

ZTE TECHNOLOGIES

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VIP Voices

A Holistic Approach to Digital Transformation

Tech Forum

The Road to 4G/5G
Convergent Evolution

Special Topic: Pre5G

Pre5G: Building the Bridge to 5G

Nik Willetts, Deputy CEO at TM Forum

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A technical magazine that keeps up with the latest industry trends, communicates leading technologies and solutions, and shares stories of our customer success

ZTE First-Quarter Profit Jumps **27.8%** as Carrier Networks and Smartphone Sales Rise

17 April 2017, Shenzhen, China — ZTE posted a 27.8% rise in first-quarter profit as the company increased sales of carrier network solutions and smartphones.

Net profit attributable to holders of ordinary shares of the listed company jumped to RMB 1.21 billion in the first three months, according to ZTE's quarterly results announcement today. First-quarter revenue increased 17.8% to RMB 25.75 billion.

Innovation is powering the growth in ZTE's business as the company's research and development in the first three months accounted for almost 13% of quarterly revenue.

ZTE is strengthening its position as a global leader in 5G research, as the company deepens its collaboration with the world's largest carriers with the new proprietary FDD-LTE based Massive MIMO solution. ZTE's innovative Pre5G products are now deployed in more than 40 networks in 30 countries. ZTE is on track to begin 5G pre-commercial deployments in the third-quarter of 2018, with full commercial deployment starting in 2019. ZTE's network virtualization solutions are deployed in more than 180 networks globally, and the company this year unveiled the world's first Carrier DevOps platform.

For wireline products, ZTE led the industry in innovations for 5G-ready bearer network products that integrate IP and optical transport technologies, introducing the 5G Flexhaul solution in February. The company is sustaining its momentum as one of the global industry leaders in PON products and fixed access products, and gained 70% market share in a recent annual tender by China Mobile for data center servers.

In the first quarter, ZTE posted more than 25% growth in shipments of set-top-boxes as the company's big video business continues to strengthen. ZTE is also gaining market share in rich communications

suite and cloud-computing solutions, as the company leverages innovations in network cloudification and artificial intelligence.

In Internet of Things (IoT), ZTE is leading the market in the development of narrowband-IoT (NB-IoT) services, and was the first vendor to release a pre-commercial NB-IoT based smart-parking system, helped by proprietary innovations in networks, chipsets and devices. ZTE's self-developed chipsets posted 70% year-on-year growth in shipments in the first quarter.

ZTE, maker of the AXON and Blade lines of smartphones, in February introduced an upgraded version of AXON 7, the company's first device to support Google Daydream, to deliver compelling virtual reality experiences to consumers. At the Consumer Electronics Show in Las Vegas in January, ZTE unveiled the Blade V8, a new smartphone that allows users to take Bokeh photos and supports 3D photography.

In the government and corporate business, ZTE is consolidating its position as one of the global leaders in Smart City technologies, with new projects in major Chinese cities, as well as in western European markets including Germany and France.

Looking forward, ZTE will proactively pursue new growth opportunities, with the company continuing to strengthen its ongoing commitment to R&D and rigorous operation management. ZTE will also deepen its collaboration with partners and customers to build healthy and sustainable industry ecosystems and mutually beneficial relationships.





ZTE Wins 2016 Transport Network SDN Interoperability Standardization Best Practice Award

26 April 2017, Shenzhen, China — ZTE announced that it has won the 2016 Transport Network SDN Interoperability Standardization Best Practice Award at the 2017 China SDN/NFV Conference, for its elastic network intelligent controller (ZENIC) software defined optical network (SDON) solution. The award won at the conference, hosted by the China SDN/NFV Industry Alliance together with the China Institute of Communications, is in recognition of ZTE's efforts and achievements in transport SDN northbound interface interoperability tests.

In 2016, the China SDN/NFV Industry Alliance initiated the transport SDN northbound interface interoperability test. ZTE participated in and completed the tests in over two months, complying with all indexes defined in "OTN-based software defined transport network (SDTN) northbound interface specifications V1.0" by China SDN/NFV Industry Alliance. All interfaces between the controllers from different operators and vendors conform to telephony application programming interface (T-API) specifications. Being a key technology in multi-domain interconnection, northbound interface uses mature T-API to reduce complexity, as well as implement interface interoperability and extension, so as to advance the development of transport SDN.

ZTE Uganda Launches NOC for Better Service Delivery

18 April 2017, Shenzhen, China — ZTE has announced the launch of ZTE Uganda's network operations centre (NOC), in order to deliver superior network operations and maintenance services. Uganda's Minister of ICT, Mr. Hon. Frank Tumwebaze, MTN Uganda's CEO, Mr. Wim Vanhelleputte, MTN Uganda's CTO, Mr. Gordian Kyomukama, and other senior personnel attended the official opening of the NOC. The CTIO of MTN Group, Mr. Babak Fouladi visited the NOC soon afterwards.

ZTE is currently working with MTN Uganda to provide its network with a full scope of managed services for its equipment

from various telecommunication equipment providers. The total number of network elements will be increased from over 4000 to over 5000 by the year 2019.

This NOC is the most advanced in Uganda, and will serve the entire MTN Uganda network. The establishment and opening of the NOC will ensure MTN's leading performance in the local market, improve network quality, simplify network management and fortify a solid foundation of deepening and widening business exchange between China and Uganda, thus creating a new means of cooperation that is in pace with modern times.

ZTE Among 3GPP 5G Air Interface Standard Editors

19 April 2017, Shenzhen, China — ZTE announced that Mr. Sergio Parolari and Mr. Yang Li from ZTE have become editors for 5G new radio (5G NR) air interface protocols at the 3GPP RAN WGs in Spokane. At this meeting, which marked a step further into 3GPP 5G NR standardization, Mr. Sergio Parolari was named an editor for TS 37.340 E-UTRA and NR multi-connectivity, and Mr. Yang Li as an editor for TS 38.414 NG-RAN NG

data transport, which demonstrated the strength and contribution of ZTE in 5G standards.




A Holistic Approach to Digital Transformation

Reporter: Liu Yang

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JUN 2017

ZTE



Digital transformation is becoming a hot topic today for a wide range of industries. TM Forum is the global industry association for digital business. In a recent interview with *ZTE Technologies*, Nik Willetts, Deputy CEO at TM Forum, talked about key factors for a successful transformation and trends in digital services and business models. He emphasized that digital transformation needs a holistic approach. It is not only about technologies but also about business models.

Nik Willetts, Deputy CEO at TM Forum

What is the most important mission of TM Forum now? Has it evolved over time?

Our mission has evolved. We have been in the business for 28 years. At that time, we always focused on driving collaboration in the industry. But our mission today is to help the telecommunications industry transform itself as quickly as possible. We think there's been a radical digital business transformation. What that means is to transform every aspect of the digital business that exists today. We think about the operators' operations, culture, talents, the way that the operators innovate, the underlying technology and how that all needs to evolve. Just evolving any one of those is not enough to see the growth opportunities of the digital world. So our mission is to help companies transform to see those opportunities existing in the digital business.

How do you drive collaboration within the organization?

We have proven methods of driving collaboration. That starts with identifying the problems we are going to solve. We do that by working very closely with leading operators to understand their challenges and problems. We take those into sprints where we work with collaborative teams made up of companies like ZTE, trying to solve those problems. We have a very successful program called Catalyst Program, which is a rapid proof-of-concept program. That program takes those ideas, and says not just how we understand the problems better but in three months how we stand up a real working proof-of-concept. We run 15 such projects a year with hundreds of companies involved. So we've got a very effective, efficient methodology.

What have been TM Forum's latest achievements?

One of the biggest achievements in the last few months is the success of our Open API program. This program is designed to set out an industry

agree on open API for digital service management. We launched that about a year ago. We now have 33 open APIs, which are now being used by many of the world's largest operators. We have a broad range of vendors supporting that program as well. The goal of that activity is to provide a standard suit of APIs that the whole industry can use. This will ease the speed of building initial services, reduce the cost of creating those new services and make operators play a bigger role in the digital ecosystem. The other big success for us in the last few months is the focus on digital transformation. We are approaching an industry agree on digital maturity model, which will launch this year. Of course, our Catalyst Program, one of our most successful programs, doubled in size last year. It's growing very aggressively this year and that's the rapid proof-of-concept program that allows us to very quickly take things from problems to solutions.

What is the current status of operator digital transformation?

If we compare the pace which the telecom industry is transforming with the speed of internet companies like Google, Alibaba or Amazon, telecom operators are not transforming quickly enough. At the same time, there is a huge range of opportunities in the Internet of Things and in new types of business models. But they need to go through a transformation of their business, not their technology.

The industry is not able to grow as it should be and is not able to take its right role in the broad digital ecosystem because the business is unable to innovate quickly enough or get the agility they need to deliver the services quickly. That is the problem for the operators. It's also been the problem for the supply chain—unable to move at the pace of digital.

What kind of company is in a better position to transform itself?

All companies are in a position where they can transform. But you need a number of the right ingredients. You need a very strong leadership. You need a management team that can execute on that transformation. You need to recognize that

transformation requires changing of the culture, bringing new talents, re-training people and changing the way the company actually thinks and operates. It is like moving away from a culture where failure is not acceptable to an understanding that failing fast can give you a learning that you can then take to a better outcome. Those kinds of culture changes are very big changes.

You can look across many industries and see companies who are taking brave moves in that transformation. Microsoft takes the brave decision to switch software licensing. It is painful financially in the short term but is the right bet for the long term. Nike, the shoe company, takes a big bet on the digital and is building the digital services. GE has embraced an outcome-based approach to sell products and services. This is a big change for a massive engineering company. None of these transformations have been easy. It's not a case that telcos will find it simple. We believe that the industry needs to come together now to work together to see some opportunities and to understand that they need to transform themselves.

What are the key factors to a successful digital transformation?

You've got to think about the transformation holistically and all the different layers involved.

At the top is the strategic layer. You look at how you innovate—moving from the innovation being something you do in total privacy to something you do in a more open sense. You understand that you are switching from a strategic approach, which used to be 3-5 year or even longer strategic plan horizon to an adaptive strategy where you are constantly changing.

The next layer down is the customer-centric culture, including understanding the customers, listening to the customers, looking how you create digital channels to engage with customers differently and allowing the customers to self-serve.

Then we can think about operations, the way that the company operates and builds new services and how it orchestrates its people. It is one of the most crucial pieces that need to be changed because we are going from a telecom operator that traditionally delivered small services to a lot of people to the one that delivers much more dynamic and flexible services that need to be adjusted for



different customers.

The fourth area would be the people—the culture and talents of the organization. This is one of the most challenging questions. The technology transformation we can follow through with logic but people are not always logical and you have to think about how you transform the culture of the business. It is very difficult to do.

Underpinning all of that is the technology layer. We are looking at the transformation of the technology, different approaches to building and looking after the technology, maybe leasing it rather than buying it.

These are the five areas key to a successful digital transformation. What drives all that is having the leadership and buying at the top level to go through the transformation and understanding that it's not going to be easy and it takes time but we have to get on with that journey now as an industry.



Nik Willetts, Deputy CEO at TM Forum and Jane Chen, SVP of ZTE. Jane Chen is a board member of TM Forum.

Could you share with us some recent success cases?

Yes. We published many case studies recently. We can look at Telefonica's transformation of its BSS platform in South America, where it used TM Forum's framework standards, and a big transformation of KPN in Europe. KPN's transformation is a really impressive transformation across many aspects of the digital business. How they transformed? Within that, we can see they are using a lot of strategies from the forum. We can look at companies like Orange and Vodafone who are using open APIs very successfully to transform their business and also leveraging the catalyst program to drive better outcomes. We have many success case studies with operators all around the world. What matters to us is that we can see the way that is exhilarating their business and the way

they innovate and help them achieve tangible results.

How important is network transformation to the operator digital transformation? How to unlock the potential of technologies like NFV/SDN?

I think the network remains the lifeblood of the telecom operators. It's the enabling platform for them to enable a digital world. It's something with which they can make a lot of new services and products. I think the transformation of the network to a more elastic network is crucial. It's what the digital world needs to thrive. A lot of enterprise-grade digital services like automotive, health and industrial applications need a very different quality of service around the network and they expect the network to adjust flexibly. So the elastic network is very important.

But the only way you can make money out of that is if you also transform your business model and transform your ability to innovate and create new services and products. For example, you might look at charging for an outcome rather than just a service. So if you deliver a movie on somebody's mobile handset, rather than charging for the bandwidth used, you charge a fixed fee for having a good quality experience on the handset. So much might be held true for the health application, where somebody may be receiving their health care in their home. You need a very good quality of service, like security, privacy and a lot of other capabilities, and you might charge on the basis of that service for the right outcome rather than just use per megabyte, which is done in the industry traditionally.

Therefore, rethinking the business models, rethinking how you innovate and working atop network is just as important as technology transformation.

What business models are you focusing on now?

The biggest trend is what we call platform-based business models. This is a quite well-documented trend at this point. If we look at some big internet giants like Alibaba, Amazon and Facebook, they've all created a platform-based business model. They create an environment where customers come for content or service of some kind, and other people deliver that service. Alibaba is the world's biggest retailer but it doesn't own any stock

TIPS:

Since ZTE joined TM Forum in 2001, it has adhered to the standards and specifications of TM Forum with its product attaining the certifications of TMF Framework 10.0 and Framework 12.0, becoming the first BSS/OSS product to acquire these international certifications. Due to its continued efforts, ZTE has been awarded the TM Forum Open Digital Award in 2014 and the TM Forum President's Award in 2015.

of their own. They purely provide a platform for others yet they are profiting from that. If we think of that in the telco context, the telcos try to control all that. They want to be the retailer, who bought the goods and did everything. So the platform-based business model says, "By growing a bigger platform ecosystem, I'll have a bigger role and make more money." The platform-based business model is the major trend shifting today in response to the changing economics.

What can we expect to see in digital transformation in the next few years?

We'll see a big exhilarating transformation in the industry. There would be a big focus on the role of operations software layer. We'll see more and more operators realizing they are shifting from being a telco to a software business (IT and software at the heart of what they are doing) and recognizing that's more than just about the network technologies but also about the management and OSS/BSS platform. In parallel with that, we'll also see a lot of

creativity from the industry. This industry is incredibly creative. It has a rich history of technological innovation. That's going to switch more to business innovation. I think we'll see a few companies who will lead the pack on that and others will follow.

What are the promising digital services to watch for operators?

There's a whole range. There's a lot of focus right now on the B2C market and on things like virtual reality (VR) and augmented reality (AR). There are a lot of other services that can be attached to that, and we see service providers having a lot of success where they are integrating content services. They are either procuring content or working with companies like Netflix to deliver content. In the B2C space, there is some growth that is just about securing the existing customers and locking them in for longer. There is a range of opportunities around improving customer experience, which can also be monetized. That's all relatively insignificant growth.

The bigger growth we see is in

the enterprise space on applications like Internet of Things and things like specialized solutions for certain industries. We look at industrial manufacturing, health care or energy provision. Those industries all need a large amount of technologies and network expertise but also scaling of management technologies and operational capabilities to succeed with those. As an industry, there is a lot of work to do. But there is trillions of dollars potential for operators to seize.

What is the future direction of TM Forum?

Our direction is all around industrial collaboration. We believe that growth in the future requires a greater level of true collaboration and partnership, not just the traditional value chain where you have a supplier but a true partnership where you are creating business together with certain companies. The forum has a rich history of enabling that collaboration and we will take that much further, enabling the growth of the new ecosystem and new services. That would be a big part that is helping the industry to transform.

ZTE TECHNOLOGIES

NetCologne CTO:

“My Vision is to Give Our Customers the Best Infrastructure in Germany”

Reporter: Liu Yang



Germany has established its digital agenda where the development of the broadband internet access is taken as one of the key tasks. NetCologne is one of the major regional broadband service providers in Germany, providing the city of Cologne and the associated region with reliable and future-proof telecommunication services. To cater to the growing demand for high-speed internet, it introduces G.Fast technology to accelerate its fiber deployment. In February, NetCologne and ZTE signed a strategic cooperation agreement for the joint development of GPON and G.Fast projects. In March, the two parties announced the start of the G.Fast pilot phase. Recently, NetCologne CTO Horst Schmitz talked to *ZTE Technologies* about NetCologne’s fiber broadband strategy, the significance of choosing G.Fast and his vision for the future.

What is the digital agenda for Germany?

The Federal Government of Germany has started thinking about a digital agenda for our country at the beginning of this decade. Political will and intention have so far been expressed in the broadband goal of providing all households with download speeds of 50 Mbps by 2018.

In the past months the two significantly involved federal Ministries “for Transport and Digital Infrastructure” and “for Economy and Energy” have developed respectively their own gigabit strategies. Common to both is the understanding of the future need of ubiquitous connectivity and the will to cope with the markedly increasing requirements in the course of the development of Industry 4.0 (Internet of Things, Big Data) and intelligent networking (e.g. e-health, e-government and smart cities). Thus, the government has realized that future broadband connections have to be of much

higher quality: Both ministries are now strongly committed to the task that gigabit networks will have to be set up in Germany by 2025.

As the roll out of broadband infrastructure is not commercially viable everywhere, the Ministry for Digital Infrastructure has set up a special funding program in autumn 2015. The government wants to invest a total of around 4 billion Euros up to the end of 2018. Just recently, the government has announced to invest another 350 million Euros to connect industrial parks to the fiber networks. Here, connections have to have 1 Gbps for symmetrical upload and download.

In short, the awareness of the need for fiber networks as the only future-proof infrastructure has meanwhile also reached German policy. The focus should now be on the promotion and the comprehensive deployment of fiber-to-the-building/home (FTTB/H) networks and the need to deploy fiber as the basis for all communications infrastructure for the upcoming decades, and no longer stick to outdated bandwidth goals.

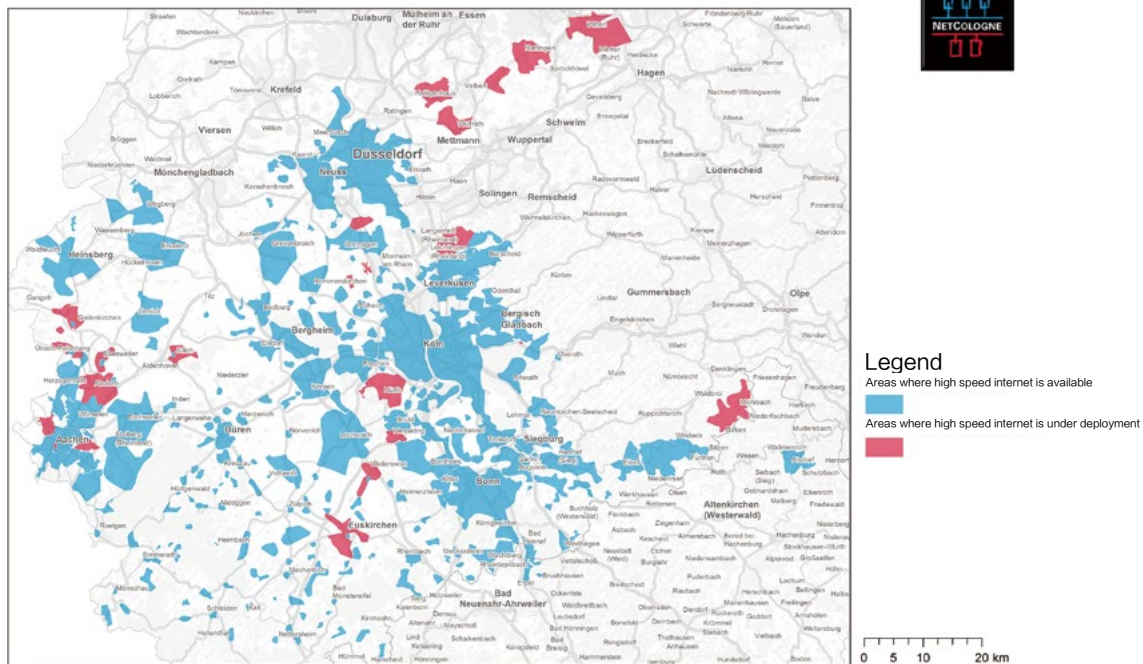
What’s the current status of NetCologne’s broadband service?

NetCologne offers a comprehensive product portfolio in the areas of internet, telephony, television and mobile communications. In doing so, we strive to meet high technical standards in order to offer our customers the best possible service. We are constantly expanding our own high-performance fiber optic network to provide bandwidths of 100 Mbps and beyond, not only in urban, but also in rural areas.

Taking a look at our service area, we have marked in red those parts on the map which are under deployment right now. In all blue-marked areas, broadband connections from NetCologne are already available.

This year, we are working on a new

NetCologne's service area in Germany



technology leap: We will be providing our customers with the next generation of super-fast high-speed connections via G.Fast.

In addition to the areas mentioned above, NetCologne is also pushing ahead with the expansion of a hybrid fiber coaxial network (HFC). Through contracts with housing companies, the modern fiber optic cable network (including Broadcast TV) is being extended on a selective basis, for example in Cologne, Düsseldorf and Neuss.

How do you plan your network evolution?

We see the broadband coverage of the area Cologne/Bonn/Aachen as one of our core tasks. However, fast internet access is

not only required in private households, but indispensable for companies in particular.

By expanding our own high-performance fiber-optic network, we are making an important contribution to economic growth in the region. In doing so, we also rely on regional partners. In many cases, expansion projects can only be realized jointly with municipalities and local energy suppliers.

What's your strategy for an all-fiber future?

We'll deploy FTTB/H in all buildings. The final game will be the infrastructure network. In our competitive areas we'll win this final game. Therefore, it's very important for us to push FTTB/H roll-out within the next few years. The



focus of our FTTH-deployment will be especially in new areas, new buildings and reconstructed buildings, because it is still difficult to bring fiber to customers in existing houses and apartments in Germany. In those areas, the solution will be G.Fast, as it is often not possible to reconstruct the buildings and replace the old copper lines for FTTH.

All in all our strategy is to get as close as possible to our customers with our own fiber infrastructure. Only then we are able to develop the best products, the best services and the best bandwidth.

NetCologne and ZTE signed a strategic partnership agreement at ZTE's headquarters. What's the significance of signing this agreement with ZTE? What's your expectation for future cooperation?

We want to improve our business in the future with new services and applications and need a strong partner. As we are working in a very competitive environment in Cologne, Germany, we intend to accelerate our business with ZTE as a partner. By entering the strategic partnership, we hope to improve network quality and user experience for NetCologne customers.

The agreement includes the deployment of the latest state-of-the-art telecommunications technologies as well as the development of new

business areas and joint marketing communications. ZTE will support NetCologne to maintain its status as the leading provider of telecommunication technologies and services in the area of Cologne/Bonn/Aachen with a strong digital competence. We are definitely looking forward to new projects in future.

What's your impression after visiting ZTE's headquarters?

It's very impressive. For me, it was very important to see and get to know the people behind the the big technology brand, because I had to make a very important decision for my company.

Can you tell us the goal and status of the G.Fast project?

The goal is to offer gigabit-bandwidths to our customers. We are the largest FTTB network operator in Germany. We had to change our old DSLAMs and install G.Fast and new DSLAMs to improve the performance and services to our customers. We started the G.Fast project last year. Now the first live connections have been successfully started in the pilot phase under real-world conditions. The technology will be available in the NetCologne network in the course of the year and is expected to serve around 260,000 households. The precondition is that the respective building has a direct

fiber-optic connection from NetCologne.

What is the significance of choosing G.Fast?

It's very important for us to deploy G.Fast since the high-speed demand is increasing. The G.Fast solution based on a copper backhaul allows for a smooth migration path from 100 Mbps services based on VDSL2 in FTTB to gigabit services in a very cost efficient way, as the existing copper infrastructure within the buildings can still be used. It also allows for a gradual migration so the growth of performance can be proportional to the market demand.

G.Fast is the right technology at the right time. In the long term, we will deploy FTTH. In the short term, which means the next five years, we will be using the copper line for G.Fast to provide 1 Gbps. But in the next few years, we'll see not only in Cologne, but all over Germany, a big FTTH deployment.

What services will be important in driving ultrafast broadband uptake?

We consider the following services as main drivers for leveraging the uptake of ultrafast broadband, as they require huge increases in bandwidth: video-on-demand services with advanced tech features like 360-degree cameras and for augmented and virtual reality scenarios as well as for use of current 4K TV and high dynamic range video options (with higher resolution in colors); cloud services for various (enterprise-class) storage applications as well as for artificial intelligence applications that are based on high-availability and high-performance servers in the cloud and the availability of centralized innovative services in the cloud; virtual reality applications & services for gaming & entertainment—for example telemedicine uses including visual technology and remote diagnostics or virtual and online payment applications and related new business models.

What is the future of the broadband market?

At this point we are just at the beginning of a completely new ICT era. We think the future of the broadband market will certainly evolve into the direction of fiber optic as the foundation of a modern industrial and service company. For that, an extended and reliable high-performance broadband infrastructure will become a main enabler for prosperity and economic growth of our modern society. The increasing penetration will become a challenge for the growing FTTB and FTTH broadband network markets—which will lead to an increase of new cooperation, wholesale and reselling business models.

How do you ensure the sustainable development of NetCologne?

We have to look at innovation. We have to look at costs, because in Germany the consumer pricing is very low. So, we have to be very cost-efficient.

We need to have a scalable network which enables us to introduce new services in short time. We cannot afford long evolution cycles. It's clear we are an infrastructure provider, not Amazon or Google. But the network should support all the functionality to enable our customers to use the best services worldwide.

As a CTO, what is your vision for NetCologne in the next several years?

My vision is to provide the market, our marketing department and our customers with the best infrastructure in Germany. There are a lot of changes. The technology is changing. The software is changing. Therefore, it is very important for us to have a reliable partner who supports us in this complex field. We are a regional network operator, but No. 1 in the market with regard to the quality of our network. We are convinced that with the combination of our technology with ZTE's technology, we will offer the best services for the future.



ZTE CEO Talks About 5G in MWC Interview

Source: GSMA's Mobile World Live

Zhao Xianming, CEO of ZTE

On Feb. 27, the first day of the MWC, Zhao Xianming, CEO of ZTE, told GSMA's Mobile World Live about ZTE's strategy on 5G, as well as the other technologies that ZTE is also focusing on.

What is ZTE's strategy on 5G?

ZTE is a leader in 5G research globally, and 5G will be critical for the digital transformation for operators and enterprises. ZTE's 5G strategy covers three aspects:

The first aspect is 5G wireless access. ZTE is leading the market with our innovations. Our Pre5G solutions are deployed in more than 40 networks globally, including SoftBank in Japan and Telefonica in Latin America, allowing operators to deliver a 5G experience on existing 4G infrastructure and devices.

What's more, it will be simple for operators to upgrade from Pre5G to 5G through a software upgrade in the future.

The second aspect is 5G backhaul. ZTE's "Network 2020" platform and ElasticNet solution will help operators build powerful core networks based on a virtualized and cloud-based architecture to support the growing traffic of 5G networks.

ZTE's ElasticNet solutions are now deployed by more than 50 commercial networks globally.

The third aspect is preparing businesses and industries for 5G. ZTE is leading the way with our innovations on NB-IoT and our solutions can be deployed on both the existing 4G base stations and NFV core networks.

We will also help our customers deploy NB-IoT in industries including financial services, energy and transportation.

What is ZTE's strategy to grow your Pre5G business? Is ZTE making announcements on Pre5G here at MWC 2017?

Our Pre5G solutions are putting ZTE in a very

strong position as we prepare for 5G. In the past year, ZTE has helped many operators deploy Pre5G solutions commercially across the world.

The key to our success is innovation. ZTE is the first company to offer FDD-based Massive MIMO base stations, and here at MWC in Barcelona, we will be demonstrating its performance advantages for 4G FDD-LTE operators.

We are also launching our AAU solutions based on 5G NR technology covering high and low frequencies.

As we prepare for future 5G deployments, ZTE is working with major global carriers including China Mobile and Telefonica on research of core technologies and standardization. Together with China Mobile, ZTE is deploying a NB-IoT pre-commercial network.

Apart from 5G, what other technologies are important for ZTE? How do you see the market for IoT?

In 2017, ZTE will continue to invest heavily in R&D to drive innovations in new technologies to support operators and enterprise customers in their digital transformation. In addition to 5G, these include virtualized networks, cloudization, big data, IoT and artificial intelligence.

We are expecting to see an acceleration in the development of IoT globally. In IoT, ZTE will focus on innovations in NB-IoT and LoRa. ZTE will be working closely with our ecosystem partners in the development of IoT.

In particular, we will be driving innovations in connected devices and terminals, networks, applications, analytics, information security and services for different industry verticals.

ZTE will focus on IoT solutions in four areas—Smart City, Smart Home, Industrial Internet and Connected Vehicles.

At MWC 2017, ZTE will be co-hosting the Global IoT Summit together with the GSMA. And speakers from our partners including Intel, Telia and Qualcomm will also be presenting their plans for IoT at the event.

ZTE TECHNOLOGIES

Major Global Operators' Views on ZTE and 5G

Source: Adapted from a 5G video

5 G is the future of mobile internet of everything (IoE). ZTE is a world leader in 5G from technology verification and product development, and it works with the operators side by side to promote 5G commercialization and industrialization. ZTE is working with China Mobile and SoftBank on Pre5G deployments. Together with operators in Hungary and Belgium, ZTE has set network speed records in Europe. Together with Telefonica, ZTE is implementing cloud networks in seven Latin American countries.

Let's see what these operators say about ZTE and 5G.

In August 2016, ZTE announced the signing of a major network modernization deal with Telenet, the largest provider of cable broadband services in Belgium. Telenet acquired mobile operator BASE from KPN in 2015.



Micha Berger, CTO of Telenet Group

“Telenet has chosen ZTE to be their partner in this whole network upgrade and this whole infrastructure digitalization of our mobile network. We've also recently announced and demonstrated a speed test of 1.3 gigabit per second download speed on our live mobile network with the ZTE equipment.”

In early 2016, ZTE signed a Pre5G memorandum of understanding with Hutchison Drei Austria to build the first Pre5G trial site in Europe. In the following December, Hutchison Drei Austria and ZTE successfully conducted the first test of Massive MIMO implementation in Europe.



Matthias Baldermann, CTO of Hutchison Drei Austria GmbH

“I think the key fact is that we are partners, and we appreciate ZTE should be that partner. ZTE is a partner we found flexible, very supportive and always looking for a solution, which serves both parties. And that wasn't a passed report and it would be more in future.”

In July 2015, ZTE signed a memorandum of understanding with SoftBank to collaborate on research and development based on ZTE's Pre5G technology, including the use of massive multiple input multiple output (MIMO). In 2016, SoftBank launched Massive MIMO in Japan.



Hideyuki Tsukuda, SVP of SoftBank

“Deploying Massive MIMO in the 2.5 GHz frequency band was a global breakthrough in 5G.”




Takashi Tsutsui, SVP & Chief Scientist of SoftBank

“Just put resource on SDMA. I expect that will become a great future for ZTE as well.”

In June 2016, ZTE signed a memorandum of understanding for the development of 5G technologies with Telefonica. The partnership strengthens ZTE's position as a strategic technological partner for Telefonica. In the following December, ZTE announced a contract to help Telefonica build a large-scale virtual IP multimedia subsystem (vIMS) network in Latin America.



Enrique Blanco, Global CTO of Telefonica

“5G does not only mean radio and antenna capabilities. 5G also means DWDM capabilities, means to cover the capabilities in the backhauling, in the edge, and, for sure, in the radio, and means to cover the capabilities in the fixed with FTTH. We choose ZTE because they are offering us future.” 



Pre5G: Building the Bridge to 5G

By Ding Guanghe

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JUN 2017

ZTE

At the award ceremony of the Mobile World Congress (MWC) 2016, known as the Oscar in the telecom industry, ZTE won the Best Mobile Technology Breakthrough and the Outstanding Overall Mobile Technology—The CTO's Choice 2016 awards for its Pre5G Massive MIMO technology. This is not a sudden success for ZTE. Since June 2014 when ZTE was the first to put forward its Pre5G at the LTE World Summit, Pre5G has become the most important technological concept that is highly recognized by the industry for evolution from post-4G to 5G. With years of effort, ZTE has worked with operators worldwide to deploy commercial Pre5G networks.



Ding Guanghe

Director of Wireless Solution, ZTE

The Idea of Advanced and Practical Development

The core concept of Pre5G is to use in advance certain key 5G technologies in 4G

networks and make them compatible with existing 4G commercial terminals, so that users can enjoy 5G-like experience before the formal 5G commercialization. Taking into account the LTE evolution, Pre5G also incorporates LTE-A Pro related technologies defined by 3GPP. Therefore, Pre5G is a technical solution portfolio that connects 4G and 5G.

Based on deep understanding of the challenges operators face in their network upgrade concerning spectrum and site resources, terminal compatibility, and return on investment, ZTE has launched the practical Pre5G concept that can manage trade-offs among time to market, cost-efficiency, and network performance and help operators maintain a healthy development.

- Time to market: Pre5G attaches importance to seizing market opportunities. It uses in advance some 5G technologies instead of waiting for mature 5G standards and commercialization. Pre5G also provides compatibility with existing 4G terminals,

and delivers ahead of schedule future-oriented new services such as virtual reality, HD videos, and IoT, helping operators seize the high-end market.

- **Cost efficiency:** Most of the Pre5G technologies evolve smoothly based on a 4G network without great changes to the network. Moreover, as Pre5G is deployed in high-traffic areas and for high-rate services and high-end user groups, it can obtain high returns on a relatively small investment.
- **Network performance:** Pre5G increases spectral efficiency by six to eight folds, which is close to the ultimate spectral efficiency limit of 5G. This helps operators address the issue of limited spectrum resources. Pre5G also provides low latency and massive access capabilities to support new services as well as cloud-based solutions to build more flexible, open and synergy networks.

Above all, the early commercial use of certain key 5G techniques including Pre5G Massive MIMO enables ZTE to obtain rich commercial experience and measured data from actual network scenarios. This provides valuable real data and new channel models for 3GPP and ITU, and gives the references for future 5G commercial deployment. Pre5G benefits 4G networks and users as well as future 5G networks, serving as the bridge from 4G to 5G.

A Complete Evolution in Four Areas

Pre5G shows its value in the four areas: Giga+ MBB, superior experience, Massive IoT, and cloudization:

- **Giga+ MBB:** Giga+ MBB focuses on addressing the capacity challenge of hotspot cells and high-rate services. Through the combination of Massive MIMO, Massive CA/LAA, 256QAM, and Pre5G UDN, the cell peak rate can increase to above 1 Gbps.
- **Superior experience:** User experience has always been the greatest concern of operators. ZTE's innovative eVideo and eVoLTE based solutions can bring high-definition mobile video and high-fidelity voice experience to users.
- **Massive IoT:** IoT brings new market opportunities while changing people's lives. Typical IoT applications include internet of vehicles, smart home, and smart city. Focusing on NB-IoT and eMTC applications, Pre5G can provide end-to-end IoT solutions ranging from chips, module terminals, to networks and application platforms.

- **Cloudization:** Cloudization makes networks and platforms more elastic, open, and synergic. It supports smooth evolution to 5G. Based on virtualization, the Pre5G cloudization solution can reconstruct network infrastructure and functions. Moreover, cloudization is also applied to the radio access side. ZTE's Cloud RAN solution uses virtual BBUs and 5G-oriented network architecture, and also introduces mobile edge computing (MEC).

Leading the Pre5G Commercialization to Win Worldwide Recognition

R&D is the foundation of a successful product commercialization. ZTE has invested a lot in R&D of Pre5G products and solutions, among which Massive MIMO is a hit product. Following mass commercial use of its industry-first TDD Massive MIMO, ZTE overcame technical difficulties related to FDD Massive MIMO in less than one year by using self-developed high-performance vector processing chips as well as innovative channel measurement and estimation algorithms. At the end of 2016, ZTE launched FDD Massive MIMO and completed the joint field tests together with China Unicom and China Telecom. The new-generation TDD Massive MIMO made its debut with more carriers, more streams, and newer style.

As the first vendor to put forward the Pre5G concept, ZTE has led the commercial use of Pre5G. Owing to the advanced and practical development idea as well as outstanding performance, ZTE has been highly recognized by global middle- and high-end operators for its Pre5G. As of 2016, global mainstream operators had deployed over 40 Pre5G networks in 30 countries around the world, such as SoftBank, Telefonica, Hutchison, Vimpelcom, Telenor, Singtel, China Mobile, China Unicom, and China Telecom. Japan's SoftBank became the world's first to deploy commercial Pre5G Massive MIMO network; Telefonica and Vimpelcom deployed virtual cloud-based networks respectively in seven Latin American countries and five countries; Belgian operator Telenet used multi-carrier aggregation to achieve a download speed of 1.3 Gbps in an outfield Pre5G test; and China Mobile ran a commercial NB-IoT trial in Wuzhen, a city of China's Zhejiang province, for smart parking and integrated water control systems.

ZTE TECHNOLOGIES

Pre5G TDD: To Boost the Value of Your Network

By Zhang Shizhuang

21
JUN 2017
ZTE

4G networks have widespread commercial deployments. It is estimated that super-high traffic areas will account for 10 percent of the 4G sites in China's first-tier cities by the end of this year, and the requirement for user experience cannot be met if the operator still uses the ordinary solution of increasing capacity through adding LTE frequency bands. ZTE's Pre5G TDD solution can multiply the spectral efficiency to cope with network expansion challenges during the transition from 4G to 5G.

Huge Challenges Facing LTE in Post-4G Era

From 2017 to 2020, the development of 4G networks will present several challenges: enormous capacity demand in hot spots, improving cell-edge user experience, and 4G networks converging with the future 5G networks.

- Unbalanced network capacity distribution and big challenges from hot spots: Cisco predicts a 10-fold increase in mobile traffic from 2015 to 2020. A report on the 4G networks of Japan shows that the single-user traffic will grow at a compound annual

growth rate of 40%. A statistical analysis shows that 10 percent of the 4G sites in China's first-tier cities will be super-high traffic areas by the end of this year, and it is urgent to provide a capacity expansion solution.

- Higher single-user data rate for a single service and stable data rates from the cell center towards the cell edge: Cisco forecasts that three-fourths of the mobile data traffic will be video. Video is gradually moving from 2K (6 Mbps) to 4K HD (45 Mbps). The network should provide stable data rates for at least 2K video, and the cell-center and cell-edge users should have the same experience. However, the existing cell edge data rate is usually set at about 1 Mbps, far from meeting the development requirements of the video services.
- Convergence of 4G and the future 5G networks: How the newly-built 4G networks can be converged with the future 5G networks is a focus of operators this year.

It is expected that a large-scale commercial use of 5G networks and terminals will be achieved after 2020, and most of the challenges need to be overcome before the arrival of 5G. Table 1 summarizes the challenges posed to 4G mobile networks.



Zhang Shizhuang

Director of TDD Product Planning, ZTE

Table 1. Challenges to 4G mobile networks.

	Demand	Current status	Gap
Whole network capacity	10×	1×	5 to 10 times
Single-user rate	45 Mbps to 300 Mbps	6 Mbps	Over 9 times
Cell-edge rate	6 Mbps to 45 Mbps	1 Mbps	Over 6 times

ZTE Pre5G: A Bridge to 5G

Responding to the challenges, ZTE puts forward the Pre5G TDD solution. It revolves around Giga+MBB, ultimate experience and cloud-based networks to increase the value of TDD networks.

Methods for Expanding Network-Wide Capacity

The network capacity is expanded through adding spectrum, enhancing spectral efficiency and increasing site density.

- More licensed spectrum: Before the massive commercial use of 5G networks, it is proper to effectively use TDD spectrum resources. TD-LTE is converging with FDD-LTE in terms of industry chain, and commercial chips and terminals support both TD-LTE and FDD-LTE. The candidate frequency bands for TD-LTE (B40, B41, B42, and B43) are low-frequency bands that offer high bandwidth.
- More unlicensed spectrum: The usage of unlicensed spectrum can be made more efficient by using the LWA and LAA technologies.
- Higher spectral efficiency: Among the 5G candidate technologies, only Massive MIMO can significantly enhance the spectral efficiency, and increase the peak data rate by six to eight times, making it especially suitable for transmitting video services with large packet sizes.

- More sites and smaller cells: The capacity can be improved through increasing the site density. The key solution is Pre5G UDN.

Among all the solutions mentioned above, Massive MIMO is the only one that can multiply the spectral efficiency and network capacity without consuming more spectrum resources.

Methods for Improving Single-User Rate and Cell-Edge User Experience

A good mobile user experience lies in the consistency between the available rate and the planned service rate.

- CA: Carrier aggregation (CA) is a mature technology to improve a single-user peak data rate.
- SDMA+MU-MIMO: The single-user data rate can be increased through spatial division multiplexing. Massive MIMO is the key.
- User-centric network: With CoMP, Massive MIMO, and Pre5G UDN technologies, the network can decrease interference, convert interference into a desired signal, and improve the cell-edge performance. TDD Massive MIMO and Pre5G UDN are the most important technologies for improving user experience.

Pre5G Massive MIMO: Multiplying Capacity

Pre5G Massive MIMO is one of the key

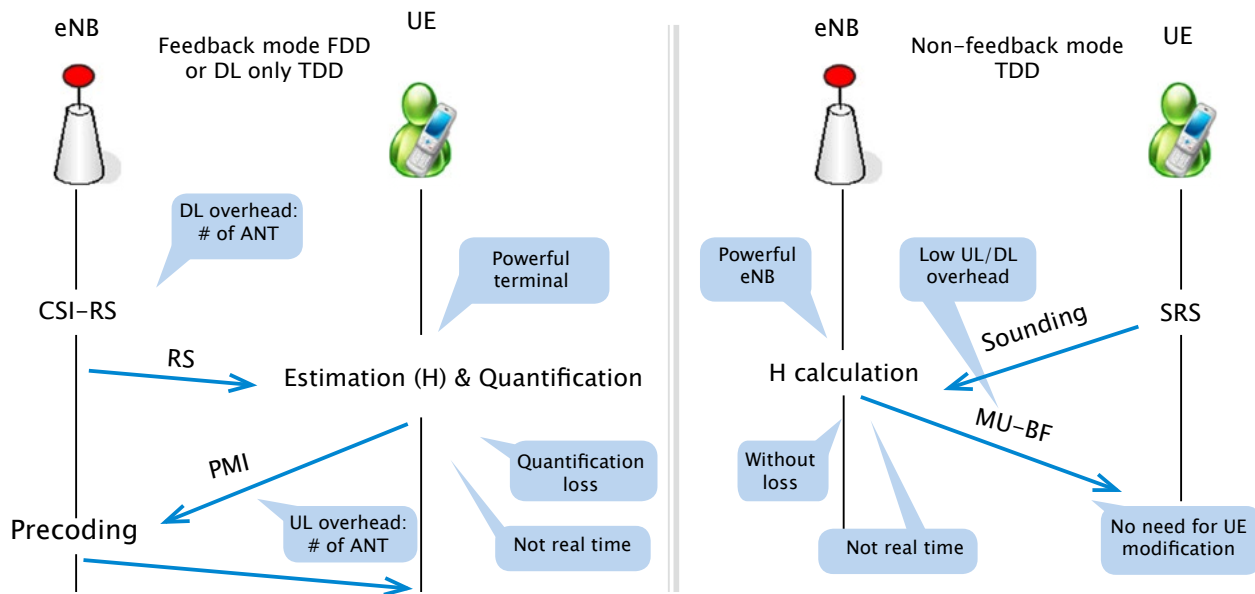


Figure 1. Core technology of Massive MIMO: precise channel measurement.

technologies in the LTE network evolution. Massive MIMO, based on highly precise channel measurement and curve-fitting results, provides 3D beamforming and generates user-level ultra-narrow beams, which avoids interference among multiple user-level beams and greatly enhances system capacity.

Precise channel measurement is one of the core technologies of Massive MIMO. Fig. 1 shows a TDD-based Pre5G Massive MIMO system. The downlink channel state information can be obtained without the terminal feedback by exploiting channel reciprocity. This saves the uplink channel overhead, avoids uplink feedback information quantification loss, breaks the transmission bandwidth limits and ensures a higher precision of the obtained downlink channel information. This is also the key advantage of Pre5G TDD Massive MIMO.

With a large antenna array, Pre5G TDD Massive MIMO is capable of 3D beamforming. It can focus the energy in the direction of specific users, provides more orthogonal spatial channels and supports more spatial streams. There are higher performance gains of SDMA including six to eight times

increase in the cell peak data rates.

Pre5G TDD Massive MIMO is backward compatible with the existing terminals (R8/R9 and later releases). There is no need to address the terminal penetration problem caused by the use of new technologies. It can effectively enhance user experience and network competitiveness on the whole. Fig. 2 shows a comparison of spectral efficiency improvements of different technologies.

Pre5G Massive MIMO can also improve the cell-edge data rate and provide a consistent user experience. A 4G network field test in Guangzhou, China shows that under almost the same coverage conditions, 95% of the coverage area of a Massive MIMO cell has a downlink rate higher than 6 Mbps as compared with 80% of a macro cell. Pre5G TDD Massive MIMO provides a solution to improve the continuous coverage of video service.

ZTE has started Pre5G deployment for more than 20 operators in China and other countries, such as China Mobile, Deutsche Telekom, T-Mobile, SoftBank Mobile, Korea Telecom, U Mobile (Malaysia), and Hutchison Drei Austria.

User-Centric Pre5G UDN

As the existing network become denser, there is growing coverage overlap and serious interference. To solve the problem, ZTE puts forward the Pre5G UDN solution that is centered on user experience and based on the existing network architecture. This solution densely deploys base stations in some traffic hotspots to increase the TDD capacity density per unit area and uses inter-cell interference suppression technology, which significantly improves the spectral efficiency and network capacity and ensures the consistency of user experience.

D-MIMO, the key of the Pre5G UDN solution, is based on the same principle as Massive MIMO. It distributes Massive MIMO antennas among the densely-deployed small RRUs to form D-MIMO clusters. By using the reciprocity between uplink and downlink in TDD systems, multiple cells in a cluster can achieve coherent joint transmission. A cell can properly select its neighboring cells for cooperative transmission and a UE

is able to combine coherently the signals received from multiple cells while avoiding interference. In this way, the system spectral efficiency can be improved significantly. The solution divides the available frequency resources among the densely-deployed small base stations based on the principle of minimum total interference and improves cell-edge user experience. It is estimated that the average SINR will be increased by 20% and the average download speed by 15%; and thus a consistent and seamless high-speed user experience can be achieved.

Pre5G TDD Supporting Network Convergent Evolution

Based on the Cloud RAN network architecture, the Pre5G TDD solution can use a set of cloud-based networks to support 4G, Pre5G, and 5G networks by using the multi-connection technology. Together with its open service capability and flexible network architecture, the Pre5G TDD solution will create tremendous market opportunities.

Summary

Massive MIMO and Pre5G UDN, two typical Pre5G TDD technologies, aim at solving the capacity problem of 4G networks, improving the spectral efficiency by six to eight times through technology combination, and enhancing cell-edge user experience. Based on the Cloud RAN architecture, the ZTE Pre5G TDD solution is capable of smooth evolution to 5G and helps operators build high-value LTE Advanced Pro networks.

ZTE TECHNOLOGIES

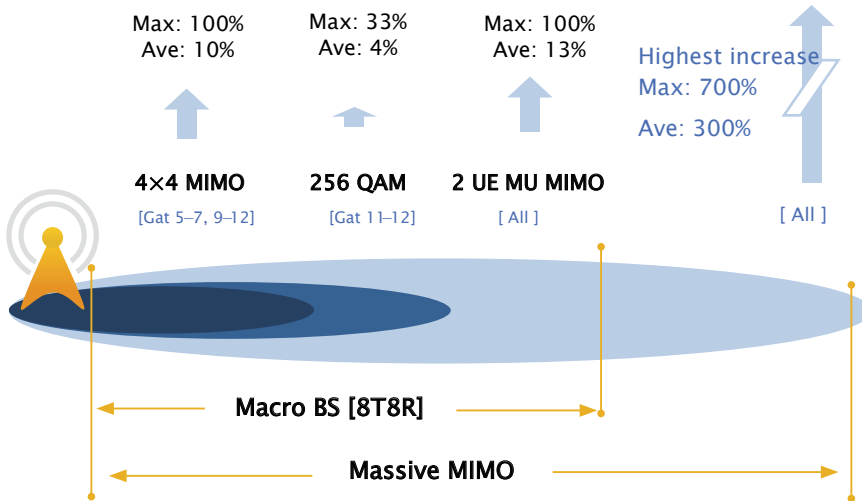


Figure 2. Spectral efficiency improvements of different technologies.

Pre5G Giga+ MBB: Leading Mobile Broadband

Toward the Gigabit+ Level

By Ni Yanzi

Ultra-broadband experience is always the most important pursuit for users. Their demands for wireless network bandwidth have been growing explosively with the rapid development of mobile terminals and related applications. Although current 4G networks can meet most needs for video watching, internet surfing, and social networking services, new technologies such as high definition/ultra high definition (HD/UHD), virtual reality (VR), and augmented reality (AR) have entered people's daily life, and 4G bandwidth capacity has gradually become a bottleneck to the growth of mobile business. 5G

networks are expected to increase the peak data rates to 10 Gbps or above to bring users a completely new broadband service experience. However, it will be several years before 5G will be officially launched in 2020. Expanding the existing 4G network capacity and performance has become a practical concern of operators.

In June 2016, ZTE was the first to put forward its Pre5G concept and solutions to creatively apply 5G technologies to 4G networks. The solutions can improve 4G network performance indicators and capabilities by an order of magnitude while protecting existing investments of operators. Giga+ MBB, one of four key Pre5G solutions, can increase data rates of a mobile network to the Giga+ level and allow users to have ultra-broadband service experience in advance.

Key Giga+ MBB Technologies

ZTE's Pre5G Giga+ MBB is neither a brand new wireless technology nor a complete transformation of the existing network, but the introduction and convergence of multiple technologies to allow wireless data rates to reach the Giga+ level. It involves using in advance some key commercially available 5G technologies such as Massive MIMO in the 4G network to provide 5G experience based on

existing commercial 4G terminals. It also includes LTE-A Pro related technical enhancements defined by 3GPP, scalable 5G technologies such as 4×4 MIMO, Massive CA, license assisted access (LAA), LTE WiFi aggregation (LWA) and 256QAM, ZTE's innovative neat cell solution for improving higher-order modulation enabler ratio, and ZTE's unique X-Site solution for smooth evolution to multiple sectors and higher-order MIMO. The key Giga+ MBB technologies are listed below:

High-Order Modulation

Through the introduction of 256QAM—a higher-order modulation scheme, the peak rate can be increased by 33% compared to 64QAM. Due to the strict requirements for wireless environments, 256QAM is mainly used in indoor coverage and hotspot scenarios. Moreover, ZTE has also launched its innovative neat cell solution to reduce pilot interference and inter-cell interference. This can improve the signal-to-interference-plus-noise-ratio (SINR) and channel quality, thereby increasing the 256QAM modulation enabler ratio, cell throughput, and spectrum efficiency.

Massive CA

Carrier aggregation (CA) is an important means of expanding network



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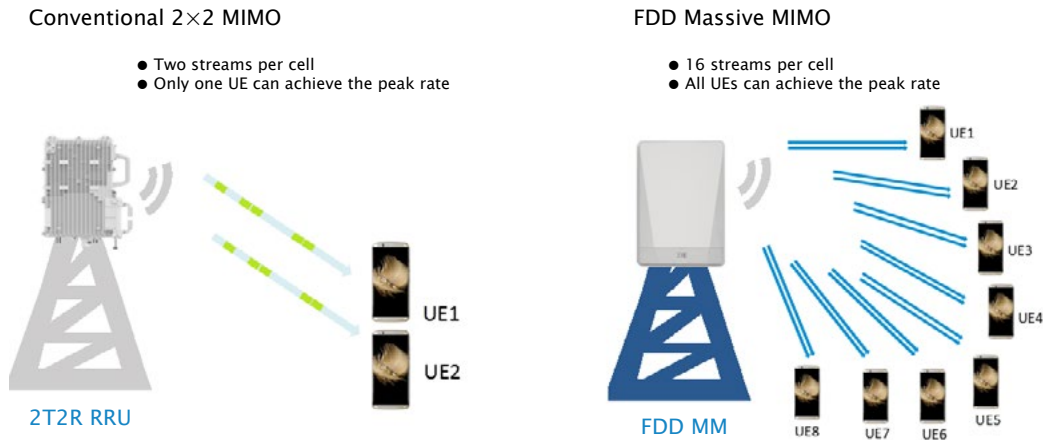


Figure 1. The comparison of conventional 2×2 MIMO and FDD Massive MIMO.

capacity. The CA technology evolves from two-carrier aggregation to cross-carrier aggregation and then to LAA/Massive CA.

- From 2CC to 3CC to 5CC to Massive CA: Five-carrier aggregation (5CC) is a milestone of the CA technology for LTE-A, while Massive CA—a key technology of LTE-A Pro will support the aggregation of 32 carriers at most.
- Cross-carrier aggregation: Pre5G means not only the evolution of a single technology but also the convergence of multiple wireless technologies. With the aggregation of FDD and TDD carriers, network convergence is implemented more easily, and network capacity is therefore expanded.
- Carrier aggregation using unlicensed frequency bands: The licensed spectrum resource is limited and expensive. To meet the needs for ultra bandwidth, unlicensed frequency bands have been gradually used in the telecom industry as a supplementary resource. LAA and LWA can allow the unlicensed spectrum to be used in LTE and Wi-Fi. LAA aggregates LTE carriers in both licensed and unlicensed bands, while LWA aggregates carriers in licensed LTE bands and unlicensed Wi-Fi bands to exponentially expand bandwidth capacity.

High-Order MIMO

- 4×4 MIMO: 4×4 MIMO is a MIMO system with four input antennas and four output antennas. In theory, more antennas indicate higher transmission rates and higher reliability. The simulation results

show that the average cell throughput of a 4×4 MIMO cell is increased by over 90% compared with 2×2 MIMO. ZTE's unique X-Site solution helps operators smoothly evolve to 4×4 MIMO while protecting their investments for maximum benefits. The evolution to 4×4 MIMO can be implemented in three ways: using RRU cascading to save combiners and antennas and implement 4×4 MIMO configurations for multiband sites; splitting vertical cell sectors to prepare for future smooth evolution to 4×4 MIMO; and using ZTE's patented X-antenna to enable seamless software switching of 6-sector 2×2 MIMO to 3-sector 4×4 MIMO.

- FDD Massive MIMO: Massive MIMO is a key 5G technology that uses large-scale antenna array to support both horizontal and vertical 3D beamforming and provide larger site throughput than that of any existing multi-antenna base station solution. Massive MIMO can greatly improve spectrum efficiency. Pre5G Massive MIMO is the best solution that directly applies key 5G technologies in 4G networks and is compatible with existing 4G terminals. Pre5G FDD Massive MIMO uses the dense 128-antenna array in combination with ZTE's TDD Massive MIMO application based big data analysis and its unique patented algorithm to address the worldwide problem of uplink and downlink channel reciprocity. When combined with ZTE's unique vector chips, it can also efficiently analyze and track users in real time and send

them accurate narrow beams to deliver ultra-high throughput services and offer a six- to eight-fold increase in spectrum efficiency (Fig. 1).

Recommended Giga+ MBB Deployment

Area Selection

Giga+ MBB provides Giga+ ultra broadband experience. The following two areas are preferred for Giga+ MBB deployment.

- Heavy-traffic hotspot areas: Hotspots are mainly located in central business districts (CBDs), city squares, commercial centers, stations, and gymnasiums in dense urban areas. In these places, the network environment is complicated due to high population density, high data traffic, and numerous tall buildings.
- Areas requiring ultra-high-speed services: Ultra-high-speed services include HD/UHD videos, UHD online games, VR and AR. These services require high bandwidth and low network delay.

In the next few years with the continued growth of network usage and user needs, operators can gradually expand the areas for deploying Giga+ MBB and finally deploy it across the whole network.

Technology Selection

Giga+ MBB involves multiple technologies that have different levels of maturity. Operators can introduce different technologies in stages based on their own requirements, technological maturity levels, and terminal commercialization. ZTE has recommended that operators would deploy Giga+ MBB in accordance with the following plan in the next two years.

- In 2017: Upgrade software to support 256QAM and deploy 3CC/4CC, LAA, and 4×4 MIMO on a small scale (Even if 4×4 MIMO is not available currently, it is also recommended that 4T RRUs be selected preferentially in hotspot areas to prepare for future

4×4 MIMO launch).

- In 2018: Deploy 4×4 MIMO and LAA on a large scale, run 5CC trials on a small scale, and launch FDD Massive MIMO selectively for hotspot areas.

Successful Giga+ MBB Applications

Since ZTE officially launched Pre5G in June 2016, the Giga+ MBB solution has received special attention of operators from both home and abroad. The operators have actively worked with ZTE to carry out Giga+ MBB tests, field verification and commercial deployment, and have created industry records one after another.

In November 2016, ZTE successfully demonstrated Pre5G FDD 1.75 Gbps service with a single terminal at the ZTE VOICE Towards 2020 Summit in Kuala Lumpur, Malaysia. The demonstration became the focus of attention in the summit.

In December 2016, in a 4G+ wireless network enhancement technology seminar held by China Unicom, ZTE accomplished 3CC aggregation and 4×4 MIMO based on the existing network devices and spectrum, and demonstrated 1 Gbps rates using 256QAM technologies. ZTE worked with Belgium's Telenet to complete the Pre5G field test, and Telenet became the first in Europe to offer a rate of 1.3 Gbps in a real environment, which was fourfold the rate of the existing 4G network. ZTE and Indonesia's largest operator Telkomsel jointly held a press conference to officially announce the rollout of a commercial Pre5G network in two tourist cities: Makassar and Manado. The Pre5G network increased the rate of the existing network by 2.6-fold. In Budapest, ZTE and Hungary's Telenor announced the successful demonstration of Pre5G Giga+ MBB services with the peak rate close to 1.2 Gbps, which was also the first Pre5G demo in the Telenor Group.

Since 2017, more operators have started to introduce ZTE's FDD Giga+ MBB solution. So far, this solution has been tested and deployed in more than 20 networks in 15 countries, leading global mobile broadband towards the Gigabit+ level. **ZTE TECHNOLOGIES**

Pre5G Creates the Ultimate Customer Experience

By Lv Pei, Guo Qing

As mobile broadband (MBB) develops rapidly, operators and end users are attaching more and more importance to quality service experience. ZTE has rolled out its Pre5G ultimate customer experience solution that focuses on improvement in voice and video quality and guarantees excellent user experience.

eVoLTE MOS4.0+ Solution

ZTE's eVoLTE MOS4.0+ solution allows users to enjoy perfect voice and video call experience anytime and anywhere, helping operators boost their brand image and customer loyalty. This in turn helps operators attract more customers and gain more profits. The eVoLTE MOS4.0+ solution includes the following four aspects:

- 50%+ coverage increase to improve the voice coverage bottleneck in the uplink: In coverage-limited cases, the MOS4.0+ solution uses robust header compression (RoHC), enhanced TTI binding (TTIB), voice CoMP, and ECN-A to increase the voice coverage radius by 50%. This greatly reduces dropped-voice-call rate, enabling users to enjoy HD voice

services anytime, anywhere.

- MOS > 4.0 to enjoy perfect user experience: The eVoLTE MOS4.0+ solution supports brand-new enhanced voice services (EVS) technology and covers the 50–16000 Hz audio spectrum, including all low frequencies, medium frequencies, and most high frequencies at which humans can hear. This dramatically improves the definition and hearing comfort of HD audios, perfectly restores the original sound, and provides UHD audio and video conversation experience for high-end users. Moreover, the solution uses various technologies for quality improvement, including active authorized scheduling and NI-based frequency-selective scheduling, to increase the mean opinion score (MOS) to above 4.0. This boosts operators' competitiveness as well as customer satisfaction and loyalty.
- Double voice user base to handle big events with ease: The eVoLTE MOS4.0+ solution uses a series of capacity enhancement functions, including semi-persistent scheduling (SPS), RoHC, industry-leading active delay scheduling, flexible VoLTE service admission, load



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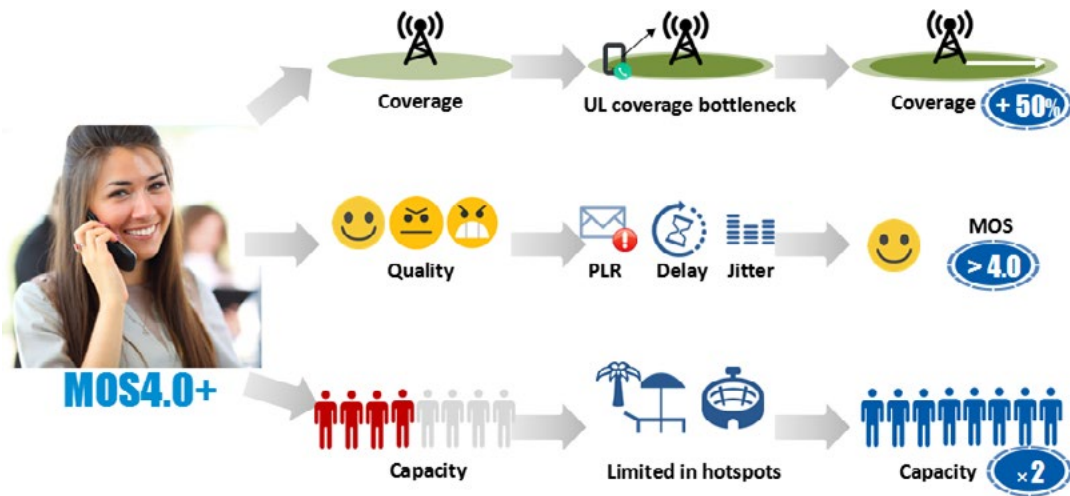


Figure 1. ZTE's eVoLTE MOS4.0+ solution.

balancing, and congestion control to save scheduling resources and opportunities. It enables 60–100 subscribers to call per unit time per cell, bringing additional revenue of about \$60. It also provides stable data rates for subscribers and helps operators increase profits and reduce TCO. Even in high-capacity scenarios such as vocal concerts, sports events, and large gatherings, the solution can provide excellent voice and data service experience.

- End-to-end MOS evaluation analysis and optimization tools to reduce Opex: As VoLTE involves various types of network elements (NEs), operators have always suffered from difficulties in voice quality quantization, fault locating, and failback in the radio network, core network, and IMS. This may cause a huge waste in Opex. ZTE provides end-to-end MOS evaluation analysis and optimization tools to enable

network-wide drive tests without using expensive MOS boxes and manpower. These tools not only provide quantitatively evaluated MOS values at any time but also can be automatically associated with measurement reports to perform statistical analysis of the MOS values. They can also automatically locate faults and resolve voice problems, for example, detect, locate, and restore unidirectional calls, helping operators greatly reduce their Opex.

To date, ZTE has successfully put the eVoLTE service into commercial use for operators including China Mobile, Digi in Malaysia, PT Smartfren Telecom, and SWAN of Slovakia. Moreover, ZTE is now running pre-commercial trials of eVoLTE with high-end operators, helping them speed up the VoLTE commercialization, enhance their competitiveness, and increase customer loyalty.

Big Video Solution

But along with the rapid growth of data traffic in mobile networks, charges for data services decrease. Only when the pace of data growth is faster than that of decline in data tariffs can there be a healthy total revenue growth. The global traffic analysis indicates that in recent years most new traffic comes from video services. Videos especially HD videos greatly stimulate data services, driving rapid growth of user data consumption.

An indicator system that can quantify user experience is needed to ensure that the network construction can satisfy user video experience. The KPI-KQI-QoE architecture model is now widely used in the industry. Because of video complexity, there has not yet been a standard video experience indicator system that can be generally applied in the industry.

Drawing on years of R&D experience in the video field, ZTE has

put forward a set of video quality of experience (v-QoE) indicator systems and algorithms. Video experience needs to be evaluated by many factors, which fall into the following three categories:

- Sustainable play capability: focusing on whether video play is stable, smooth or not, and whether there are blurry, freezing screens or not.
 - Interaction response experience: focusing on whether live channel switching is quick or not, and whether VOD cache time is short or not.
 - Content quality: focusing on video resolution, the number of coded frames, and video size.
- vMAX—ZTE’s self-developed big data network analysis tool—can provide V-QoE quantification scores. It can also perform further analysis to determine whether network problems are in the RAN, EPC, transmission, or UEs. vMAX offers more targeted solutions to the network problems.

To ensure video experience,

performance at the radio network side also needs to be improved in four aspects, including coverage, interference, capacity, and function.

Coverage Optimization

Video experience is directly related to coverage. The coverage has direct impact on the quality of video services.

Good radio coverage guarantees basic video experience. It is the premise to ensure the quality of mobile communication networks and also has a direction connection with the quality of video services. In radio network optimization, the first step is to optimize coverage, which is also a critical step especially for LTE networks. As most LTE networks adopt co-channel networking mode that results in serious co-channel interference, the coverage and interference issues significantly influence network performance.

As 4G indoor distributed sites fail to provide good coverage for video

services, it is necessary to give priority to indoor small cell deployment in heavy-traffic scenarios.

Interference Optimization

Interference directly affects the quality of video services. It can be resolved by:

- PCI planning and optimization to avoid PCI conflict
- adjusting engineering parameters
- increasing the signal strength in the serving cells and reducing the interference signal strength
- searching for external interference sources.

Capacity Increase

Network load and the number of online users can also affect video quality. Video experience of mobile networks can be improved by monitoring PRB resource utilization and the number of valid RRC users and by balancing the network load.

New Function Deployment

New functions at the radio network side including TCP optimization and DNS cache can enhance video user experience, accelerate the video play speed, and reduce cache time and video play delay.

ZTE’s Pre5G voice and big video solution can help operators deliver high-quality user experience, enhance user stickiness, and improve their brand competitiveness.

ZTE TECHNOLOGIES



The Road to 4G/5G Convergent Evolution

By Zhang Zhi

Since the first commercial deployment in 2010, LTE networks have been widely launched around the world, stimulating the rapid growth of mobile broadband services. Mobile internet and the internet of things (IoT) are moving into a new stage of development where there will be a thousand-fold increase in data traffic, hundreds of billions of connections, and more diversity of services. Therefore, 3GPP has defined a new 5G air interface with technical enhancements in three major applications such as enhanced mobile broadband (eMBB), massive

machine-type communication (mMTC) and ultra reliable low latency communication (URLLC).

To meet the demand for new service growth, existing LTE/LTE-A networks are gradually enhanced and evolving. The enhanced and evolving technologies are partly in line with the 3GPP 5G standards and can be deployed in combination with enhanced 4G/5G convergent techniques to enable smooth evolution to next-generation networks.

In terms of UE development and compatibility, the network evolution falls into two phases. The phase 1 is defined as Pre5G where 3GPP R12/R13/R14 technologies are introduced on the basis of compatibility with current LTE UEs to improve network capacity and user rates and carry more diverse services. The phase 2 is 4G/5G convergence, in which a 5G new air interface technology is completely introduced for necessary scenarios through the convergent networking and interoperability between LTE and NR on the condition that UEs support 3GPP R15 new radio (NR) and multi-connection technologies. This ensures the

Based on the Pre5G technologies, ZTE has also been well prepared for further 4G/5G convergence, aiming to help cooperative partners achieve the evolution from mobile internet to internet of everything (IoE).

—Zhang Zhi, Chief Engineer of TDD Planning, ZTE



continuity of convergent network coverage, enhances user network awareness, and offers an abundance of services.

Phase 1: Pre5G

The Pre5G technologies contain Massive MIMO, LAA/eLAA, and IoT.

- **Massive MIMO:** More antenna arrays are used in RRUs and AAUs through beamforming to improve spectrum efficiency and expand network capacity and coverage. As 5G NR takes Massive MIMO as its core technology, Pre5G Massive MIMO base stations that are being deployed can also allow their antenna devices to smoothly evolve to 5G NR without any change. Although at present 5G NR terminals are not commercially ready, deploying Massive MIMO networks can help operators improve their LTE competitiveness, ensure the fastest evolution to 5G at lowest costs, and maintain their leading network advantages in the 5G era.
- **LAA/eLAA:** ITU has allocated a great number of new spectrum resources to 5G NR, ranging from 6 GHz to 90 GHz. To provide greater network capacity, LTE needs to make full use of existing spectrum resources. LAA/eLAA based on unlicensed spectrum and carrier aggregation can fully utilize existing spectrum resources to quickly increase capacity in heavy-traffic density areas. Using DFS, LBT, and TPC technologies, LAA enables interference avoidance and rapid resource scheduling in the unlicensed spectrum. This guarantees not only fair competition among different radio systems but also radio transmission efficiency when a conflict occurs. Moreover, eLAA also enables uplink transmission in the unlicensed spectrum

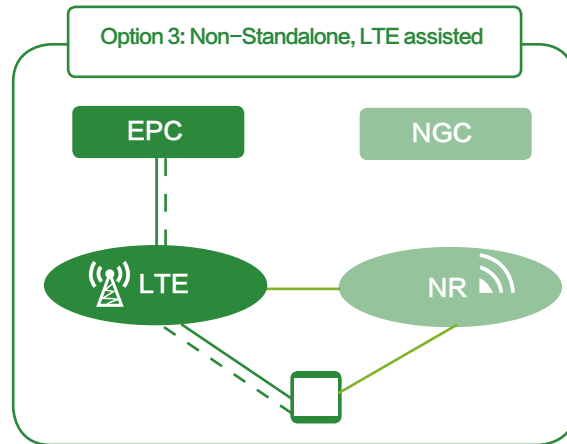


Figure 1. Option 3: Non-Standalone/LTE assisted, EPC connected.

to address the issue of insufficient uplink resources in some networks. Massive MIMO and LAA can allow a single UE to deliver a peak rate of 1 Gbps and the networks to deploy high-bandwidth new services, helping operators develop new business models and applications.

- **IoT:** As higher requirements are placed on in-depth coverage of IoT, it is recommended that low frequency bands with good coverage be a preferred choice for wide-area mobile IoT. eMTC may be used for networking with existing LTE in-band carriers. $N \times 1.4$ MHz radio resources of the existing LTE carriers are dynamically allocated to eMTC. Since eMTC and LTE share the same frequency resources, IoT services that have low real-time requirements can be shifted to be delivered on the time when the network is idle. This increases IoT service bearer capability with no impact on LTE user experience, making LTE and Pre5G networks more valuable and efficient.

Phase 2: 4G/5G Convergence

The first version of 5G NR standards will be completed in 2018. As 5G NR standards are set to be frozen, commercial 5G NR terminals will emerge. Mainstream 5G NR chip vendors support multi-connection between LTE and NR, which can be used to meet user requirements for seamless network coverage and enhanced service experience.

In the initial 5G deployment, LTE UEs and NR terminals will coexist for a long time, and a very large proportion of terminals are LTE UEs while there are few NR terminals.

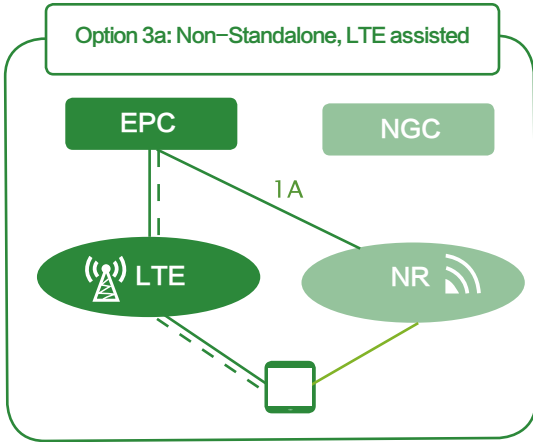


Figure 2. Option 3a: Non-Standalone/LTE assisted, EPC connected.

When 5G networks start to be deployed in local areas as needed, deploying 4G and 5G convergent networks can provide best user experience.

In this phase, the spectrum of Massive MIMO base stations will be gradually reformed to that of 5G NR. Initially, according to the distribution proportion of end users, a part of LTE frequency resources are reformed to those of 5G NR. As the distribution proportion of end users varies, more LTE frequency resources will be reformed.

5G NR base stations can be plugged in 4G ones for 4G/5G convergent networking. The convergent networking can use the 5G architecture options defined in 3GPP such as Option 3: Non-standalone/LTE assisted, EPC connected (Fig. 1) or Option 3a: Non-Standalone/LTE assisted, EPC connected (Fig. 2). The two modes differ in that in Option 3, the 4G/5G PDCP converges in the core network while in Option 3a, the 4G/5G PDCP converges on the base stations.

In these two options, the control-plane anchor point of a 4G/5G convergent network is in the LTE network, which guarantees a continuous coverage of 4G/5G multi-mode

terminal services while offering enhanced service experience in the 5G deployment areas.

A 4G/5G convergent network can also use the separation of user plane and control plane to offload the 4G/5G convergent multi-mode user-plane traffic to the NR network and use the SCG split bearer to reduce changes to the existing LTE base stations and auxiliary transmission facilities, as specified in Option 3+ (Fig. 3).

The split between a central unit and a distributed unit (CU/DU) in a 4G/5G convergent RAN depends on service scenarios and needs to consider performance, fronthaul, costs, and chipsets. A suitable split point is placed at the RLC and PDCP layers, that is, CUs are placed at the PDCP (or higher) layer and DUs are placed at the RLC (or lower) layer.

CUs can be virtualized by using general-purpose processors. Considering the cost-effectiveness, DUs use special-purpose processors. CUs and DUs can be deployed flexibly through the software technology such as network slicing to meet various service scenarios.

The Pre5G technologies advocated by ZTE have been widely accepted in the industry, and ZTE has started to deploy

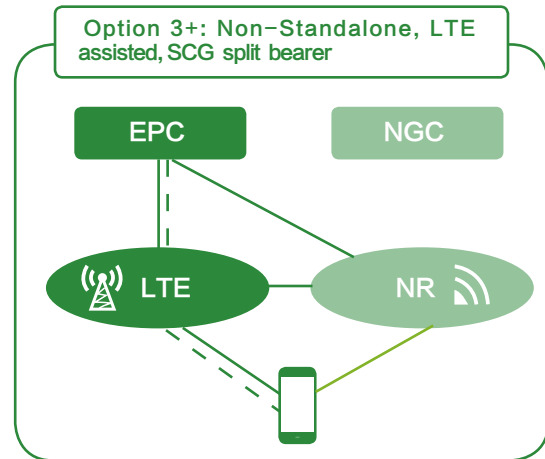


Figure 3. Option 3+: Non-Standalone/LTE assisted, EPC connected.

them globally. Based on these technologies, ZTE has also been well prepared for further 4G/5G convergence, aiming to help cooperative partners achieve the evolution from mobile internet to internet of everything (IoE). **ZTE TECHNOLOGIES**



JAPAN'S SOFTBANK STARTS ITS 5G ERA

By Han Gang, Duan Ganggang

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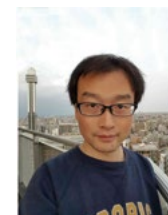
As mobile communication develops rapidly, the IoT and 5G era is just around the corner. Many countries have put forward their commercial 5G plans to seize first-mover advantages. China has planned to put 5G into commercial operation in 2020. Korea has planned to roll out a pre-commercial 5G network in 2018, expecting to first provide 5G services for the Olympic Winter Games to be held in Pyeongchang. Japan is aiming to launch 5G in 2020 when the Tokyo Olympic Games will be held. The US telecom operator Verizon has proposed taking the

lead in commercializing 5G in 2017. In Europe, every country is required to nominate at least one major city to be '5G enabled' by the end of 2020. All leading operators around the globe are striving to pioneer 5G commercialization.

On September 8, 2016, Japan's SoftBank held a global conference, announcing the official start of their 5G project, which oriented the next-generation high-speed communications standard. SoftBank became the world's first operator to put Pre5G Massive MIMO into commercial operation. As a strategic 5G partner of SoftBank, ZTE is an important facilitator of this program.



Han Gang
Vice President of ZTE's TDD Products



Duan Ganggang
TDD Product and Solution Manager, ZTE



SoftBank's 5G project kickoff conference

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TDD Being the Magic Weapon to Win in the Data Era

SoftBank has both FDD and TDD spectrum resources, so it has used open network architecture to leverage the advantages of both systems. The FDD network that features symmetrical uplink and downlink channel resources and relatively lower frequencies is chiefly used to carry voice and some data services, while the TDD network based on the flexible configuration of uplink and downlink channel resources is chiefly used to carry data services. According to SoftBank, the TD-LTE network, in the fourth quarter of 2016, carried 63% of SoftBank's entire mobile broadband downlink data traffic, 43% of its uplink data traffic, and 55% of its total 4G users. These data traffic and users were all supported by SoftBank's 30 MHz TD-LTE spectrum, which accounted for only 20% of SoftBank's commercial spectrums.

In the next three to five years, SoftBank will use Pre5G Massive MIMO and 8T8R to enhance TDD

spectrum efficiency and to gradually move towards 5G. Based on SoftBank's frequency and technology plans, TDD will handle at least 70% of data traffic in the network by 2020.

Innovative Solutions to Build Highly Competitive Networks

SoftBank selected ZTE's innovative tailor-made solutions for its existing networks. The solutions include advanced C-RAN architecture, TD-LTE/PHS co-site shared antenna and feeder design, and SuperCell, which can be used to address the interference issue to improve network capacity, and to build quality networks with high performance and high competitiveness.

Advanced C-RAN Architecture

C-RAN, a state-of-the-art architecture solution for radio access network, has four features: centralized, cooperative, cloud, and clean. BBUs are centrally

deployed to greatly reduce energy consumption and O&M costs of the radio access network. Baseband resources are shared for intra-site and inter-site synergies. This can significantly improve radio network performance.

TD-LTE/PHS Co-site Shared Antenna and Feeder Design

The costs for new-site construction account for more than half of total network construction costs. After carrying out a number of field surveys and network planning and simulation activities, ZTE came to the conclusion that SoftBank's existing PHS sites could be reused as new TD-LTE sites. According to the statistics, approximately 80% of SoftBank's TD-LTE and PHS sites are co-located. Through a series of ZTE's tailor-made solutions, SoftBank's TD-LTE and PHS equipment can share antennas and transmission facilities. This co-site shared antenna and feeder design can significantly reduce site rental and auxiliary hardware costs.

Innovative Interference Avoidance

SoftBank's TD-LTE network uses omni-directional antennas, and the distance between two sites is much smaller than that in an ordinary LTE network. This causes serious co-channel interference. To solve this problem, SoftBank and ZTE jointly launched the SuperCell+SDMA technology that can avoid inter-cell interference by combining adjacent physical cells. The tests performed after the SuperCell+SDMA technology is used in SoftBank's actual network show that the average network capacity is significantly expanded with the control signal interruption rate being less than 2% and the cell-edge user spectral efficiency going up by 150%.

3.5 GHz 8T8R Solution to Further Improve Network Competitiveness

To meet SoftBank's requirement for lowering TCO, ZTE has put forward the 3.5 GHz 8T8R solution based on the C-RAN architecture and the existing 2.5 GHz TD-LTE and 1.9 GHz PHS co-site shared antenna and feeder design. The 8T8R solution allows the 3.5 GHz TD-LTE, 2.5 GHz TD-LTE and 1.9 GHz PHS networks

to share sites, antennas, and feeders to considerably lower TCO. The C-RAN solution is beneficial to the implementation of subsequent centralized solutions, so that the 8-antenna based 3.5 GHz network solution, including 2CC CA and 256-QAM, can not only achieve the basic 1 Gbps requirement from Japan's Ministry of Internal Affairs (MIC) but also enable SoftBank's network to evolve to 5G more easily.

Introducing Latest Technologies to Establish As a Technology Pioneer

In 2015, SoftBank and ZTE signed a Memorandum of Understanding (MOU). Both parties agreed to actively cooperate in Pre5G and 5G research to jointly promote the development and commercialization of new TD-LTE technologies and products. In June 2016, SoftBank, together with ZTE, tested and verified the ultimate performance of Massive MIMO. In a real commercial environment, the peak throughput of a single Massive MIMO cell reached up to 316 Mbps. Massive MIMO also could simultaneously access 200 UEs to smoothly handle various services such as watching videos and browsing web pages, offering users extremely good experience. For cell edges with weak signal strength, compared with traditional macro base stations, Massive MIMO brought 8 to 10 times better internet access experience, greatly reducing the proportion of low-rate users in the network and dramatically improving overall cell performance and user experience.

After five years of rapid development, SoftBank has deployed over 66,000 commercial TD-LTE sites across Japan. From the previous sparse network covering only the first few major cities to the current nation-wide seamless network, the number of TD-LTE users has reached 22 million. Now SoftBank and ZTE are jointly carrying out more extensive research and cooperation in terms of innovative 5G technologies. Committed to becoming the world's No.1 mobile internet company, SoftBank will surely seize the next-generation network deployment opportunity to lead Japan or even the world in the telecom market. [ZTE TECHNOLOGIES](#)

ZTE Gets Serious About IoT

By Chong Jinn Xiung

Mar 01, 2017

Source: Digital News Asia

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ZTE

The internet of things (IoT) is not the future. IoT is already here today and it is definitely evident at this year's Mobile World Congress in Barcelona.

Throughout the conference and in many booths, companies are putting their focus on providing IoT solutions that bring together smart devices, gather data and make sense of it.

At Barcelona, ZTE Corporation signed a strategic cooperation agreement with Intel Corporation to jointly establish an innovation lab for research and development of future key IoT technologies including experimental verification, evaluation and development of related technologies.

Both companies have previously collaborated in other fields such as IoT access technologies, open-source collaboration and solution integration.

IDC forecasts that global spend on IoT will hit US\$1.29 trillion by 2020. Coincidentally, that is the same time frame in which 5G networks are expected to be commercially deployed.

But it is no coincidence that telecommunications equipment provider ZTE is hard at work on IoT solutions on top of developing the 5G backbone that is required to facilitate communication between all these connected devices.

To this end, ZTE has developed its smart IoT operating system that provides intelligent capabilities for IoT terminals and acts as an IoT management platform.

As an ICT enabler for the IoT industry ZTE said it utilises solutions involving narrow band IoT (NB-IoT), LTE and various modules for smart devices and software to accelerate the development of sensor technologies.

ZTE has also formulated end-to-end security solutions to provide customers with security services for simultaneous planning, construction and operation. The company hopes to cooperate with partners to provide an overall solution for governments and enterprise customers.

ZTE senior vice president Jane Chen highlighted that ZTE's IoT strategy moving forward focuses on four key areas: smart cities, smart homes, the industrial IoT and connected vehicles.

Cities are getting busier and smarter, so connected technologies that apply to traffic management, energy conservation and environmental monitoring are crucial.

Chen said ZTE has deployed its IoT solutions in over 140 cities in 40 countries globally. She stated that a wide variety of solutions using smart meters have helped optimise city infrastructure with smart street lighting, parking as well as water and air monitoring.

Some examples include the deployment of 20 thousand smart



street lamps in Paris' smart city project: the City of Light. These smart street lamps are outfitted with sensors that help manage its energy consumption and maintenance optimisation.

To help alleviate traffic jams in congested cities, ZTE has smart parking solutions that notify users where they can park their vehicle without having to search for hours on end for parking spots.

With its smart building and environmental monitoring, building managers would be able to better manage power distribution within the building.

Smart home solutions account for about 30% of IoT applications and requirements. To this end, ZTE has its future-oriented smart home solution called ZTE Alighting that acts as a control centre to help control interconnected smart home appliances device from anywhere in the home with just a smartphone.

Uses include regulating environmental control and monitoring one's home remotely even from abroad. Wireless water leak detectors alert users of potential leaks while infrared motion sensors and audible as well as visual alarms help keep the home safe.

ZTE feels that security will be the primary use of connected devices as camera monitoring systems with motion detection can sense if there is an intruder in your home when you are out.

Connected vehicles will be another big area of IoT as cars and trucks get an upgrade to become smarter and safer. ZTE has worked with Chinese car maker Geely to make safer and better-maintained vehicles both for private and commercial use.

Chen described how smart sensors in a vehicle are constantly connected to a network and would be aware of the environment around it. The sensors would use weather reports to advise drivers to drive carefully if it rains or snows and would also report on potential engine problems before they happen.

"These sensors would be able to gather data on a driver's driving habits which can be used by insurance companies to accurately price their premiums and incentivise drivers to adopt safer driving habits to enjoy greater savings," said Chen.

The usage goes beyond end consumers with their cars and can be applied in fleet management for transport trucks hauling cargo around the country. Smart trucks would be able to monitor a driver's driving habits and report if they are driving dangerously.

Admittedly, the IoT market is still in its very early stages and not many areas are profitable yet, said Chen. Many companies are still figuring out how they can take their solutions and go to market. This is where ZTE provides assistance to its customers, advising and supporting them as an end-to-end solutions provider. **ZTE TECHNOLOGIES**



Leading 5G Innovations