large scale in the global market including China, Japan, Europe and Asia Pacific. Also, we have made further innovations. We took the lead in the industry to release FDD Massive MIMO, and cooperated with Telenet Belgium to complete the first FDD Massive MIMO field test in Europe, setting a record for LTE single-cell throughput at a bandwidth of 20 Mbps. MUSA is another key 5G technology proposed by ZTE. By eliminating scheduling operations and selecting resources randomly, MUSA achieves an overload rate of up to 600 percent. This solves the mass commercial application problem of future massive IoT connections.

So we can say innovation is our only choice to tackle all the problems. In the future, we will still adhere to innovation in three aspects. First, develop more advanced NR technologies to support leaping enhancements in 5G technical indicators; second, provide a more flexible architecture to support future new functionalities and services while being adaptive to the existing transmission, site resources, 4G to 5G evolution and their convergence; third, introduce end-to-end network slicing based on virtual infrastructure to enable real-time, flexible, and on-demand allocation of network resources.

We have established a 5G R&D team of over 4,500 specialists and have invested 3 billion RMB

in 5G R&D each year, accounting for 15% of our total R&D staff and 25% of our total investment in R&D respectively. This is to ensure our leading position in time-to-market (TTM) and performance of 5G products and maintain our cost advantage.

What has ZTE accomplished towards the commercial deployment of 5G?

Zhang Jianguo: ZTE made continued effort in commercializing 5G in 2017. We have established partnerships with more than 20 high-end operators worldwide and has completed over 10 pre-commercial 5G tests and trials.

Together with Wind Tre, Italy's largest mobile operator, and Open Fiber, Italy's wired operator, ZTE won the bid for building the first pre-commercial 5G network in Europe. This indicates that ZTE has been recognized by European mainstream operators. ZTE also signed a cooperation agreement with Orange France on testing standalone architecture of a 5G multi-site trial network located in Europe. Jointly with Telefonica, ZTE completed phase-1 5G transport test including CU/DU split architecture, NG core, and 5G Flexhaul solution. Both partners will continue to perform phase-2 transport test and further verification for 5G end-to-end solutions. In November 2017, Japan's SoftBank started 5G field tests with ZTE immediately after obtaining the license for a 5G test at the 4.5 GHz band. In China's Guangzhou University Town, ZTE and China Mobile conducted the 5G field test for continuous coverage involving multiple base stations, which almost met the requirements of commercial 5G networks. Moreover, ZTE ran 5G trials in Shenzhen and Suzhou in cooperation with China Unicom and China Telecom respectively.

By the end of 2017, ZTE had established partnerships on 5G with global top operators such as China Mobile, Japan's SoftBank, Telefonica, Wind Tre, Orange France, T-Mobile, Telenet,

VEON, Telekom Malaysia, Korea Telecom, China Unicom, and China Telecom. ZTE focuses on deploying commercial 5G networks in major countries and for mainstream multinational operators, aiming to provide products and services for the world's first 5G commercial deployments. We have also been promoting and exchanging ideas about 5G with renowned Vodafone, Telstra, and SingTel to extend our partnerships with more partners.

The success of 5G depends on the maturity of the whole industry chain. What does ZTE think of that?

Zhang Jianguo: Industry collaboration is of great importance in driving 5G commercialization. This is also ZTE's mission. Not long ago, ZTE collaborated with China Mobile to complete the world's first end-to-end 5G NR IoDT test based on 3GPP R15 standards. In this test, ZTE's 5G pre-commercial base stations and Qualcomm's 5G terminal prototypes were used. ZTE also collaborated with Intel to launch the world's first SDN/NFV-based 5G RAN solution. ZTE's advanced SDN/NFV virtualization technologies combined with the latest Intel architecture processors will significantly drive the commercial use of 5G.

Furthermore, ZTE actively participated in China's 5G tests led and planned by the government and successfully completed the phase-1 and phase-2 tests. The results were far beyond KPIs defined by ITU, setting many new records in the industry. ZTE is in a leading position in the industrial development of 5G.

What role does ZTE play in the standardization of 5G?

Zhang Jianguo: ZTE has always been a major participant and contributor in the formulation

of 5G standards. We are the first in the industry to promote unified global 5G standards while opposing 5G standards fragmentation. We have submitted more than 3500 proposals on 3GPP 5G NR and gained three editor seats for essential 5G standards including 3GPP RAN2, RAN3 and RAN4. ZTE 5G expert, Ms. Gao Yin, has been elected as Vice Chairman of 3GPP RAN3. With its intensive research and innovation advantages in MUSA, ZTE initiated and played a leading role in NOMA, a key technology focusing on the physical layer aspects of 5G NR, and led the research on the NOMA project as the first speaker. It is commonly agreed in the industry that ZTE lagged behind rivals in 2G, caught up with them in 3G, and stood at par with them in 4G, but by now ZTE as a representative of China Power has gradually taken the lead in 5G.

More vertical industries will be involved in 5G. How do you see the impact of the industrial ecosystem on commercial 5G deployment?

Zhang Jianguo: In the 5G era, there will be more cross-industry collaborations to drive in-depth 5G integration with vertical industries and to endow great power to 5G. ZTE will no longer be a pure equipment vendor, but still be committed to promoting 5G industrial applications and building the ecosystem. We have joined the Apollo alliance and collaborated with Baidu, China Mobile, and Beijing University of Posts and Telecommunications to verify the key technologies of autonomous driving. We have also become a member of the 5G Automotive Association (5GAA), and have jointly promoted the development of 5G autonomous driving with 40 other members. Moreover, ZTE has built up 5G research centers in cooperation with many universities in China. All these are explorations and efforts we have made in building the entire 5G ecosystem. **ZTE TECHNOLOGIES**

Pre5G:
Enabling the 5G Era

By Ding Guanghe

As Pre5G technologies and services evolve continually, their performance and applications are increasingly marked by 5G-like features. Meanwhile, the 5G standards have gradually matured, and the time for 5G commercialization is drawing near. What "sparks" will be created when Pre5G meets 5G? There are certain expectations or curiosities in the industry. Can Pre5G co-exist with 5G? Will Pre5G evolve to 5G? Is it better to first deploy Pre5G than wait for 5G? In October 2017, ZTE launched its Pre5G upgrade solution following its innovation philosophy of "enjoying the present, co-building the future". The solution points out a direction for the industry.

Ding Guanghe
Director of Wireless Solution, ZTE

Enjoying the Present, Co-Building the Future

At present, although the time for 5G commercial use is approaching, the mass commercialization of 5G must rely on a mature industry chain including business models and terminals. From the terminal aspect, based on industry experience in 4G commercial use , it is predicted that 5G terminals will be used on a large scale in two years or even later after 5G standards have matured. It is therefore believed that 5G deployment and application is an on-demand and step-by-step process that can give a full play to post-4G technologies. The performance of existing networks is being gradually increased during the 4G network evolution. ZTE's Pre5G not only covers the 4G network evolution but also uses key 5G technologies on 4G terminals in advance. Therefore, with 4G networks having 5G-like performance, people can enjoy 5G experience now, as proven by plenty of Pre5G networks currently deployed for commercial use.

In the future, or in at least the next decade, Pre5G will serve as a mainstream service-bearer network and co-exist with 5G for collaborative development. On the one hand, due to differential service development, 5G will be gradually deployed in high-end markets, while 4G evolution (or Pre5G) networks will still dominate the middle- and low-end markets. These multiple networks will co-exist for a long term. On the other hand, due to user habits, 4G subscribers will still dominate the market. That is, 4G and post-4G networks after the introduction of Pre5G will still play a principal service-bearing role, while 5G networks will largely bear the services of high-end and hotspot areas and new services like uRLLC. Under this circumstance, the 4G evolution and 5G deployment will advance abreast to collaboratively improve user experience with multiple networks. Moreover, with SDR features, Pre5G will evolve to 5G through software upgrade. This creates a more promising prospect for Pre5G.

Building 5G-like Networks, Enabling the 5G Era

The total Pre5G solution revolves around enabling the 5G-like eMBB, 5G-ready network architecture, and 5G-oriented service applications for comprehensive 5G network construction.

5G-Like eMBB

eMBB is the first and most important 5G service that can reach a peak cell rate of 10 Gbps. Pre5G has adopted various mobile broadband technologies and their portfolios, such as high-order MIMO, multi-carrier aggregation, ultra-dense networking, and high-order modulation, and these technologies continue to evolve. The Massive MIMO technology increases the spectrum efficiency by eight times. With function portfolios including multi-carrier aggregation, Pre5G can increase the cell peak throughput to the xGbps level, bringing 5G-like broadband service experience.

5G-Ready Architecture

Cloudification has become an irresistible trend in network development, and the industry players have totally accepted the concept that cloudification should precede 5G deployment. The Pre5G solution introduces a cloud-based network architecture that encompasses the core and access networks and continues to evolve. ZTE's Cloud ServCore, based on network function virtualization (NFV) and Cloud Native, is facilitating the smooth and quick introduction of 5G network functions. ZTE's Cloud RAN, based on the NFV and access cloud engine (ACE), is also moving toward a commercial stage.

5G-Oriented Applications

Based on the xGbps MBB and massive IoT, Pre5G can provides broad lines of 5G-oriented digital services and applications that include eMBB-based high data rate services (for example, ultra HD videos, VR, and online HD games) and massive IoT applications based on NB-IoT and eMTC (like smart city, intelligent parking, environmental surveillance, and wearables) , thereby enabling the seamless connection to the future 5G digital life.

As a world-leading wireless solution provider, ZTE, while implementing the Pre5G solution, has been advancing the global commercial use of 5G networks, such as xGbps networks, NB-IoT networks, and virtualized cloud-based networks. By the end of 2017, ZTE's Pre5G-related products and solutions had been deployed in over 110 networks of 60-plus countries including China, Japan, Austria, Belgium, Spain, Singapore, Malaysia, Thailand, and Indonesia. The worldwide application of Pre5G not only benefits 4G subscribers but also provides valuable reference for 5G commercial deployment in the future.

With years of commercial Pre5G practices and comprehensive 5G investments, ZTE has been providing 5G end-to-end network solutions and pre-commercial products covering wireless, core network, transport and network management, greatly signifying its role as a 5G pioneer in the industry. As a chief contributor in global standard research, ZTE has submitted more than 4,000 international proposals concerning 5G NR and led the research on the 3GPP NOMA standard. In China, ZTE took the initiatives to complete all the 5G phase 2 testing items in 2017, with the results in the eMBB, eMTC, and uRLLC scenarios hitting the ITU-defined KPIs and the industrial records in succession. Meanwhile, ZTE has been working with mainstream operators like China Mobile, Softbank, and Telefonica to carry out field and pre-commercial tests. **ZTE TECHNOLOGIES**

The Convergence of 4G and 5G

Drives Network Evolution

By Zhang Jiong

Zhang Jiong
FDD Product Solution Manager, ZTE

From the technical development perspective, 5G is an innovation and revolution based on 4G and also a natural evolution and extension of 4G. From the perspective of network deployment, initial 5G networks may not be deployed on a continuous and complete basis but need to converge and collaborate with existing 4G networks that are more extensively covered and well developed.

According to the GSMA's forecast, global 4G connections will grow rapidly for many years and even continue to surpass 5G connections for a period of time (Fig. 1). This growth trend matches the maturity of 4G and its industry chain, the potential of 4G evolution, the abundance of 4G terminals, and the unbalanced development of current networks worldwide. In this context, in order to maintain competitive advantages, it is imperative to converge 4G and 5G, and optimize the capital structure and network evolution path

based on existing 4G networks. All this raises a real and pressing need for the convergence of 4G and 5G.

The evolution of 4G networks needs to leverage the fruits of 5G development as many as possible. Applying a part of 5G technologies in 4G networks in advance allows ordinary users to enjoy better service experience. This doesn't mean to separate 5G completely from 4G to miss the opportunities for network evolution. ZTE's Massive MIMO is just a typical solution that applies 5G core technologies in advance to current 4G networks. Without modifying the
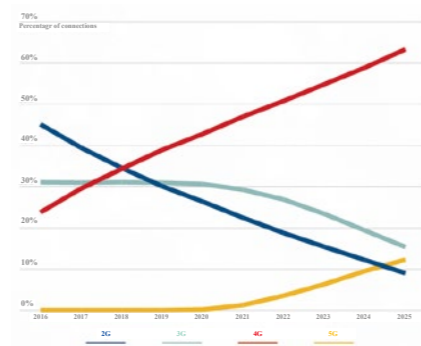

Fig. 1. GSMA's global mobile connections forecast.

core network or changing existing 4G terminals, the solution can significantly improve spectrum efficiency. Moreover, the deployment and upgrade of existing 4G networks needs to be prepared for 5G evolution. This ensures a smooth evolution while protecting the existing investment. ZTE's 4G series of products including RRUs, AAUs, and BBUs support the smooth evolution to 5G, and can be directly deployed in 4G networks to offer 4G services. Once 5G standards are frozen and operators begin to deploy 5G networks, these products can support 5G through software upgrade.

The convergence of 4G and 5G also needs to consider the network evolution. Accordingly, the convergence has to be done in stages.

At the first stage, by using the cutting-edge LTE-A, LTE-A Pro, and part of 5G technologies, 4G networks continue to evolve in terms of larger capacity, lower latency, more connections, and more flexible architecture. ZTE's Pre5G is a total solution that incorporates new and innovative technologies and solutions such as Massive MIMO, LAA, and NB-IoT/eMTC. The Pre5G solution has been deployed and commercialized in more than 110 networks of over 60 countries.

At the second stage, 4G and 5G networks will start to converge, after the first version of 5G standards will be released in 2018 and 5G networks will be gradually deployed by operators in some countries. Over a period of time, 4G and 5G networks will co-exist, and so will 4G and 5G terminals. The percentage of 4G terminals will be significantly higher than that of 5G terminals. In this case, a quality 4G/5G network will certainly require a superb solution to 4G/5G convergence.

From the RRU perspective, ZTE's Pre5G Massive MIMO is a perfect solution for seamless intra-frequency upgrade to 5G. The solution supports gradual frequency refarming to 5G on appropriate bands. However, in the 4G era, a non-Massive MIMO RRU also needs to support 5G at a minimal cost. ZTE's new-generation

ZXRAN R8894E   ZXRAN R8998E

ZXRAN V9200

RRU series is exactly the leading product solution that can support 5G only through software upgrade. For example, both ZXRAN R8894E and ZXRAN R8998E support 4G and 5G, and allow for easy evolution to 5G. They are the most cost-effective and flexible solution for deploying 5G-oriented networks at the present stage.

From the BBU perspective, a BBU needs to support both 4G and 5G, and has the capability of flexible configuration and collaboration. ZTE's new-generation BBU is a virtual BBU based on the IT platform. It supports both 4G and 5G, and implements dual connections in a converged 4G/5G network scenario. Its distinct advantages like small size, large capacity, and flexible deployment are important guarantees for the evolution from 4G to 5G. ZXRAN V9200, a leading BBU based on the IT platform, supports both 4G and 5G, and flexible configuration and networking modes. With ultra-high capacity, ZXRAN V9200 can meet the needs for deploying 4G, 5G, and converged 4G and 5G networks in multiple scenarios.

The convergence of 4G and 5G drives smooth backward network evolution, so the cost-effective smooth evolution solution with advanced technologies and superior performance are a preferred choice for operators. Drawing on its rapid and efficient deployment and delivery experience and the future evolution capability, ZTE has rolled out a complete industry-leading 4G/5G convergence solution that will certainly help operators gain an upper hand and have more success in the upcoming 5G era. **ZTE TECHNOLOGIES**

Feasibility Analysis
of 3.5 GHz NR SA Deployment

By Wang Xiaoming

A s the first release of 5G standards is approaching, leading operators worldwide are making preparations for their initial 5G launch. Since the 3.5 GHz band (3.3 GHz–3.8 GHz) will be a dominant mid-band choice for these early 5G deployments, its coverage capability will have a big influence on operators' 5G strategy. Some operators prefer the non-standalone (NSA) deployment mode as they believe that 3.5 GHz new radio (NR) is incapable to provide continuous coverage. To fully understand the coverage performance of 3.5 GHz NR, ZTE has worked hard with its partners in the research involving theoretical analysis and field trials. Based on the research results, ZTE is confident to announce that 3.5 GHz NR can provide similar coverage as FDD LTE 1.8 GHz, and can support either standalone (SA) or NSA deployment mode as required by operators.

Wang Xiaoming
Wireless Solution
Architect, ZTE

New Technologies in NR for Coverage Improvement

As the 3.5 GHz band suffers higher propagation loss than typical LTE low bands such as FDD 1.8 GHz and TDD 1.9 GHz, it is commonly believed that the 3.5 GHz NR may cover less areas than 4G bands. However, 5G NR is a totally new air interface that has introduced advanced technologies to compensate most of the additional loss. These technologies include:

- Enhancement in the terminal side: Mainstream 5G NR terminals will have two transmitter (Tx) antennas in the uplink (UL) with a total output power of 26 dBm, while typical 4G terminals have only one Tx antenna with an output power of 23 dBm. The higher output power and Tx precoding scheme will greatly enhance UL coverage.
- Massive MIMO: At the base station, 16 or 64 antennas will be deployed
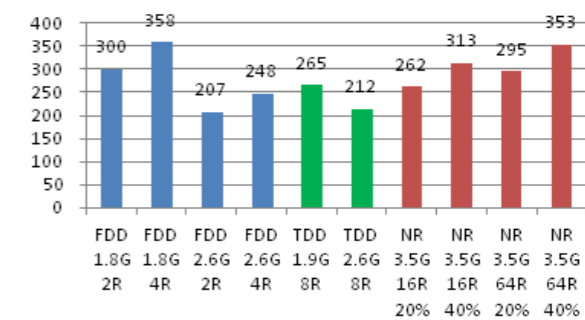
for 5G NR. Multiple antennas and its flexible beam forming capability can increase receiver sensitivity in the uplink and support MU-MIMO and high-dimensional anti-interference.

- Huge bandwidth: Typical 3.5 GHz carrier bandwidth approaches 100 MHz that is much larger than LTE 20 MHz. This bandwidth advantage can be easily transformed to coverage advantage via less inter-cell interference and longer uplink transmission duration.

Link Budget and Simulation

A detailed link budget calculation has been made for 3.5 GHz NR and typical 4G scenarios including FDD 1.8 GHz (2R/4R), FDD 2.6 GHz (2R/4R), TDD 1.9 GHz (8R) and TDD 2.3 GHz (8R). The 3.5 GHz NR considers four scenarios: 16 antennas with 20% UL ratio, 16 antennas with 40% UL ratio, 64 antennas with 20% UL ratio, and 64 antennas with 40% UL ratio. Other assumptions include 20 MHz bandwidth for 4G and 100 MHz for 5G NR. The antenna configuration at the terminal side is 1T2R for 4G (23 dBm Tx power) and 2T4R for 5G NR (26 dBm Tx power). For TD-LTE, 20% UL ratio is adopted. The cell edge rate is set as 2 Mbps and 1 Mbps separately (Fig. 1A and B).

Fig. 1 shows whether at the edge rate of 2 or 1 Mbps, 3.5 GHz NR with 16 antennas (40% UL ratio) or 64 antennas (20% UL ratio) has similar cell radius as FDD 1.8 GHz (2R), and TDD 1.9 GHz (8R) is comparable with 3.5 GHz NR (16R with 20% UL ratio). The figure also shows that more antennas and larger UL ratio in NR can lead to better coverage

as more antennas give more dimensional freedom, and larger UL ratio means longer UL transmission duration. These comparisons are targeted to uplink budget because the coverage of both 4G LTE and 5G NR is uplink-limited. In the downlink (DL), 3.5 GHz NR can provide much better coverage than 4G LTE because bandwidth advantage in the DL can be easily transformed to data rate advantage.

A misunderstanding about NR coverage is that many people think NSA can improve NR coverage, but this is not true. In the NSA mode, terminals need to assign one Tx antenna for 4G and leave only one antenna for 5G NR UL transmission, while in the SA mode both two Tx antennas are allocated for 5G NR. Based on ZTE's calculation, NR cell radius in the NSA mode will shrink 30% compared with the SA mode. Moreover, this single antenna transmission in the uplink will convey less channel information to BS and lead to performance degrade of DL MU-MIMO.

ZTE has further researched the coverage performance of 3.5 GHz NR deployment based on operators' existing 4G networks. Assume an operator deploys 3.5 GHz NR by solely utilizing existing 4G sites, and ZTE runs some simulations to estimate its coverage performance. For example, a dense urban area contains 102 4G sites. If 3.5 GHz NR is deployed in all these 102 sites, the simulation shows that 97.7% of the area can achieve a DL data rate of over 100 Mbps, and 96.5% of the area a UL data rate of over 2 Mbps. If 12 new sites (almost 10% of existing sites) are added, the 2 Mbps UL coverage ratio can increase to 98.2%, and the 100 Mbps DL coverage ratio can reach 98.5%. The similar results are also shown in other cases.
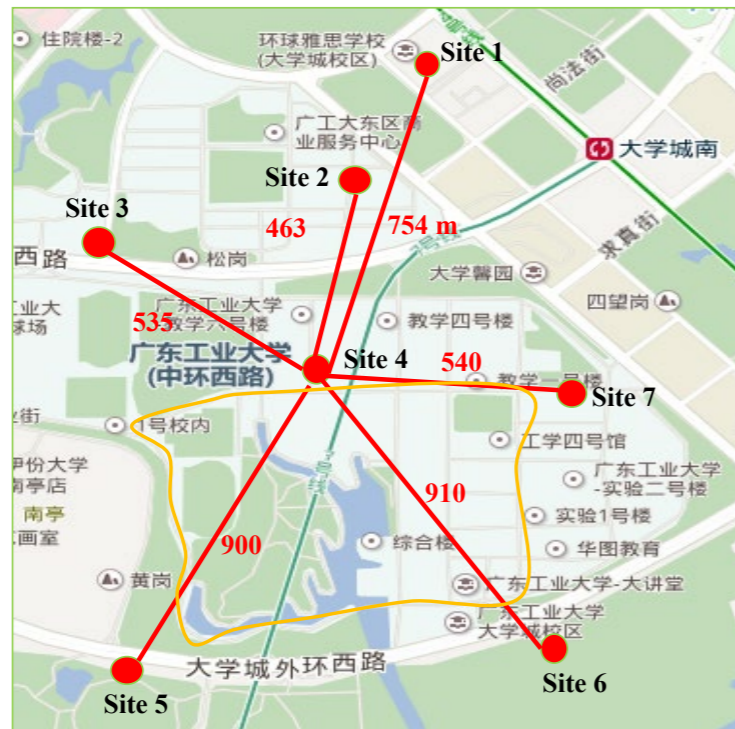

Fig. 1A. Comparison of UL coverage at the edge rate of 2 Mbps.

Fig. 1B. Comparison of UL coverage at the edge rate of 1 Mbps.

Fig. 2. Site distribution of 5G NR field trial in Guangzhou, China.

End-to-end 5G Network Slicing:
Key to Digital Transformation

By Huang Yan

Field Trial in Guangzhou China

To better learn the NR coverage performance in real environments, ZTE has partnered with China Mobile to conduct verification tests in a 5G NR field trial in Guangzhou China. This trial is one of the world's largest 5G NR field trials jointly set up by China Mobile and ZTE, operating at the 3.5 GHz band (Fig. 2).

Many tests items are designed to verify the 3.5 GHz NR coverage performance and its difference from 4G. One test item is to compare 4G and 5G UL throughput within the same cell coverage. 4G antenna and 5G NR AAU were mounted at the same pole, with the same Azimuth and tilt. The ratio of time slot allocation for 4G TDD was set as SA/SSP = 2/7 and that for 5G NR was set as DL 70%. One 4G terminal and one 5G NR test terminal were used for testing UL throughput in a full buffer mode. Both terminals were installed in the same trolley, using the same antenna type (external 5 dBi omni). The 4G terminal adopted 1T2R, while 5G NR were configured with 2T2R. The preliminary results from early tests showed that 5G NR provided much better UL throughput in almost all locations no matter in LOS or NLOS scenarios. More tests are currently made by both parties, and the results will be released soon.

Summary

Both link budget analysis and field trial have proven that 3.5 GHz 5G NR can provide comparable coverage as the current mainstream 4G bands. ZTE's simulation based on the existing 4G sites has also shown that operators do not need to invest a lot in additional sites for NR continuous coverage.

To meet operator needs for SA deployment, ZTE has placed the same priority on SA development as on NSA development, and has planned to support SA (option 2) at the second half of 2018. ZTE is conducting or has planned to conduct SA field trials with leading operators worldwide including China Mobile, Orange, and WindTre to better learn the cons and pros of various deployment modes.

ZTE believes that 3.5 GHz NR can provide continuous coverage and the SA deployment mode is technically feasible. For operators owning 3.5 GHz bands for NR, both SA and NSA are viable options. NSA option features quick time to market and less investment in initial launch, while SA mode features minimum impact on existing networks and straightforward evolution path. Operators can choose their own deployment options to best meet their 5G strategies. **ZTE TECHNOLOGIES**

5G brings challenges to existing networks in terms of technologies and business models. Due to the limitations of the legacy network capabilities, network requirements for various industries can only be solved by creating dedicated networks. With the legacy silo architecture, networks become more and more complicated and O&M increasingly difficult. High investments and low efficiency restrict the industry development and business opportunities.

The development and applications of virtualization, SDN and cloud computing make it possible for vertical applications to run in the isolated 5G network slices that are created on top of a common infrastructure. 5G network slicing will produce new business models, and promote the digital transformation of industry and society.

E2E Network Slicing to Support

Diverse 5G Scenarios

5G scenarios such as enhanced mobile broadband (eMBB), ultra-reliable low-latency communications (uRLLC) and massive machine type communication (mMTC) have different requirements in terms of bandwidth, mobility, security, latency, reliability and charging. Creating a dedicated network for each service will lead to high costs for network construction and increasingly complicated O&M. Network slicing will effectively solve these problems.

ZTE's E2E 5G network slicing technology (Fig. 1) enables operators to create multiple virtual networks over the same physical infrastructure. The virtual networks provide various telecom services and network capabilities to support diverse 5G scenarios. ZTE's network slicing technology has the following characteristics:
- Resource sharing to reduce costs and enhance efficiency: Multiple network
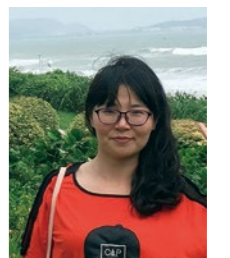
Huang Yan
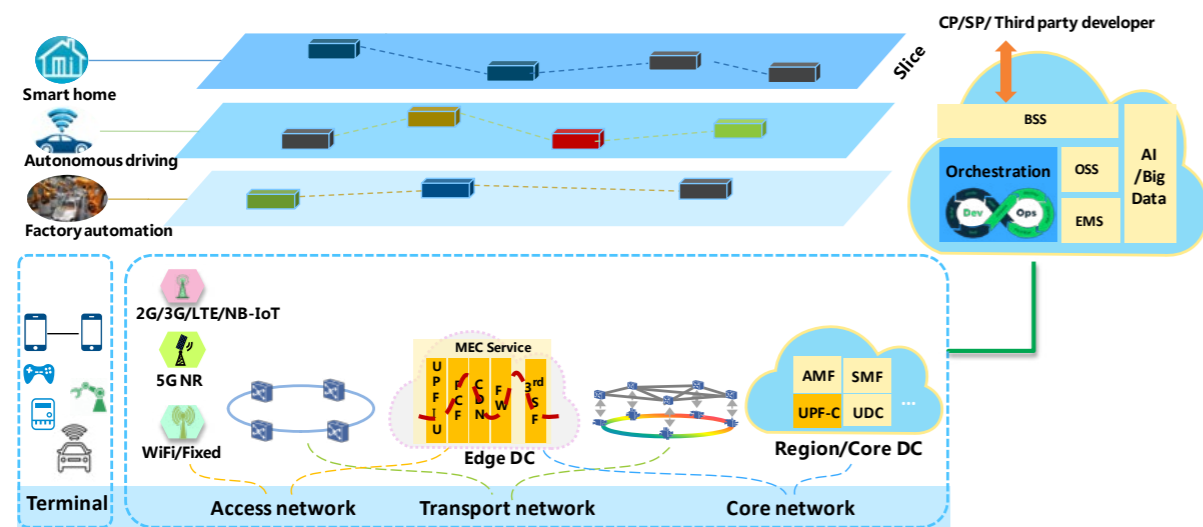Wireless Planning Engineer, ZTE

Fig. 1. E2E 5G network architecture.

slices running on a common network infrastructure greatly reduce construction cost, improve utilization of network resources, and shorten time-to-market.

- Logically isolated to ensure security and reliability: The network slices are isolated from each other and each slice is self-contained. The failure on one slice does not adversely affect the operation of other slices.
- Customizable and elastic: Network slicing is based on a cloud native, service-oriented architecture and enables customized network slices for different scenarios. With real-time monitoring of slice performance, network resources can be dynamically allocated to different slices, which helps fulfill SLAs.
- Implemented in an end-to-end manner to fully meet the diverse service requirements: A network slice instance covers multiple domains of the network (terminal, access network, transport network and core network).

E2E Network Slicing to Meet Differentiated Network Demands

While constructing end-to-end network slice, the network capabilities of each domain can be configured separately and adjusted on demand. As a result, the end-to-end bandwidth, QoS and security

can be fully guaranteed.

Access Network

Network slicing is achieved by implementing decoupling and network function reconstruction. MEC is utilized to improve user experience.

Decoupling not only refers to the separation of radio resource allocation from service requests (network parameters such as QoS, GBR, and ARP are used to achieve loose coupling between services and resources), but also refers to the separation of the hardware and software functions within an access network. After the decoupling, the BBU is reconstructed into two functional entities: the centralized unit (CU) and distributed unit (DU). The CU provides non real-time processing functions, while the DU provides real-time processing functions, which allows for real-time performance optimization, on-demand scheduling of the network resources and the slicing of access network.

MEC introduces the virtualized service platform to the wireless network, which effectively moves the service anchor towards the edge, shortens the service response time, and pushes computing capabilities to the edge nodes. By tapping into local content and real-time radio network information, it accelerates the delivery of contents, services and applications, thereby reducing

core network traffic and improving service environment and user experience.

Transport Network

Network slicing in transport network is enabled by the SDN-based IP/optical integration.

Resource allocation and security isolation in transport networks are critical to the end-to-end network slicing. With ZTE's end-to-end network slicing, SDN is used to provide connectivity among clouds, which helps achieve multi-tenant WAN and cross-site VM migration, automatic service adaption, and end-to-end orchestration using open APIs. In addition, SDN backbone networks can achieve synergy between the IP and optical layers, automatically adjust bandwidth and SLAs on-demand, optimize traffic scheduling by using the global view of the network, and reduce transmission cost.

Core Network

It is based on a service-oriented cloud native architecture to enable flexible and on-demand construction of slices.

ZTE's 5G core network is based on a cloud native microservice architecture that allows for network function re-configuration. It has three features. The first feature is application componentization. An application is divided into a set of microservice components with each microservice supporting a specific function. These components can be used as building blocks to create network slices on demand. The second one is a stateless and hierarchical design, which separates applications from data, and provides more elasticity and better fault tolerance. The third is lightweight virtualization. Containers are a form of lightweight virtualization that provides rapid scale in/out and high performance. Cloud native applications are deployed in containers to achieve better resource utilization and rapid delivery and agile maintenance of services.

Carrier-Grade DevOps for Network Slicing

As there will be a large number of different network slices in the 5G era, automation of network slice design, deployment and maintenance will directly affect the speed of service innovation and exploitation

of business opportunities.

ZTE's Carrier DevOps Builder is the world's first commercial carrier-grade DevOps environment, which provides end-to-end automatic slice O&M. It has the following characteristics:

- Wizard-based development: It supports a wizard-based graphical interface, components drag-and-drop, and rich slice templates to enable quick design of network slices and easily complete the self-definition from network function (NF) to network service (NS) to 5G network slices.
- E2E orchestration, minute-level launch: One-key deployment enables new services to be quickly applied to the network. The online intelligent inspection module guarantees the correctness before service on-boarding. E2E resource orchestration and coordination is supported vertically over the layers of application, network and physical resource, and horizontally over different domains (access, transport and core). Real-time monitoring for slice status, and automatic coordination can guarantee the service quality of network.
- AI-driven O&M: The network slicing orchestration system can perceive the resource status and makes decisions according to predefined policies, thus achieving true, zero-touch automation.

The complete DevOps O&M model makes it possible to achieve rapid service innovation and network intelligence.

Summary

Facing the complicated 5G scenarios, it is difficult for any information service provider to provide all the information services; therefore, an open and convergent industrial ecosystem is particularly important. Operators, vendors and vertical industries need to cooperate with each other to supply efficient and diversified network services to users. As one of the leaders in network cloudification, after launching the industry's first commercial cloud native Carrier DevOps Builder, ZTE keeps optimizing its application scenarios and verifying its commercialization capability. ZTE has cooperated with global leading operators, such as Wind Tre, Open Fiber, Orange and Telefonica, to build 5G pre-commercial networks and to test key 5G enabling technologies, pushing forward the digital transformation of society. **ZTE** TECHNOLOGIES

5G E2E Solutions

Tailored to Your Needs

By Duan Xiaowei

Fig. 1. ZTE's E2E 5G solution.

Duan Xiaowei

Wireless Solution
Architect, ZTE

As 5G standards and field tests develop rapidly, 5G has undoubtedly become the hottest topic in the mobile communication industry. Compared with 4G, 5G not only increases access rates but also enables mobile communication to be more closely connected to vertical industries and human production and life. 5G will lay a solid foundation for the coming of the IoT digital society.

In commercial 5G deployment, the completeness and maturity of 5G solutions that vendors offer will have a significant impact on the overall performance of 5G networks and long-term development of operators. Although operators do not always purchase an end-to-end (E2E) 5G system from a vendor, the capability of offering an E2E solution helps the vendor more deeply understand 5G network requirements and provide more competitive 5G solutions to meet operators' business needs.

5G E2E Solutions

ZTE, a pioneer in 5G innovation, is committed to providing the most competitive 5G end-to-end solutions for global mobile operators, based on its powerful R&D capability. The company strives to work closely with its strategic partners in the first wave of 5G commercialization, aiming to jointly promote the development of the 5G industry chain and accelerate the process of 5G commercialization.

ZTE is also one of the few equipment suppliers in the industry that can provide 5G E2E solutions covering 5G RAN, Flexhaul, Cloud ServCore, MANO, and Ecosystem (Fig. 1). The solutions have the capabilities of service-oriented E2E slicing, flexible function orchestration, and on-demand NE deployment.

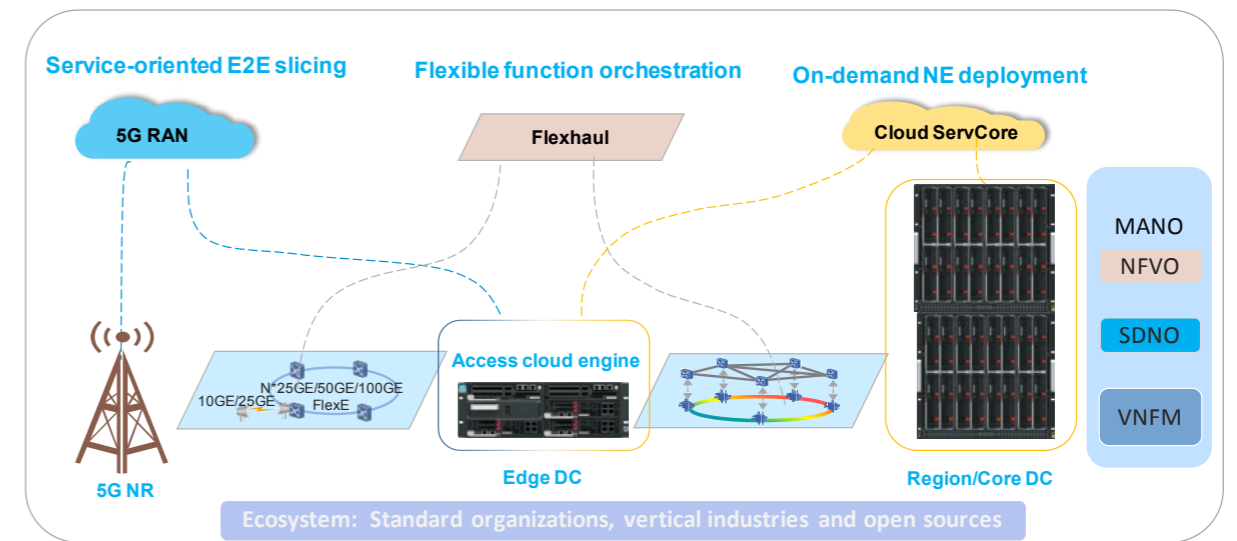In the 5G RAN part, ZTE has developed a series of 5G RF modules

covering 26 GHz and 28 GHz millimeter wave (MMW) and mainstream candidate 5G bands such as 3.5 GHz, 4.5 GHz, and below 1 GHz. The baseband platform based on virtualized architecture supports flexible deployment of 5G centralized units (CUs) and distributed units (DUs). Moreover, ZTE has led the research and commercial use of key 5G Massive MIMO technology.

In the 5G transport part, ZTE's Flexhaul solution not only handles hybrid access of front-haul, mid-haul, and back-haul flexibly but also meets the requirement of on-demand connections among data centers after network functions are virtualized. With the world-leading FlexE technology, the Flexhaul solution can provide the ultra-high-speed broadband access capability for eMBB services through flexible slicing and deliver ultra-low latency forwarding for delay-sensitive services.

In the 5G core network part, ZTE's Cloud ServCore solution based on cloud native and micro-service architecture can satisfy the needs of diverse vertical industrial applications through its flexible service orchestration capability, agile development and O&M flow, and on-demand deployment mode. At the SDN NFV World Congress 2017, ZTE won the "Best New Orchestration and Control" award with its Carrier DevOps Builder. The award fully showcases ZTE's innovation capability and leading position in the SDN/

NFV field.

In the MANO part, the global management and orchestration system schedules and manages 5G RAN, transport, and core network resources in a unified manner, to generate optimal end-to-end network slices for specific vertical industries or service. These network slices are dynamically adjusted and optimized as required by services.

In the Ecosystem part, ZTE is committed to collaborating with partners to build a 5G new ecosystem and is totally involved in the fields covering standard research and collaboration, open source collaboration, operator collaboration, and cooperation with vertical industry. This lays a solid foundation for 5G ecosystem construction, scale commercial deployment, and exploration in 5G business models.

Four Capabilities

5G E2E networks have four outstanding capabilities over 4G networks. The four capabilities are ultra-broadband access, massive IoT connectivity, ultra-reliable low latency, and E2E network slicing.

Ultra-Broadband Access

Ultra-broadband access is the earliest 5G

application scenario and also the focus of operators nowadays. With its rich experience in the wireless communication field, ZTE has achieved excellent performance in the national Phase-2 and 5G field tests conducted by China Mobile. The peak cell throughput in the eMBB scenario exceeds 19 Gbps, and the peak rate of a single user exceeds 2 Gbps using 200 MHz bandwidth at the 3.5 GHz band.

Massive IoT Connectivity

IoT is another important 5G application scenario besides eMBB, and also a major source of operator revenue in the future. The fast maturity and scale deployment of NB-IoT delays to some extent the operator requirements for 5G IoT access capabilities. However, with the rapid development of IoT applications, the number of IoT connected terminals in the 5G era will far exceed the access capability of NB-IoT. With the non-orthogonal multiple access (NOMA) technologies such as multi-user shared access (MUSA), 5G can increase the number of low-speed wide-area IoT connections to over 2 million per cell.

Ultra-Reliable Low Latency

Ultra-reliable low latency communication is the basis for mission critical applications including automatic drive, augmented reality (AR), virtual reality (VR), tactile internet, and industrial control. It is also one of the core capabilities that distinguish 5G from 4G. In China's national Phase-2 test, ZTE demonstrated the air interface capability with an ultra-low latency of 0.42 ms. Assisted by the Flexhaul ultra-low latency forwarding technology and mobile edge computing architecture, ZTE can provide the most competitive E2E ultra-low latency solution in the industry.

E2E Network Slicing

Network slicing enables operators to sell network services and capabilities by the slice as required. This helps operators introduce innovative services and improve their network value. ZTE's 5G network slicing supports end-to-end (covering wireless, transport and core network) on-demand orchestration and management, and also supports logical and secure isolation among network slices. To date, ZTE has successfully completed 5G network slicing verification tests with China Mobile, Telefonica, and China Telecom.

Benefits

ZTE has launched 5G E2E solutions that can satisfy the needs of the first 5G commercial operators worldwide. It has also made outstanding achievements in 5G key technologies, solution architecture, and product development. For instance, its Massive MIMO is the first to be commercially deployed in the industry, and ZTE has gained rich commercial experience. Its 3.5 GHz 5G NR RF modules are ahead of those made by western vendors in terms of commercialization and network performance. Its virtualized baseband platform can handle the largest 5G NR configuration in the industry and support the convergence of 4G and 5G. Its 5G transport prototype is the first to be launched in the industry, with a node forwarding latency of less than 1 us. Its Carrier DevOps Builder, the 5G core network based on cloud native and micro-service architecture won the "Best New Orchestration and Control" award in the SDN/NFV field.

Moreover, ZTE has actively worked with leading mobile operators such as China Mobile and Softbank to complete the pre-commercial verification of its 5G E2E solutions. ZTE has also established close cooperation with Orange, Telefonica, and Telstra to jointly validate the network performance of 5G E2E solutions and push forward the process of global 5G commercialization. **ZTE TECHNOLOGIES**

ZTE's 3-Pronged IoT Strategy:
## Chipset, Network and Cloud

By Yang Longzhi

D uring the past decade, people have been thinking about how to use technology to improve quality of life. Recently, Sidewalk Labs announced that it will develop Quayside in Toronto, Canada into the city of the future using cutting-edge digital technologies. In China, ZTE also actively participates in similar exploratory projects.

Current Status of IoT

Although the concept of the internet of things (IoT) was put forward decades ago, there have been no large-scale IoT deployments due to fragmentation of standards and a lack of strong use cases. However, with the technological developments which change the way we work and live, international standard bodies, such as ITU and 3GPP, are paying increasing attention to developing a globally unified IoT communication standard. Narrowband IoT (NB-IoT) is a low power wide area network (LPWAN) radio technology that enables a wide range of devices and services to be connected using cellular telecommunication bands. Standardization of NB-IoT began in 2015 and was completed in 2016. 2017 saw pre-commercial trials of NB-IoT in key areas worldwide. Therefore, NB-IoT is the standard that has been popularized most quickly in recent decades. The LTE-based eMTC technology also attracts great attention, especially in North America, due to its advantages in low power consumption, full-duplex operation, and VoLTE support.

Moreover, facing the technically demanding environments and complicated application scenarios in the future, the global telecommunication industry is committed to developing the 5G standard to enable ultra-reliable low latency communications (uRLLC) that requires very low latency and very high
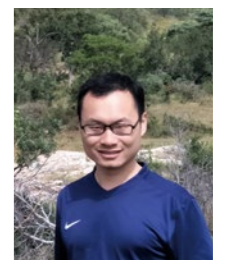
Yang Longzhi
Secretary-General of
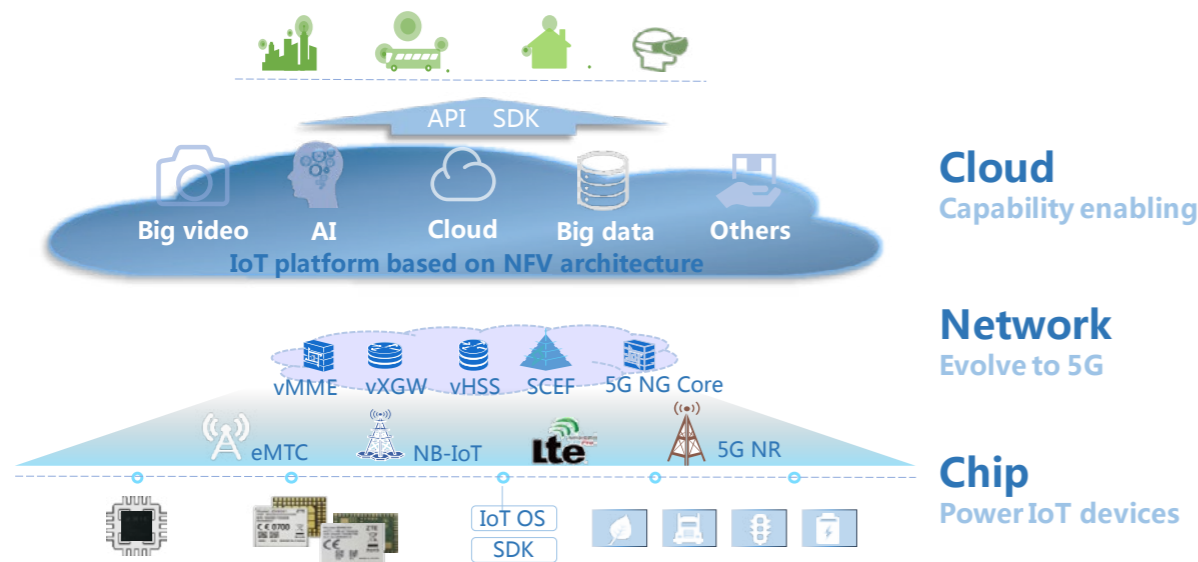ZTE's IoT Technical
Expert Committee

Fig. 1. ZTE's end-to-end IoT infrastructure solution.

reliability, massive machine type communications (mMTC) that requires high connection density, and enhanced mobile broadband (eMBB) that requires large bandwidths to implement IoT services and traditional telecommunication services. It is obvious that NB-IoT/eMTC-based low-speed IoT and 5G-based high-speed IoT are the necessary steps to enable the internet of everything. The 5G mMTC technology is very likely to evolve from the current NB-IoT/eMTC technology.

ZTE's Strategy

As a global telecommunication equipment provider, ZTE is committed to providing its customers with end-to-end IoT solutions covering chips, radio networks,

RoseFinch7100 launch conference

cloud platforms, and related technologies and services. ZTE has a three-pronged IoT strategy of chipset, network and cloud (Fig. 1). For the typical four-tier architecture of IoT, ZTE has heavily invested in the research on the three layers (sensor, network and platform) below the application layer.

With respect to chipsets, in September 27 2017, ZTE launched RoseFinch7100, which is the first self-developed NB-IoT chip in China. RoseFinch7100 features the chip-level security with the trusted execution environment (TEE). For the future, ZTE has carried out research on 5G terminal chips (Wisefone series) to meet ultra-high rate and ultra-low latency requirements in the complicated IoT application scenarios. ZTE has also launched two NB-IoT modules (ZM8300 and ZM8301) to ensure the development of the LPWA IoT industry, and developed the new-generation IoT OS&SDK to reduce the difficulty in application development.

With respect to networks, ZTE is capable of providing operators with the most economical and complete IoT network deployment solutions. For NB-IoT and eMTC, ZTE can rapidly implement low-speed IoT services based on operators' existing LTE networks through software upgrades, saving both time and investment cost. In addition, ZTE has made adequate preparations for 5G IoT. It can use short TTI and CU/DU separation to reduce end-to-end latency

MTN's NB-IoT pilot project

in networks, the innovative MUSA technology to support a huge number of connections, and SDMA to drastically increase the transmission capacity. Meanwhile, with years of R&D in virtualized core networks, ZTE can support various services ranging from NB-IoT/eMTC to 5G IoT with an NFV-based core network, which ensures a smooth generational shift of IoT technology.

Cloud refers to the cloudified platform. Based on the research on cloudified platforms during the past few years, ZTE has started the R&D on the new generation IoT platform in early 2017. The new-generation platform comprises of device management platform (DMP), connectivity management platform (CMP), and operation and maintenance portal (OMP) with application enablement platform (AEP) sitting at the core of it. With the PaaS virtualized architecture, the new-generation IoT platform allows for the implementation of various capabilities as microservices. The microservices, which are scalable, can be accessed by service applications and developers via APIs. Thus, a universal platform can be applied to

various professional fields. Meanwhile, by utilizing the CMP platform, ZTE can also fully optimize the interconnection with the core network and provide carrier-class connectivity for IoT terminals.

ZTE has been actively promoting the development of IoT. Since 2008 when ZTE provided the M2M platform for China Mobile, ZTE has already accumulated 10 years of experience in the IoT field. Good news came frequently in the past two years. In 2016, ZTE became the first in the industry to demonstrate the verification based on NB-IoT in China Mobile's 5G innovation laboratory. In May 2017, ZTE worked with MTN in South Africa to complete the NB-IoT end-to-end function verification. In October 2017, ZTE in partnership with Telenet offered a live demo of its smart parking service. For the future 5G IoT applications, ZTE has completed key indicator tests in eMBB, mMTC, and uRLLC scenarios, highlighting its powerful technical strength.

Summary

It is no doubt that the IoT will become a critical technology and have a great impact on our daily lives. In the next five years, the IoT market will have tens of billions of connections and generate trillions of dollars in revenue. IoT is poised to transform almost every major market sector. With the arrival of the IoT era, ZTE will follow the "chipset, network, and cloud" strategy to build a brilliant future. **ZTE TECHNOLOGIES**

ZTE PRE5G HELPS JAPAN'S SOFTBANK BUILD A SMART GYM

By Xiong Manqing

Xiong Manqing
Brand Manager, Wireless at ZTE

J apan's SoftBank Hawks sealed a 4-3 victory over its opponent and won the championship at the main venue Yahuoku! Dome during the 2017 Japan Series. When preparing for the match, SoftBank worked with ZTE to deploy Pre5G Massive MIMO 2.0 (antenna 64T64R) after replacing some previous macro sites at the Fukuoka Yahuoku! Dome. Faced with high traffic, the MIMO 2.0 solution guaranteed proper communication for the whole championship and served as a comprehensive solution to the coverage, capacity, and user experience problems, helping SoftBank build a smart and high-performance gym network.

As the home field of SoftBank's Hawks, the Fukuoka Yahuoku! Dome can hold nearly 40,000 people. Held on a magnificent scale, the championship attracted a large audience, with the attendance rate reaching nearly 100%. It also formed a network guarantee scenario with the densest communication and most concentrated services in Fukuoka recently. The high-density traffic raised serious challenges for the capacity of the existing network.

ZTE, which strove to guarantee proper communications services for the championship, carefully deployed onsite communications equipment, applied customized solutions such as simulation, onsite surveys, and optimization of core parameters (Massive MIMO antenna beamforming), and deployed Pre5G Massive MIMO 2.0 products to help SoftBank build a smart and high-performance gym.

According to relevant statistics, during the championship, the Pre5G Massive MIMO 2.0 (antenna 64T64R) accounted for 80% of the total traffic volume in SoftBank's network. Statistics show that after the Pre5G Massive MIMO 2.0 products were deployed, the downlink aggregate traffic increased by 451.5%, the uplink aggregate traffic rose by 759.5%, and the average user uplink rate went up by 42.88%. The excellent overall performance of the Massive MIMO 2.0 network at the Yahuoku! Dome demonstrated its superb performance in high traffic scenarios.

In Tokyo, Japan, ZTE and Japan's SoftBank Group officially signed a memorandum of understanding on joint research and development of Pre5G in July 2015. In September 2016, SoftBank announced that the "5G Project", a project based on the next-generation high-speed communications standard 5G, was kicked off. SoftBank was the first operator to put the Massive MIMO technology into commercial use, with ZTE being its major supplier.

In 2014, ZTE first proposed the Pre5G concept and a series of solutions to apply key 5G technologies to 4G networks in advance and to fully enable 4G networks to evolve towards 5G networks. Compared with 4G, Pre5G enhances the system capacity by eight times, the average user bandwidth by five times, and the number of connections per unit area by 100 times. Pre5G involves not only the application of some key 5G technologies that can be put into commercial use (for example, Massive MIMO) in 4G networks but also the enhancement of LTE-A Pro technologies under the 3GPP architecture, such as Massive CA, UDN, 256QAM, LAA, LWA, and NB-IoT. Pre5G implements a smooth evolution based on the existing 4G networks, effectively lowers network construction costs, and supports rapid deployment, dramatically increasing the cost-performance ratio. In terms of the Giga + MBB, Massive IoT, and network cloudization, a combination of different technologies can be used to help operators fully upgrade from 4G to 5G network capacity.

ZTE's Pre5G has been highly recognized in the industry. To date, its Pre5G-related products and solutions have been deployed for more than 110 networks in over 60 countries, including China, Japan, Austria, Singapore, Spain, Malaysia, Thailand, and Indonesia. **ZTE TECHNOLOGIES**

ZTE PRE5G BREAKS INTO HIGH-END MARKETS

By Qiu Peng

Qiu Peng
TDD Product Manager, ZTE

As the world has ushered in the mobile internet era, existing networks are faced with the conflict between capacity demand surges and insufficient site resources. In this context, ZTE makes innovative use of Massive MIMO technology to enhance wireless spectrum efficiency and boost network capacity. In a commercial network, the average single-carrier peak rate of Pre5G Massive MIMO exceeds 700 Mbps, increasing spectral efficiency by six to eight times as compared wtih that of existing 4G networks. Pre5G Massive MIMO uses beamforming technology to expand from 2D to 3D coverage, and implements intensive and extensive seamless coverage. The technology is flexible and can adapt to high-rise buildings, hotspot macro coverage, stadium coverage, and last-mile scenarios, dramatically improving overall network quality.

Win-Win Cooperation with Hutchison Drei Austria

After ZTE exclusively reconstructed all mobile networks including 2G, 3G, 4G and core networks for Hutchison Drei Austria (hereafter referred to as Drei), Drei ranked first in Austria and second among 10 operators in the German-speaking regions in the third-party test organized by "CONNECT", a famous communication magazine

in Europe. The sharp increase in the number of subscribers causes explosive growth of data traffic. How to use existing spectrum resources to reduce network load and increase user satisfaction has become a major problem Drei has to face. To solve this problem, Drei has chosen ZTE's Pre5G Massive MIMO solution that helps to resolve firstly the conflict between capacity demand surges and insufficient site resources before 5G commercialization. The solution uses existing sites, spectrum resources, and terminals to deliver network speeds and capacity far superior to 4G networks. Compared with traditional base stations, Pre5G Massive MIMO products are smaller, support the BBU+AAU architecture, and are more suitable for 5G evolution. They also support carrier aggregation (CA) to satisfy operator needs for large capacity, multistream transport, and enhancements in network efficiency, flexibility, and cost. Pre5G Massive MIMO helps Drei improve user experience in high-capacity and heavy loaded areas and relieve its Opex pressure caused by high loads of existing network equipment.

3D-MIMO: Eye-Catching Technique in the Industry

The commercial implementation of Pre5G is a consequence not only of the close collaboration between ZTE and global mainstream operators and their verification tests but also of ZTE's huge R&D investment and strong R&D capabilities. 3D-MIMO plays an important role in Pre5G commercialization.

3D-MIMO has inherent advantages in TD-LTE 4G networks. Based on uplink and downlink symmetry, it supports measurement of hundreds of channels without adding feedback channels. As a core technology for 4G evolution and 5G, 3D-MIMO provides more precise beamforming and more effective spatial multiplexing to greatly reduce inter-cell interference, enhance anti-interference capability, and improve network

A technical exchange meeting

performance. Therefore, 3D-MIMO is an important means of improving network capacity for 4G operators with wide coverage.

ZTE started field tests on its 3D-MIMO base stations as early as September 2014. By virtue of its R&D capabilities and leading technologies in the 3D-MIMO field, ZTE won several awards in a year, such as the 2015 GTI Award for Innovative Massive MIMO Solution, the GTB Award for Wireless Network Infrastructure Innovation, and the 2015 Global Technology Innovation Award in 5G Networks by Frost & Sullivan.

Promoting Industrial Partnerships for the Future

As the 5G era approaches, ZTE will go all out with industry partners to bring 5G into reality in standards, spectrum, technology, architecture, practice, and ecology fields. In March 2017, ZTE, China Mobile and Qualcomm announced that they planned to jointly carry out the world's first low-frequency 5G interoperability data testing (IoDT) in line with 3GPP R15 specifications. In November 2017, the three parties jointly announced they had successfully achieved the world's first end-to-end 5G NR IoDT system demonstrating a data connection based on 3GPP R15 standard. The successful interoperable connection of the end-to-end 5G NR IoDT system serves as a significant industry milestone towards pre-commercialization of 5G NR technologies at scale, driving rapid development of 3GPP standards-compliant networks and devices.

From the perspective of service applications, ZTE has collaborated with Baidu, China Mobile, and Beijing University of Posts and Telecommunications to verify the key technologies of automatic driving, and has became a member of the Apollo alliance, 5G Automotive Association, and other intelligent/automatic driving industry alliances.

From the perspective of standards research, ZTE has worked jointly with many research institutes and universities worldwide to promote 5G development. They have completed core IPR preparation and validation in many aspects, including the MUSA, high-frequency channel model, and Massive MIMO technology.

The best way to predict the future is to create it. ZTE is willing to embrace the great 5G era with innovation, practice, collaboration, and win-win philosophy. **ZTE TECHNOLOGIES**

Leading 5G Innovations