Pedro Calvillo, CTO of Euskaltel

Special Topic   **5G Evolution**

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ZTE

Success Stories

Third Eye

ZTE Small Cell Solution Wins Top Award from Telecom Asia

3 December 2015, Singapore — ZTE is pleased to win the Small Cell Innovation of the Year award from industry publication Telecom Asia.

The award recognizes the industry-leading capabilities of ZTE's Small Cell solution, which enables operators to build high-performance multi-mode 4G LTE, 3G and 2G indoor coverage networks with seamless handoff and large capacity. ZTE's Small Cell solution supports fast and flexible deployment, enabling customers to configure and manage their networks with low cost of ownership.

The annual Readers' Choice & Innovation Awards, organized by Telecom Asia, reward outstanding achievements in the region's telecom industry. Winners are chosen by readers of Telecom Asia, from a shortlist nominated by editors, analysts and consultants.

ZTE-Empowered Hutchison Drei Austria Network Ranks No. 1 in Mobile Performance

4 December 2015, Vienna — ZTE is pleased that Hutchison Drei Austria's network ranked top in *CONNECT* magazine's annual network performance evaluation tests for local mobile operators.

Hutchison Drei Austria, deploying ZTE's industry-leading wireless solutions, was ranked top for voice services in Austria in the performance tests, run by *CONNECT* magazine in conjunction with network optimization company P3 Group. Drei was also ranked at top place in the data services category, together with Telekom Austria A1.

Each year, *CONNECT* magazine works with wireless network optimization company P3 Group to organize formal tests of mobile networks covering the German-speaking countries Austria, Germany and Switzerland (D-A-CH countries). The programme includes tests for download speeds, upload speeds and user experience. The objective is to help improve network performance across the whole region and covers the voice and data services in urban areas and on inter-city railways.

Telefonica Completes ZTE vIMS and vSBC Performance Tests in Madrid NFV Reference Lab

9 December 2015, Madrid — ZTE and Telefonica have jointly tested ZTE vIMS & vSBC VNFs, part of ZTE's Cloud UniCore portfolio, in Telefonica's NFV Reference Lab in Madrid, Spain. OpenMANO stack, the ground-breaking module for the easy creation and deployment of complex network scenarios of Telefonica's NFV Reference Lab, was used to test ZTE's solutions.

The objective of the tests was to benchmark the deployment and performance of network functions virtualisation (NFV) solutions. The resulting data has provided clear evidence of the performance range service providers can expect from virtualised, software-based networking infrastructure.

The establishment of NFV benchmarks is part of a joint effort by both companies within the Telefonica NFV Reference Lab framework. ZTE's virtualised evolved packet core (vEPC) was previously tested in Telefonica's Reference Lab as part of this effort.

The results delivered were outstanding, reaching Telefonica's expected performance levels and smooth deployment objectives which allowed the test to be completed in a very short amount of time. ZTE and Telefonica will continue testing other elements of ZTE's NFV portfolio in the coming months.

ZTE USA and the Houston Rockets Complete Third Annual Season of Giving

20 December 2015, Houston — ZTE USA, the fourth largest smartphone supplier in the U.S. and second largest in the no-contract market, and the Houston Rockets concluded their third annual Season of Giving by wrapping up the third of three events in the Houston area. Throughout the past two months, ZTE employees, and members of the Rockets organization, players and staff, completed various charitable activities that impacted those in need during this holiday season.

"We are extremely proud to be able to partner with the Rockets and give back to the local community in Houston through the Season of Giving," said Lixin Cheng, Chairman and CEO of ZTE USA. "We are committed to impacting the lives of those less-fortunate in all communities we live and operate in."

"We are honored to have worked with ZTE on enriching the lives of those less-fortunate throughout our city," said Rockets Chief Executive Officer Tad Brown. "We thank our partners at ZTE for helping make this year's Season of Giving events a success."

The Season of Giving included three events hosted by ZTE and the Rockets: thanksgiving dinner shopping spree, arcade frenzy, and a night at the museum.

ZTE Helps 3 Macau Launch a Commercial 4G LTE Network

24 December 2015, Macau — ZTE helps Hutchison Telephone (Macau) Company Limited (3 Macau) roll out a commercial 4G LTE network. Customers can enjoy fast and smooth world-class 4G LTE services that cover more than 90% of outdoor areas. The network enables download speeds of up to 112 Mbps and upload speeds of 37.5 Mbps on the 15 MHz paired spectrum.

ZTE's 3D-MIMO Moves Step Closer to Commercial Deployment

2 December 2015, Shenzhen — ZTE is pleased to take its proprietary pre5G technology a step closer to commercial deployment, after the successful testing of the company's 3D-MIMO solution on China Mobile's commercial network.

ZTE's 3D-MIMO helped increase average data throughput by two to four times, with data rates at the cell edge going up as much as five to seven times, according to results from a test conducted on China Mobile's commercial network in a metropolitan area of Guangzhou. The pre-commercial test, conducted jointly with China Mobile's Guangdong provincial subsidiary, and China Mobile Research Institute, demonstrated the capability of ZTE's 3D-MIMO solution to improve network throughput and coverage in an area with a high concentration of tall buildings.

3D-MIMO provides more precise beamforming and more effective spatial multiplexing to greatly strengthen network resistance to interference and improve performance of cells and the overall network. It is a key component of ZTE's pre5G technology.

ZTE's 3D-MIMO base stations feature the company's patented intellectual property, with 128 built-in antenna elements and advanced baseband vector processing chipsets, and are fully compatible with existing 4G LTE infrastructure and user terminals, making them easy for operators to deploy.

EUSKALTEL:

Being a Reference for Managed Services

Reporters: Pan Xiaolin, Mario Bilbao

Pedro Calvillo, CTO of Euskaltel

"Values such as closeness, proximity, availability, and quick response to customer needs are part of our DNA. We believe these and high-performance technologies and products are the keys to our success," said Euskaltel CTO Pedro Calvillo.

Euskaltel is the largest operator in the Basque country of northern Spain. In 2014, Euskaltel and ZTE entered into a strategic alliance by signing a ten-year network-wide managed services contract. The alliance is an essential step forward for ZTE's investment in Europe. ZTE will help Euskaltel with the transformation of its networks and services. How is the progress of the cooperation so far? And how will the partnership evolve in the future? Reporters Pan Xiaolin and Mario Bilbao recently interviewed Pedro Calvillo, CTO of Euskaltel, at his office.

Euskaltel is the leading operator in the Basque country. It has been ranked No. 1 in fixed telephony, broadband, and Pay TV, and No. 2 in mobile phone. What are the keys to your competitive advantages?

Understanding customer needs is the key to success of any company. Values such as closeness, proximity, availability, and quick response to customer needs are part of our DNA. We believe these and high-performance technologies and products are the keys to our success.

To gain the upper hand, operators are considering transforming their services and networks. What are the main challenges

faced by operators in South Europe in their transformation? How can Euskaltel compete in this challenging environment?

The availability of new-generation networks is a reality in our country. These networks can offer high-performance products and services. Euskaltel has a network that covers 85% of households in the Basque country.

The products offered by these networks require going beyond the transmission quality or signal bit quality. The quality of massive audio and video during transmission presents a new challenge. Proper network optimization and operation are critical for gaining a competitive advantage. The evolution of benefits in the functionality offered to customers is another challenge that operators are facing.

To address these trends, Euskaltel is seeking an alliance with technology providers who can help us develop and adapt to these new demands.

Euskaltel and ZTE formed a strategic alliance in 2014 by signing a ten-year network-wide managed services contract. What is the significance of the strategic alliance to Euskaltel?

With this agreement, Euskaltel can go beyond collaboration for network operation. We intend having

a collaborative partner to help us in the current network operation, optimization, and evolution, with the aim of adapting to the new competitive global market. This will allow us to offer the most advanced, highest-quality services to our clients and thereby secure the leading position in the telecommunications market.

Why did you choose ZTE as your strategic technical partner in the transformation?

ZTE provides a reference to telecom companies worldwide and has strong leadership. Our alliance with ZTE creates in the Basque country a new managed services company that will be a reference for Southern Europe. Moreover, the strategic technical alliance with ZTE will also create a wealth of qualified employment for Euskadi and related industries in the sector.

How do you comment on the progress of the cooperation so far and how is Euskaltel benefiting from it?

The partnership began in December 2014. We have just completed network transition and stabilization. The results to date have been consistent with our expectations.

We highly value being a reference center for managed services. In addition we have strong awareness of the techniques and solutions that are developed. All

this means competitive advantage.

Besides the managed services contract, ZTE also assists us with network evolution. We are deploying a 4G network with ZTE's technologies and our own license that will cover our customers in the Basque country. We hope the first radio stations will be in service soon. We are also deploying ZTE's FTTH in several industrial areas and hope to put it into service. Finally, we have started migrating our core circuit switching to packet switching. With the three projects we have initiated a process of network evolution that will benefit our customers with higher-performance products and services.

What do you think ZTE can improve to create more value for Euskaltel's development in the future? What role will ZTE play in managed services in future?

Right now, ZTE is blooming in terms of new technologies for delivering managed services. The evolution from network operation center (NOC) to service operation center (SOC) and then to customer operation center (COC) is our objective. Technologies like big data, virtualization machines and functionalities, and data in the cloud can help us improve user experience. We believe that ZTE is called to be a global player in this type of evolution. **ZTE TECHNOLOGIES**

MTN GUINEA:

Great Ambition in a Small Market

Reporter: Liu Shuang

Themba Mkhululi Khumalo, CEO of MTN Guinea (Areeba)

TN Guinea, one of the major operators in Guinea, has a subscriber base of 2.8 million people. It is a subsidiary of MTN Group, a South Africa-based multinational mobile telecommunications company that operates in many African, European and Asian countries. In November 2015, MTN Guinea said that in the next two or three years, its mobile signals would cover all of Guinea. In addition, it will improve network performance in order to seize more market share. Recently, *ZTE Technologies* interviewed Themba Mkhululi Khumalo, CEO of MTN Guinea (Areeba). He talked about his career, MTN Guinea's achievements and opportunities, overall strategy, main challenges and key targets in 2016. He also shared with us his expectations for ZTE and his views on future trends in the global telecom market.

Could you introduce your career history?

I am Themba Mkhululi Khumalo, CEO of MTN Guinea (Areeba). I have a Masters in Electrical Engineering from the University of Iowa. I joined MTN in South Africa at the introductory stage of GSM in 1994 as an engineering manager, responsible for site implementation.

MTN SA had just been launched following successful GSM license award as one of two GSM operators. Our main objective was to urgently close the coverage gap between us and the main player at the time, Vodacom SA.

I began my career in telecommunications in 1982 with Swaziland Posts and Telecommunications Corporation, which is a government-owned fixed line operator. I was responsible for a number of projects ranging from satellite earth station management, transmission planning (wireline, UHF radio and microwave systems) and left in 1991, when I was head of network operations (access, transmission, switching and customer services). I relocated to South Africa.

At MTN, I have had a wide and rich career spanning many countries in various disciplines. I served MTN Swaziland as CTO from 1999 to 2003 and subsequently CEO in same country from 2003 to 2007. I subsequently served as CEO in Rwanda and Uganda from 2007 to 2012, after which I returned to MTN Group as an

Operational Executive responsible for 13 tier-3 countries of the Group.

What are the major achievements of MTN Guinea in the past year?

MTN Guinea (Areeba) has been a special case in many respects; a small market in challenging times with intense competition and the scourge of Ebola. The business lost its market leadership in 2013.

The major achievements of the company in this period have been to focus on strategic issues that will help us attain a good position in the competitive environment. We have achieved a high quality network for our customers in both 2G and 3G services. In these difficult times, it was critical to review total cost of operations (TCO), which led to a major national radio network swap-out.

We swapped out the Ericsson radio network for ZTE equipment, including the national backhaul links. Throughout this process, we also modernized our network to ensure improved customer experience. In addition, we stabilized the company from market share decline and addressed a number of fundamentals internally and externally to ensure that we have a robust asset to compete effectively in the market.

All these initiatives have helped us deliver the best quality services and experience.

Africa has been the fastest growing telecom market in the world. What opportunities do you see for MTN's growth in Guinea?

Guinea has a potential of becoming an economic engine in West Africa. The country has huge deposits of bauxite, diamonds, gold and super quality timber amongst others. Infrastructure development has a long way to go, but it presents huge opportunities for the government and the country.

MTN Guinea is positioning itself to deliver world class telecommunication facilities and provide a good environment for investors. We are a strategic party in the development of Guinea. It is vital that we develop key strategic partnerships with selected vendors to secure successful delivery on this promise.

As CEO of MTN Guinea, what is your overall

strategy to ensure its sustainable development?

One of our business objectives is the development of local human resources to run our operations. MTN has its roots in Africa; we take this seriously as we believe that an investment in human resources will ensure sustainable development.

Moreover, we are cognizant of the technological roadmap for telecommunications to guide our investments towards the future. Outsourcing of support functions has been the key to our strategy.

What are the main challenges in your role? How do you tackle them?

Skilled labor shortage, utility power availability, indirect taxes, and changing tax regimes have all had a negative impact on business. The first two are well managed and we deliberate investment plans addressing these issues.

An unstable tax environment is creating an uneasy situation for shareholders and investors. We have TARTEL which takes 3% of gross revenues, and TCT that increased our headline tariffs by 14%. The worst impact is that it is paid to the regulator on both billed and free minutes, thus eroding value directly and limiting incentives that operators use to stimulate usage. We endeavor to strike a balance on these conflicting demands, but traffic volumes are severely impacted with a loss of revenue to both government and operators.

Fuel supply and distribution is a big contributor to costs with limited national power generation and limited power distribution network. Our power systems have been redesigned smartly with hybrid systems and fuel telemetry systems. ZTE was our partner in both these systems with their existing solutions portfolio.

What is your plan to expand your network capacity? What are your major concerns for capacity expansion?

We expanded our radio network aggressively in 2014 and 2015 in order to provide both capacity and expanded 3.5G coverage. More focus will be placed on expanding high demand areas, particularly in Conakry, to deliver on our promise.

LTE is of interest; however, spectrum and regulations

are concerns. More engagement with authorities is planned.

How would you comment on ZTE in terms of project execution capability? How do you think the partnership between MTN Guinea and ZTE will evolve?

ZTE has played a pivotal role in our modernization process. During the worst Ebola outbreak, ZTE did not abandon us and run, like some other vendors did. This was greatly appreciated.

Overall, ZTE delivered on the projects successfully. Any challenges that arose due to our particular locations were resolved amicably. What is vital to us as an operator is to have a reliable partner that delivers on its promise.

I think the traditional relationship between supplier and operator has no place in our new business; suppliers have to become an integral part of the solutions we deliver.

What are the key targets of MTN Guinea for 2016?

2016 will be a recovery year. Our focus areas are market share growth, value share growth and exceptional customer experience.

We are consolidating our quality in key identified areas to attract and defend our high value customers. Our global solutions will be developed to capture a lion's share of the business in Guinea.

What are some of the new trends in the global telecom market?

Increasing innovation and optimization of cost structures will continue to occupy the minds of operators. The business model of telcos is now rapidly changing with increasing competition from non-traditional adjacencies. The need to reinvent telecoms is now more pressing than ever, some of these inventions will be led from emerging markets with a different set of problems in a global context.

Telecoms are now global, and any solutions that will not take this into account will not be sustainable. Our business and regulations will need to be borderless to remain relevant and protect the massive investments made by traditional telcos. Resistance to change will only lead to a catastrophic failure of our industry. **ZTE TECHNOLOGIES**

TELENOR PAKISTAN:
Empowering Pakistan

Reporter: Zhang Ying

Irfan Wahab Khan, Deputy CEO and CMO of Telenor Pakistan

Telenor Pakistan is owned by the Norwegian Telenor Group, which is an international provider of voice, data, content, and mobile communication services in 13 markets across Europe and Asia. Telenor Pakistan has a subscriber base of 34 million. In addition, it owns the Tameer Microfinance Bank, which loans money to the poor and is helping development in Pakistan. Recently, *ZTE Technologies* interviewed Irfan Wahab Khan, Deputy CEO and CMO of Telenor Pakistan. He shared with us Telenor Pakistan's performance, major developments of Pakistan's market, localized services and key focus of Telenor Pakistan. He also talked about the program of "Internet for All", his expectations for ZTE, and visions for Telenor Pakistan.

What major developments have you seen in Pakistan telecom market?

In the Pakistan telecom market, especially since the launch of 3G, the data is really booming. So we see that even though most parts of the country are rural, many people are using data and internet. The local ecosystem is also growing. It is not just the basic entertainment or information, like Facebook; people are using it for other things. They will check the latest articles where they can find the actions, where we can find incredible activities, whether it is health, whether it is education, whether it is agriculture.

So it is our chief contribution that more and more people like using smartphones, and they are using them to improve their lives. In addition, companies such as Telenor, are playing a major role in bringing financial provision, mobile banking, and also other products that we have seen a huge uptake in the local market.

Telenor was established in Pakistan in 2005. How do you assess Telenor's performance in Pakistan over the past 10 years?

Telenor entered Pakistan as the number four operator. Over the past ten years, we kept on increasing our performance. Now, we are one of the leading operators in the market. I think the reason for that is probably that we operate under a very unique culture, so culture is one of the key reasons for our success.

You know, we are able to attract many talents, people who are very smart and intelligent, who are passionate to do something, want to join us, because our vision is empowering societies. Based on that, we were able to build an organization which is around people. We bring smart people together, giving them an environment which is fun but at the same time hard work. That has been one of the main reasons for success.

Our team is very passionate because they see it as a great opportunity to make a difference. There are many opportunities, so we bring a lot of innovation to the market as well. When we launched our services, we launched them at very simple price plans.

We have taken a position where we say that we are transparent and trustable in partnership. Therefore, we don't cheat any customers; we don't have small print charges. We are honest and trustworthy.

Could you elaborate on your marketing strategies in Pakistan?

Our marketing strategy from the beginning is to connect the people; we need to communicate with them. In a word, our strategy is to improve our mass market. We started with a strategy which is "outside in", so everyone was competing in the cities, major regions of Pakistan.

In addition, we also give the portable communication services in the rural areas. As a result, we were able to connect the people. Connecting the people as well as our positioning which we are trustworthy and transparent in terms of price and offers, are our competitive advantages.

What marketing challenges do you face? How do you overcome them?

The market is very complex; there are too many companies, and too much competition. All operators are trying to give a shock price, so the competition is very tough. And there is no higher differentiation between companies.

So we will have revamped our band around customers. We were making a communication which is easier, so we can reach out at the mass market, and we are saying that we offer them simple prices, and give them full flexibility and sound transparency. However, the challenge is data monetization.

The competition as well as how to make money on data are our two big challenges.

Could you introduce to us Telenor's localized services? How have your subscribers responded to these services?

In terms of local services, we have just started the journey. There is a lot of local and regional content that is really useful, and we keep working on it, whether it is music, education, health, or agriculture. Pakistan is a big agriculture country with 20~22% of GDP contributed by the agriculture sector, 45% of Pakistanis work in the agriculture sector. It is also quite an important sector.

We also have financial services, mobile money. It is a big counting, because 80~85% of people in Pakistan don't have access to bank accounts. We are the first company to give services of mobile banking. Today, we are the largest financial company, and we are serving millions of customers for payment solutions. We have the largest digital money networks in Pakistan.

Voice is transitioning to data service. What are your thoughts on this transition?

I think it is happening globally that voice is transitioning. Voice is still very good for us; it is still very important for our customers in the marginal market. That's why we need to keep bringing more value on the voice service and need to give them content and visual services day by day because in the very near future, voice will just become a commodity from which we can benefit.

That's why we need to keep on building a very healthy digital ecosystem, where we can have different content, different services, and high model capex, so that we can again monetize the services.

How will Telenor improve user experience to seize more market share?

Our philosophy is that customers always come first, so we call ourselves a customer-centric organization. User experience is at our core. We use network promoter score (NPS). In 2014, our interactions with the customers are all marked. Whether it is call center, whether it is our shops or stores, we may find it in pictures.

We also use service design metrologies in whatever we offer, and come with new offers of our products. We pass through that offer to realize our design concept, and it really helps us. Moreover, we have established a customer experience lab. We can test our products and offers and see how customers respond to them. All we are trying to do is to give a very good customer experience, very good prices, products, services and applications. It is all centered on customers.

How would you assess ZTE's team and solutions? What are your expectations of the cooperation?

"Our vision is that ZTE will become our preferred digital service provider, and also a visual service provider," said Irfan Wahab Khan, Deputy CEO and CMO of Telenor Pakistan.
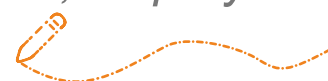
An interview

I think we have come a very long way in the journey. When we started the network, we had to overcome some difficult situations, but we came a long way as partners, going forward even closer with more collaboration. Ours is not just vendor and operator relationship, but more a partner relationship.

Because our ambition is to become a preferred digital service operator, so we would like to have the same level of experience for our customers. In order to do that, we need to have a partner like ZTE who can enter into the future in terms of the seamless experience on the good sites, and the seamless experience of services using latest technologies. So I would say that this relationship is getting closer and more practical.

We are also doing a lot of pilots together in the market. There are a lot of concepts which we may have ideas from ZTE and from Telenor. Let us work together closely, so that we can customize the market, and then we can expand the market scale later.

What is your vision for Telenor for the next few years?

Our vision is that ZTE will become our preferred digital service provider, and also a visual service provider. Telenor is going to transition from a mobile telecom operator to a digital service provider.

By doing that, we will empower Pakistan. Then we can really empower people and help them in their lives, making this journey a digital one, because we believe that digital is the future. I believe there are opportunities which will uplift the economy, which can bring revolutions that help education and other sectors for people. I think the future will be very great.

Digital is a very big trend. I think there is a role for us to play in having a digital lifestyle for our customers.

What we looking in digital are content. We are looking at digital money, we are looking at music, we are looking at health and education applications, we are looking at e-commerce, so all the things which we are looking at are not just inside Telenor, nor concrete solutions. We want to have a seamless experience across all things. That's what our customers need.

And there is also the Internet of Things. We have solutions for our business customers, which are revolutionary around the industry, such as transportation, supply chain, full portfolio and others. **ZTE TECHNOLOGIES**

Driving an ICT Journey
FOR NAMIBIA

Reporters: Zhang Ying, Liu Yang

Mbeuta Ua-Ndjarakana,
Permanent Secretary of Namibia's
Ministry of Information and
Communication Technology

The Republic of Namibia is a vast, sparsely populated country situated on the south Atlantic coast of Africa. Telecommunications in Namibia include radio, television, fixed and mobile telephones, and the internet. The new government has encouraged the development of the ICT sector; now the major cities in Namibia are connected. However, the rural areas are still not connected. Recently, *ZTE Technologies* interviewed Mbeuta Ua-Ndjarakana, Permanent Secretary of the Ministry of Information and Communication Technology. He talked about the status of Namibia's ICT sector, the greatest challenges and opportunities for the Ministry of Information and Communication Technology, and his future prospects for Namibia's telecom sector. He also shared with us his expectations for ZTE and his views on ZTE's social responsibilities.

You have been very active in promoting the development of the telecom sector. What are your priorities for Namibia's telecom sector?

Namibia is the youngest republic and the last country to become free and independent in Africa. We have remained behind for so many years, when other nations were moving forward. Therefore, we have the obligation to do things fast and to learn from others' experience so as to avoid mistakes that other countries have made. To do things better and faster, so we can catch up with other nations.

The ministry responsible for ICT was created in 2008, about 18 years after our independence. We haven't thought about ICT for 18 years. Of course, there have been some IT activities in areas within our government. It was only in 2008 that our government decided it was wise to have a coordinated approach to ICT.

We are not as old as other countries, but we don't complain. We have started; our idea is to make Namibia an ICT hub in the Southern African Development Community (SADC) region. We know it is a great task, but we are committed to making that to honor our citizens. That's why we are traveling around and seeing your technologies at your company. We are grateful that ZTE is amicable to Namibia, trying to help us and see how things can be done better.

We have an act of parliament, the Communications Act 2009, which has helped us move forward towards an information savvy nation. We also invested in a cable system in the West Africa, so that we can expand our communication lines. Of course, we had it as a joint venture between Namibia and Botswana to neighboring countries. Botswana is a landlocked country. Therefore, we invited them to join us in realizing the big dream of having a cable system that we can share.

This increased our traffic in terms of speed and volume for both the business community and public services. We have only been able to establish a regional hub for public services, which we need to expand to the constituencies, the villages and the towns in the country, but we haven't started yet. That is the areas that I think ZTE can propose solutions. We can look at them on how we can really give meaning to the investment on the cable, because otherwise, end up as just a big snake along our coast under the water but not really benefit the people.

Namibia's Vision 2030 focuses on knowledge, information and technology. What role does ICT play in realizing it?

We have developed a universal service and access policy with the idea of establishing a fund so that Namibia's enterprises can utilize the resource from the fund to maximize ICT and establish their own businesses. With this fund, they can communicate with others, reach out to businesses and manage the agricultural activities using ICT. Eventually, the whole system will change from a traditional model to an ICT model.

To help the nation moving faster in the modern and broadband technological path, that's my dream.

The competition of Namibia's telecom market is very tight. How do you create synergy between the major competitors?

Currently, people who have access to communications are about 70% of the territory of Namibia. We still have 30% of the territory that is not covered. Traditional telecom operators have not been keen to expand these areas because of the difficulty of making business there.

With the new government, in a promoted and inclusive society, everybody should feel hard of the whole family within the nation. We are working towards reducing that gap by inviting other operators and players to take advantage in the areas that are not yet

covered, so that they can be the pioneers and save their pays.

Once they have laid it out, our communication must use towers. They can then be the first to establish services. Eventually, those that have traditionally been better off will enter into this area, they will see things are changing and be interested to come into play. That will help reducing the price of services for the citizens, and then citizens will enjoy more services and more improved life styles.

What are the greatest challenges and opportunities for the Ministry of Information and Communication Technology in the next few years?

Today, we are working with ZTE, who is making progress because of its expertise and human resources. Every country needs that.

Now in Namibia, we have sagacity of expertise, particularly in the ICT sector. The ministry is not an exception. We have staff members who have wooed just traditional government employees, and who have not been orientated towards driving an ICT journey for the country. That is our main challenge.

Therefore, we look forward to partners and friends like ZTE. If we train many young people here, then they can work in the ministry and establish a new culture with sound understanding of what ICT can do for the nation, how government can drive the program to include everybody, and make the living and working conditions better for the people. In particular, the government employees can work better and deliver services timelessly without delaying access to services.

Namibia has witnessed a boom in broadband services in recent years. In you view, what have been the main drivers of this growth?

The main driver has been the political will. It indicated that as early as 2008, when the ministry responsible for the ICT sector was created. In addition to that political will, there is a commitment with resources, we will make it available to invest in our own cable. However, a major challenge is that we don't have a policy system. We don't have a broadband policy that is able to allow players and the government to manage

broadband services.

Now, we are developing this policy. I'm sure once we have laid it as our roadmap, we will be able to move forward.

How would you like us to contribute to Namibia's telecom sector?

There is grave unemployment in the country because people don't have the knowledge that guarantees them to be self-employed or employed in Nambia or elsewhere. So we need massive training for the young people in the ICT sector.

Nowadays, ICT is the engine of any society to move forward. If we could get training institutes in the ICT sector, I think that would be a great foundation for us to move forward.

We don't know how it can be done in China; we only just visited ZTE. We don't know the extent to which the whole nation, particularly the young people are prepared, because today and tomorrow belong to the young people. They need to be empowered to be able to manage their country and move it forward.

Could you tell us your future prospects for Namibia's telecom sector? What are your personal objectives?

I don't have personal objectives because in Namibia, it is a sin to become individualized. Namibia is a common home for all. That is why the president has promulgated the grand policy of improving the society.

Our focus is moving forward to ensure that everybody is a part of what happens in this country. Either in the ICT sector, or in the other culture sector, or in the construction sector, in every field of life, every Namibian should feel proud to be loved in a country called Namibia because they have a space to play their role, and they aren't an outsider in their own country. That's the dream of moving forward.

What is your achievement that you are most proud of?

There are two achievements. The first one is we have been able to put up the Communications Act, which laid the foundation for the country's ICT lifeline moving

A visit to ZTE's exhibition hall

forward as a guidance.

The second one is we have invested in the cable so fast. Our investment is not just yearly, the fruit is not disseminated yet, but we are still on focus. As an ICT ministry, we have been responsible for coordinating that journey for the nation.

Both are grand achievements that I'm most proud of.

What's next on your agenda?

As I indicated, next on our agenda is to ensure that everybody is connected and bridge the digital divide. Currently, we have people who cannot listen to the radio in our country. They have to travel more than 300 kms to hear a radio. Yes, that is what I meant by 30% of Namibia is still not connected. They are neglected in Namibia. That is a sleepless night concern for us.

It is not a belt of the country. It pockets here, and then a belt, particularly in the north and west part of the country. In Angola and other countries along the sea, there are communities who have not seen a telephone, a land-line telephone, not even to use it. They have not seen a radio. The young children have not heard a radio; they have not seen cell phone.

Even if I go there, I can't use my cell phone. I have no reason to show it to them because they can see it, but they can't use it. That is the situation.

What's your view on companies like ZTE on social responsibility?

We would like our friends from ZTE not only go to Windhoek, the capital of this country, but also go out into the countryside. They can see and experience for themselves the challenges that our citizens are facing now, so they can help our citizens with their knowledge and solutions. They will know what ZTE can do. Once they see the rural areas, they can generate new ideas, help us connect better, and solve the problems there.

I think maybe ZTE can invest in rural areas, not blindly, and then it will recoup its costs when the whole community gets connected. When the people start using the services with the excitement and everybody compete in the areas, the rural areas are covered closely one with another.

However, it is very important for ZTE representing the Chinese government in the ICT sector to have a foothold or to make an input in those areas that are not connected. The name of ZTE can be remembered forever. **ZTE TECHNOLOGIES**
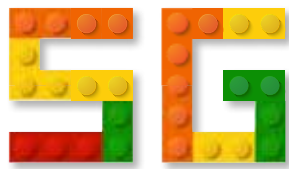
5G Network Architecture: Being Built Like Lego Blocks

By Xu Fang

China is now in the 3G and 4G and will be in the 5G era by 2020. 5G implies the interconnection of everything in a digital world, which includes man-to-man, man-to-machine, and machine-to-machine communications. 5G expects to not only introduce stretched network performance, such as 10 giga bps throughput, 1 ms delay and over 1 million connections, but have in-depth convergence with diverse vertical industries to enable abundant applications, such as high-speed railway, intelligent car, remote telecom-operation, virtual reality, and augmented reality.

In the 5G era, many use cases and customer-oriented businesses will be supported. A 5G network will be quickly set up and modified and have higher performance. This will be a big challenge for legacy mobile network architecture. A legacy network is function oriented, so dedicated hardware is used for RAN and core, and the processing of CS and PS is separate. However, a 5G network will be a unified, service-oriented, flexible telecom platform that can support an abundance of applications like IOS or Android in smart phones. The top of the

Xu Fang

Senior Architect of
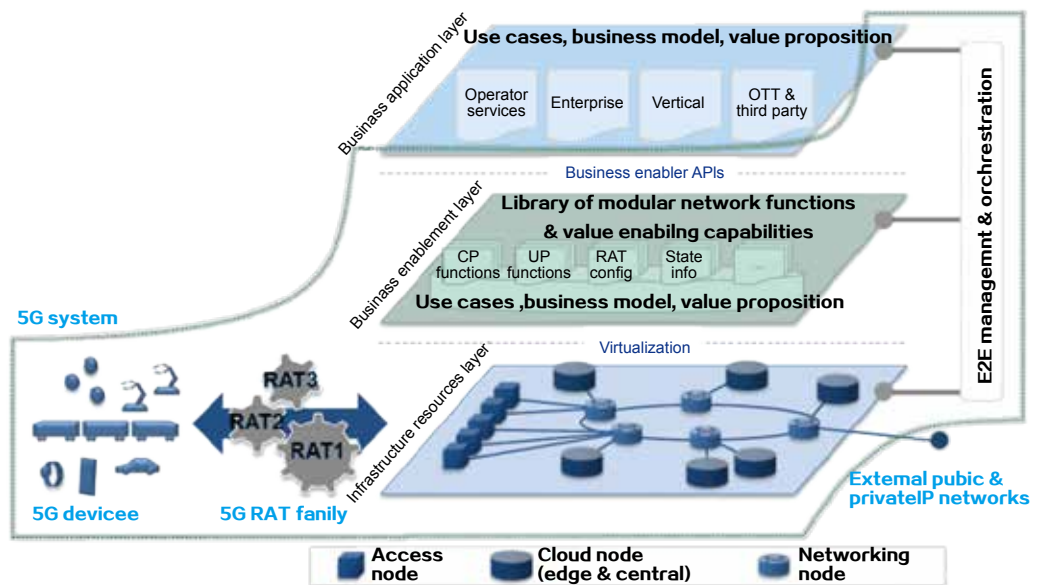Wireless Product Planning, ZTE

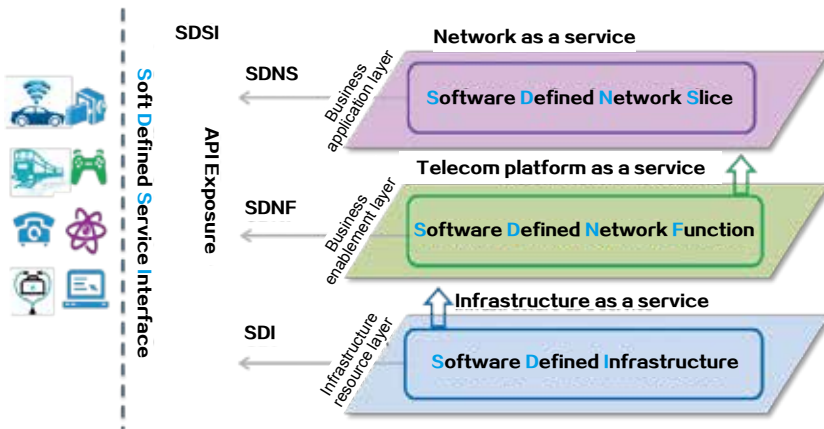Figure 1. Three-layer network architecture proposed by NGMN.

Figure 2. ZTE's 5G network architecture.

even OTT and third parties. These three layers can be managed end to end and can be dynamically orchestrated by the management and orchestration part.

ZTE's 5G network architecture is consistent with NGMN's initiative. The future 5G network will be a software-defined network that includes three plus one key characteristics (Fig. 2).

platform enables diverse applications through simple development and adaption.

The three-layer network architecture proposed by NGMN has been accepted in the telecom industry. At the bottom of the architecture is the infrastructure resource layer that includes access nodes, cloud nodes and networking nodes (Fig. 1). This layer virtualizes physical resources. In the middle of the architecture is the business enablement layer, which provides common information repository and a library of network functions such as control plan, user plan, state information, and RAT configuration. On the top of the architecture is the business application layer, which can deliver a variety of services to operators, enterprises and

Software-defined infrastructure (SDI) corresponds to the infrastructure resource layer of NGMN. Legacy hardware elements such as RAN and core are redefined. All other hardware resources except dedicated hardware including accelerators are virtualized. These resources are uniformly managed and scheduled so that on-demand virtual resources can be provided to the upper layer. The SDI concept is similar to infrastructure as a service (IaaS) of an IT system. The infrastructure resource layer is separated into physical domain and virtualization domain (Fig. 3). The physical domain provides physical resource nodes, including the access node, computing node, networking node, and storage node. On top of the physical resource nodes is a virtualization layer that can provide virtualized resources to the upper layers
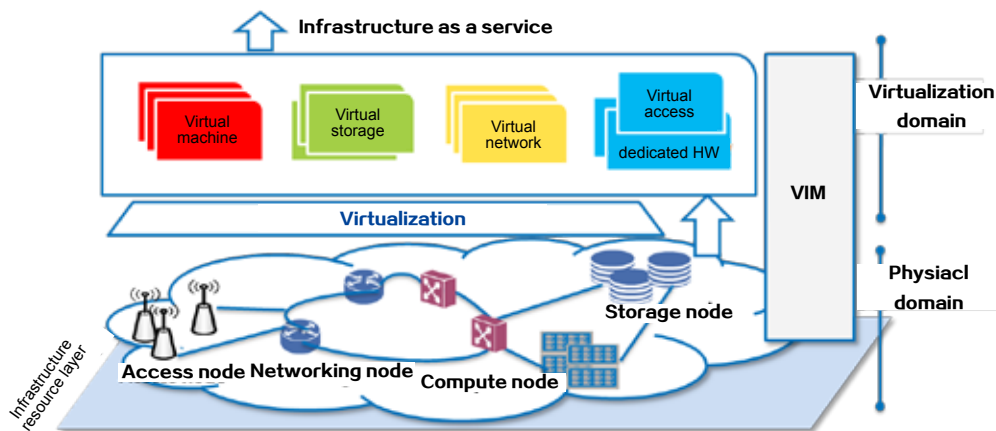
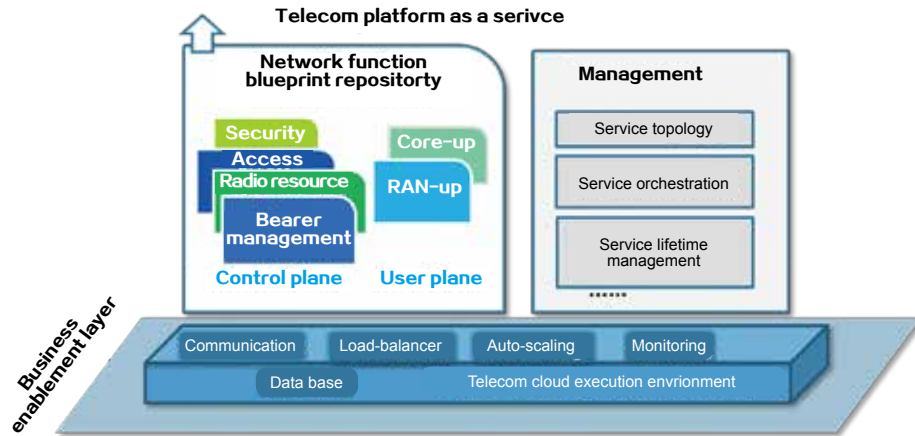Figure 3. The infrastructure resource layer.

Figure 4. The business enablement layer.

through tools OpenStack. The virtual infrastructure management (VIM) on the right side manages resources in a unified way and provides IaaS interfaces. VIM also manages dedicated hardware to enhance telecom service performance such as user data forwarding, encryption, and decryption.

Software-defined network function (SDNF) is the business enablement layer of NGMN and can provide common functions and business components. The SDNF concept is similar to platform as a service (PaaS) of an IT system. An execution environment is needed for telecom cloud. Common services such as communication, load balancing, monitoring, and database are embedded in the execution environment

(Fig. 4). On top of these services, a network function blueprint repository is provided. The network function blueprint is a description file that describes how components are composed in order to form a network function. The network function blueprint does not really work in the data center but is just a configuration to describe how components are orchestrated, similar to an application in the application store. The management system assembles and orchestrates these components, involving service topology management, orchestration management, and service lifecycle management. It functions as a manufactory where a finished product—network function is made.
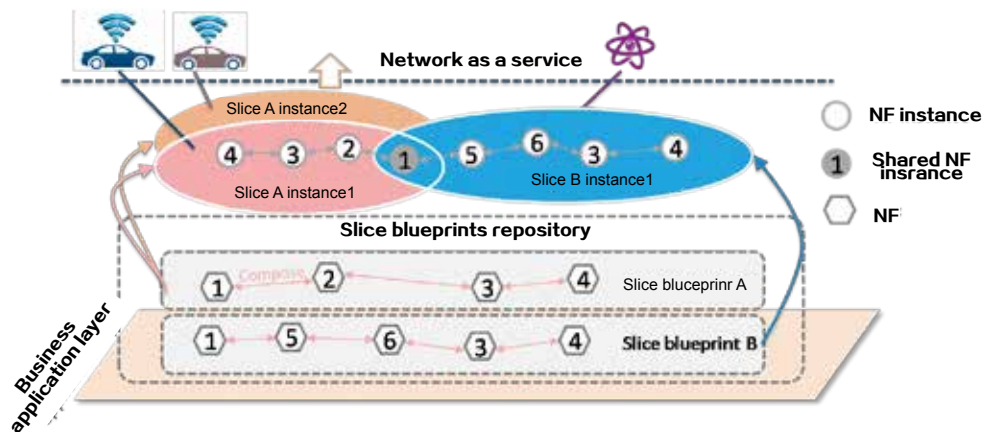
Software-defined network slice (SDNS) corresponds

Figure 5. The business application layer.

to the business application layer of NGMN. SDNS can provide different network slices to meet application requirements. Similar to network a function blueprint, a slice blueprint is also a description file that composes a number of network functions for end-to-end applications. An instance is a slice instance. These instances are real running programs that can implement specific applications, such as games downloaded from the application store running on smart phones.

The small hexagonal block in Fig. 5 is a network function. Blocks 1, 3 and 4 are used in both slice blueprints A and B, but their properties are different. Block 1 is shared network function and is also called multiple instances. Blocks 3 and 4 have a different copy in terms of instance. The shared block 1 means there may be a dedicated hardware that cannot be split, or there is the same virtual resource to be used such as an air interface. Blocks 1, 2, 3 and 4 comprise a slice blueprint A, and blocks 1, 5, 6, 3 and 4 form a slice blueprint B. The blueprints can be predefined by equipment vendors and be orchestrated by operators or OTTs.

The red, blue and yellow ellipses indicate the slices after instantiation. These slices are programs that actually run in the network. The red and yellow ones are instantiated by the slice blueprint A and provide the same type of applications for different users, such as V2V to different vehicle companies. The blue one

is instantiated by the slice blueprint B and can provide another type of service such as IOT.

Software-defined service interface (SDSI) provides open application program interfaces such as IaaS, PaaS and NaaS interfaces, as well as some user data and operating data. All this data can be delivered to a variety of vertical industries.

Based on the three-layer network architecture, a new functional module or a specific slice can be created without affecting other existing modules or slices. ZTE's brand new 5G architecture is built on virtual, componentized, independent modules, like Lego building blocks, and can be flexibly adapted to various businesses and industries to meet challenges of the new era. ZTE TECHNOLOGIES

Unified Air Interfaces

in 5G

By Yu Guanghui

Yu Guanghui

Chief Engineer of
Advanced Wireless Research, ZTE

With the development of wireless communications, a consensus has been reached that the future 5G system should be a unified network adaptable to different scenarios.

5G scenarios can be divided into three groups: mobile broadband (MBB); massive connection (mMTC: Massive MTC); and high reliability, low-latency communication (cMTC: Critical MTC). MBB provides high capacity and high speed, but it is relatively insensitive to the number of connections and reliability. mMTC provides energy efficient, low-cost access for a mass number of nodes, but the data transfer rate is not high. cMTC is mainly designed to decrease delay and increase the reliability of data transmission, but it is not designed to accommodate a mass number of nodes or provide a high data transmission rate. Compared with previous generations of WANs, the 5G access network needs to be flexible and open. It must be adaptable to individual demands and provide external standardized interfaces that enable users to accomplish specific tasks through the 5G access network platform. Therefore, the priority is designing unified air interfaces so that the 5G access network can efficiently support different services.

The structure of 3G and 4G air interface protocol stacks mainly supports mobile broadband data transmission (of which voice transmission can be considered a part). However, this single structure cannot meet the requirements of different services provided by 5G air interfaces. Tests have proven that 3G and 4G air interface protocol stacks support mobile broadband data transmission. The design of the 5G unified air interface protocol stack should be based on this, properly expanding on the 3G and 4G air interface protocol stacks.

The 5G unified air interface protocol stack introduces the L1 layer, which is the abstract physical layer. This layer is designed to extract common points of different services on the physical layer. Common points are not necessarily exactly the same, but they can be configured to be the same. Therefore, the L1 layer is transparent to various services and frequency bands. Currently, the identifiable contents of the L1 layer include waveform and frame structure parameters. CP-OFDM has been widely used in LTE, so the selected 5G waveform should be able to coexist with CP-OFDM very well. That is, CP-OFDM needs to be changed so that the 5G waveform can suit some scenarios, e.g., in the case of low out-of-band leakage or low time- and frequency-domain synchronization. A good waveform is FB-OFDM, which filters CP-OFDM at the sub-carrier level so an efficient polyphase filter can be designed. Also, because each sub-carrier filters the out-of-band leakage, the waveform has low out-of-band leakage and is robust in terms of frequency domain synchronization. The CP or stretched symbols after polyphase filtering are more robust to multipath radio channels. Generally, the only difference between CP-OFDM and FB-OFDM is that FB-OFDM has a polyphase filter. If the polyphase filter is defined as one beat, then FB-OFDM can roll back to CP-OFDM smoothly. In the 5G system, different services are carried on different frequency bands, so the frame structure parameters should be different. It is not good for each frequency band to have independent frame parameters. An efficient and flexible method involves scalability. Taking the frame structure parameters in
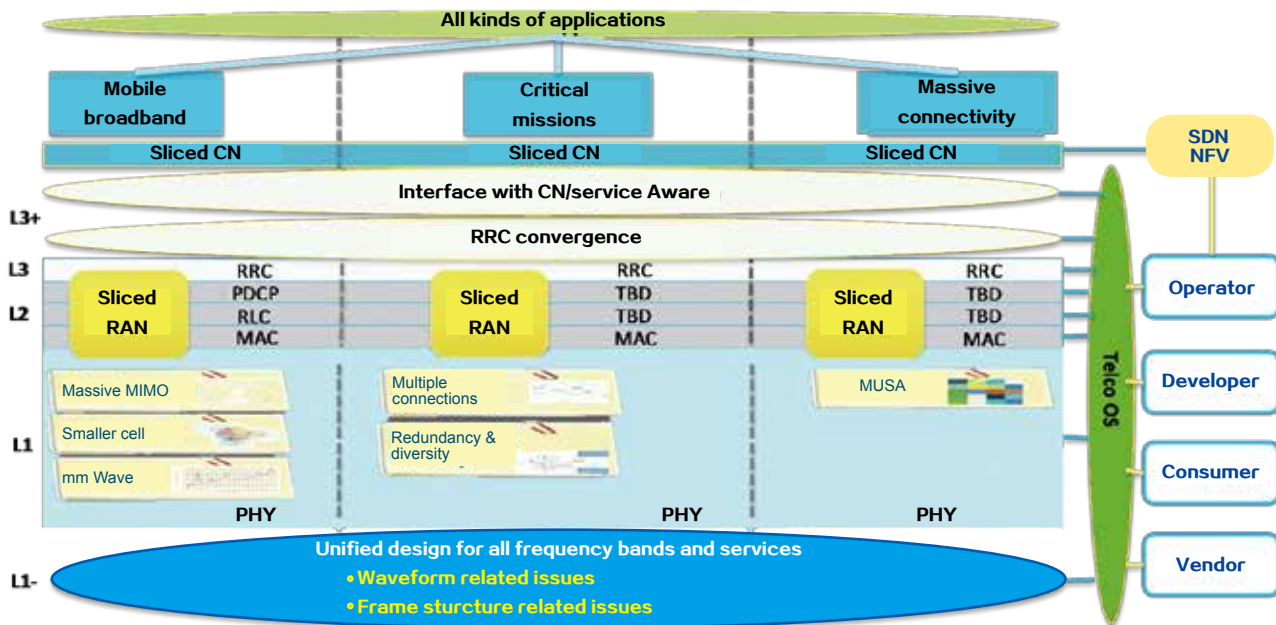
Figure 1. 5G unified air interface structure.

LTE as a starting point, we define a scalable factor S. All other parameters, such as sampling frequency, sub-carrier interval, symbol length and CP length, are controlled by this parameter. As long as the scalable parameter is configured properly, different services and frequency bands can be supported by the frame structure. For example, we generally configure higher scalable parameters at a high frequency to support larger bandwidth, using a larger sub-carrier interval, shorter symbol length, shorter CP length and shorter TTI.

In terms of the slice design on L1, L2 and L3, different services have different demands, so these layers need to be designed accordingly. For MBB service, L1 focuses on Massive MIMO, SVC, and high-frequency beam tracing. In addition, MBB service has abundant sub-services, so it requires an entire L1/L2/L3 protocol stack structure. For mMTC service, the L1 layer mainly focuses on supporting mass access, so the non-orthogonal access mechanism MUSA is a good choice. MUSA can multiplex connections more than three times on a single time-frequency, so it has an overload rate of more than 300% and low complexity. Compared with MBB, mMTC has less service data, so its L2/L3 protocol stack is not exactly the same as that of MBB. Reconstruction and consolidation are needed to reduce the overhead of the protocol stack. Low latency is required so that the protocol stack is simplified as much as possible. In this way, multiple channels are terminated at L1 and do not require a complete L2/L3 protocol stack. Although high reliability involves diversity and redundancy at different levels, L1, L2 and L3 have different characteristics. For example, multi-connection is defined on L3; error correction codes are defined on L2; and frequency,

time and space diversity are used on L1.

The 5G unified air interface protocol stack also introduces the L3+ layer, which is the service-perception layer. Traditional access networks generally do not define services and have weak mechanisms for controlling data flow. However, in the 5G system, the access network has to support different services and frequency bands, and it is necessary to introduce a service-perception layer. This layer is designed to carry on the bearer from the core network to the access network and distinguish different services in the access network. In this way, each service is carried on a different slice and configured with corresponding transmission parameters on L1.

The introduction of a carrier-class operating system has been a long-term goal for the 5G unified air interface protocol stack. To make the access network more open, it necessary to build a carrier-class operating system platform that is connected to each of the layers of the 5G unified air interfaces. Moreover, standard APIs are provided for operators, equipment manufacturers, third-party developers, and even individuals to develop and customize on-demand.

The above describes several aspects of the unified air interface design of 5G access network from the perspective of protocol stack. Unified, flexible, open 5G air interfaces are possible. 5G unified air interfaces provide a unified access mechanism for various services and frequency bands and meet the long-term requirements of operators and customers for future 5G networks. **ZTE** *TECHNOLOGIES*

OTCE: A Win-Win
Telecom Ecosystem for Operators

By Qiang Yuhong, Yang Wei

Qiang Yuhong

System Architecture of
CN Product Team, ZTE

Yang Wei

Chief System Architecture of
CN Product Team, ZTE

Plight of Operators

With the integration of the communications industry and the internet, core telecommunications services are being replaced by OTT applications and telecom operators are being relegated to mere "channel providers." The industry value chain is shifting in favor of OTT providers. OTT providers are decreasing the main business of traditional telecom operators and marginalizing new businesses. OTT providers are also undermining the loyalty of subscribers of traditional telecom operators and greatly increasing the amount of signaling in networks.

In many countries, telecommunication services are part of the national strategic infrastructure and are considered public utilities. Operators have obligations to build better networks and lower charges. However, they have not been sensitive enough to user demands for new information and services, such as e-commerce. This has resulted in insufficient development of new businesses and on overly long time to market.

"Circle of friends" features in social contact applications reduce subscriber stickiness. One concomitant of OTT applications is frequently used short-length heartbeat messages that occupy many radio channels and affect the services of other users.

Open to Collaboration for Business Blossom

Separating mobile services and network infrastructure from booming OTT services enable operators to establish new telecom multi-participatory ecosystem. They have realized that both network quality and openness to collaboration are important for winning business.

In order to expand pure end-user-oriented services to vertical industry subdivisional infotainment value-added service provider, telecom operators need to open network capability and make resources integration to create multi-win ecological environment. Maintaining sustainable progress with multiple service providers is the goal of most operators.

Some operators have gone forward to integrate and promote OTT services to enhance the overall user experience and user loyalty.

ZTE's OTCE Solution

ZTE's open telecom cloud ecosystem (OTCE) is a platform for opening network capabilities and integrating resources. It helps operators transition from being channel providers to competitive telecom/internet operators selling not only services but also network capabilities and business and technological guidance.

Following the principles of enable "capabilities open, user identifiable, service integrated, Qos guaranteed, network manageable and bills confirmable", ZTE's OTCE solution opens and expands the capabilities of CS, PS and IMS to help operators realize value chain integration as shown in Figure 1.
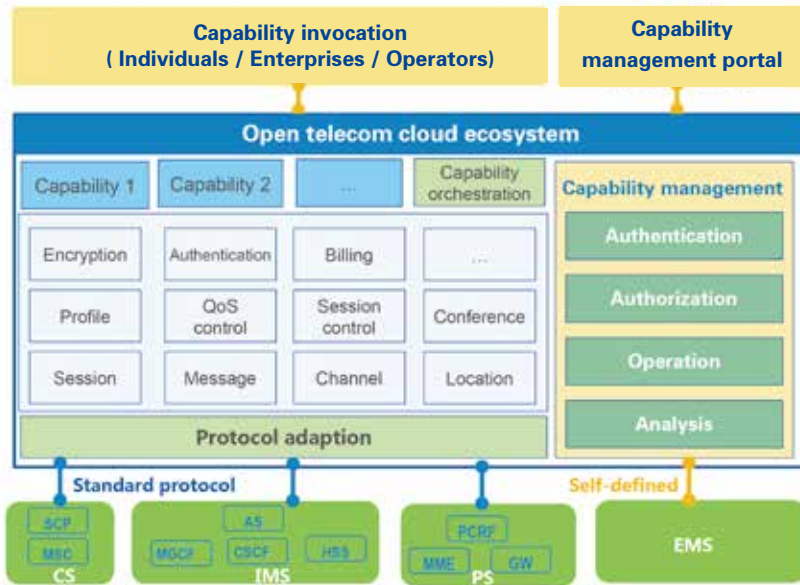
Figure 1. ZTE's OTCE solution.

With capability adaptation layer and capability management section, ZTE's OTCE solution opens the network capability with invoking authorization to third party applications. The reference points between OTCE and network elements are the existing standard telecom protocol interfaces, they can reduce the impact on existing networks so that the solution can be deployed quickly. The network capability APIs provided for third-party applications are based on lightweight internet network protocols (such as HTTP/XML and RESTFul), to eliminate the development complexity of third-party applications.

The network capability APIs of the OTCE include data transmission, QoS control, service control, authentication and accounting, secure communication, user data storage capability, and messaging capability. Network capability APIs can be divided into basic API package, enhanced API package, and compound API package, which can be ordered and invoked by third-party applications on demand. In addition, network capability APIs enable user-level or service-level control of network resources and services. Operators can analyze the most popular service types, identify user habits and preferences based on statistics of invoking network capability APIs. Furthermore, operators can provide personalized services to achieve a win-win situation between operators, third-party applications, and end users.

Based on the NFV opening technologies, the OTCE solution integrates third-party COTS hardware with ZTE's virtualization platform (OpenCOS) to accelerate service trial and deployment. It is scalable, which

means it can cope with dynamic business needs, lower OAM costs, and guarantee system stability. It also provides third-party applications with reliable execution environment. It can deploy hundreds of services at low costs, which encourages individuals developer as well as small and micro enterprises for innovation in new areas.

ZTE also offers a full range of CS, PS, and IMS core equipments. For the "non-optimal behavior" of a number of applications, ZTE can coordinate and optimize the implementation of applications and network equipment, and provide the best service channels for applications and users. For example, frequent heartbeat messages of applications lead to too many paging requests and occupy too many radio resources. The OTCE solution determines user status according to the inherent periodic signaling between networks and terminals, and provides network event triggering APIs to report user status changes to applications.

Various third-party applications are emerging in the mobile internet era. Attracting more users is the first step for application providers. The OTCE solution integrates and classifies different types of applications according to attributes—such as operator applications, third-party applications, enterprise applications, personal applications, catering, audio and video applications, and parenting platforms—and presents these applications to users according to user characteristics and preferences. This promotes applications and creates greater convenience for users.

ZTE's OTCE solution has facilitated the implementation of China Mobile's integrated communications strategy by opening IMS capabilities. The core attribute of China Mobile's integrated communications is to upgrade basic communications, namely, to upgrade communications services through the call, message, and address book on mobile phones using the GSMA RCS protocol, to meet diversified communications needs of users.

Conclusion

Revolutionary changes, sharing, and collaboration are the features of the internet era. In partnership with operators, ZTE makes innovations, seizes opportunities, and builds a win-win telecommunications ecosystem.

ZTE TECHNOLOGIES

5G Internet of Things and Standardization

By Yuan Yifei, Wang Xinhui

5G goes beyond traditional cellular services for personal use. A large chunk of traffic will come from human-to-machine and machine-to-machine communication. The internet-of-things (IoT) requires new services, standards and innovations.

Industry Trends and Requirements

The number of devices that need to be wirelessly connected in industries such as retail, healthcare, manufacturing, transportation and agriculture will be much greater than the human population.

The number of machine-to-machine connections will easily be in the hundreds of billions. However, requirements for machine-to-machine communication in each industry will be drastically different: some industries will require a very high data rate, some will require very short latency, and others will require extreme reliability. This creates great challenges for 5G networks. Considering service ubiquity and a massive number of connections, a 5G network infrastructure has to be very densely deployed. If efficiency remains at current levels, more energy will be consumed.

The cellular industry is a major contributor to global carbon dioxide emissions. Researchers need to devise smarter ways to reduce harmful interference, shrink circuits, and reduce power consumption. Increasing energy efficiency involves more cost-effective site planning, construction, and maintenance. These account for a large proportion of energy consumption in a cellular system. 5G terminals also need to be energy-efficient. To achieve a 10- to 100-fold increase in the density and number of

> Researchers need to devise smarter ways to reduce harmful interference, shrink circuits, and reduce power consumption. Increasing energy efficiency involves more cost-effective site planning, construction, and maintenance.
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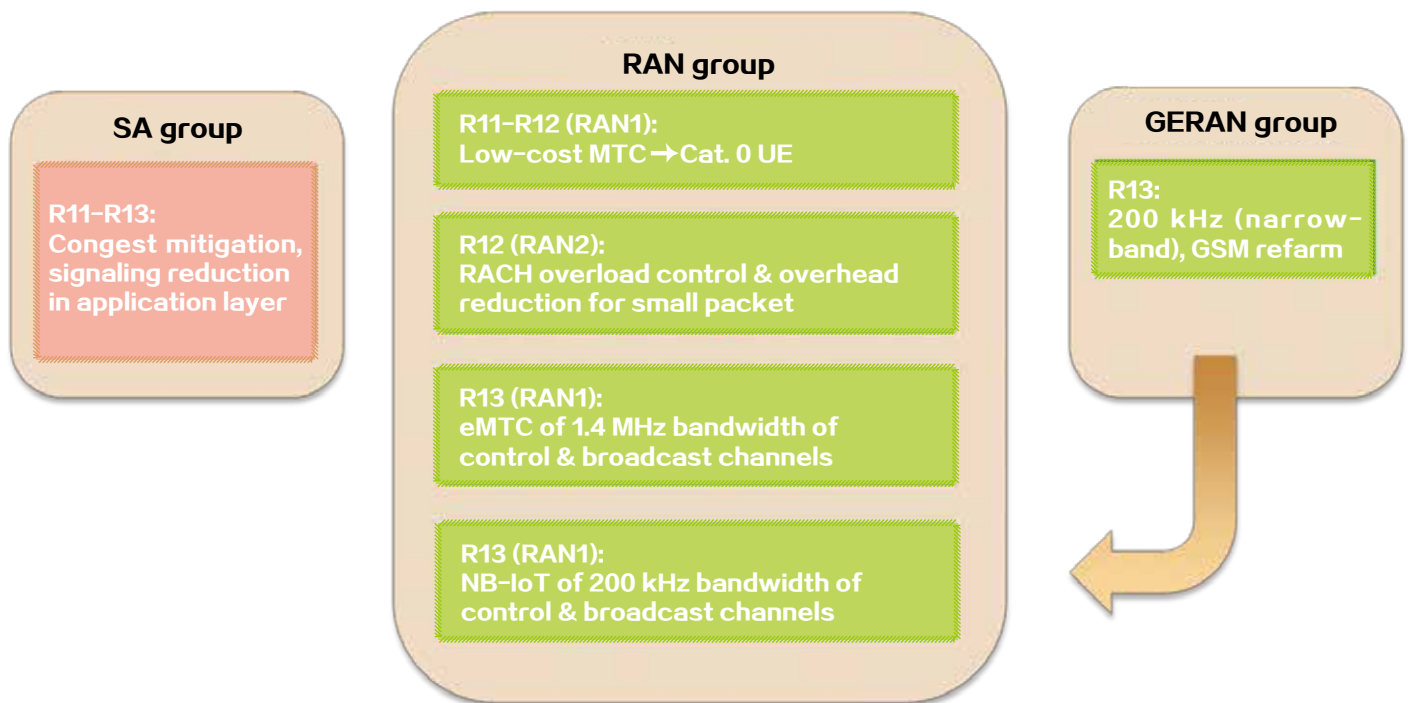> —Yuan Yifei, Chief Engineer of ZTE Wireless Standardization

Figure 1. IoT solutions specified in 3GPP.

connections, system designers and device manufacturers have to cooperate closely.

Some IoT applications, such as meter reading, involve collecting information at low speeds. Other IoT applications, such as video monitoring, involve collecting information at high speeds. Meter reading is characterized by a massive number of connections, low-cost terminals, low power consumption, and a large number of small packets transmitted. With video monitoring, there is a bottleneck in the uplink, where high data rates are required, and traffic density is high. Control-type machine-to-machine communication may be delay-sensitive or not delay-sensitive. Vehicle-to-vehicle communication is a typical delay-sensitive service with millisecond-level latency constraint. It also requires extreme reliability; e.g., nearly 100% success rate for decoding when the speed of passing vehicles is about 300 km/h each. There are many IoT applications in daily life that are not delay-sensitive. The challenge with these applications lies in the huge number of devices and connections.

Standardization

IoT network solutions have been specified by several 3GPP working groups over the past five years (Fig. 1). In the 3GPP-SA group, machine-type communication (MTC) devices can be grouped by MTC features. The serving time for delay-tolerant or infrequent-transmission features can be tightly controlled. For example, the time that a device is not permitted to access the network can be specified. This length of time is an MTC feature that depends on an operator's strategy. Overload can also be controlled by rejecting connection requests. A RAN node can be permitted to differentiate its low priority MTC traffic/signaling from other RAN nodes. A "delay tolerant" indication can be added to the RRC connection procedure for MTC devices with delay-tolerant access. An eNB can reject an RRC connection according to whether a core node is overloaded, and the eNB can add "extended wait time" in the RRC connection reject/release information to request MTC devices to wait before sending a new connection request. In the overload start information, a new parameter called "barring factor" is introduced for different types of M2M services. This enables the RAN to select appropriate parameters.

In Rel-12 RAN2, there are severe collisions in a random access channel (RACH) when numerous MTC devices try to access the RAN. Given that the RACH is the most vulnerable channel at the MAC layer during congestion, RACH overload control is a major area earmarked for improvement. Several schemes have been proposed: 1) MTC specific back-off, 2) dynamic allocation of RACH resources, 3) separating RACH resources for MTC, 4) slotted access, and 5) pull-based scheme. In the RAN2 specification, another objective is to identify and evaluate the mechanism to increase the ability of the RAN to handle traffic profiles comprising small data transmission. Data can be generated by both M2M and non-M2M devices and applications. Signaling overhead reduction and UE power consumption are two main areas in this study.

In Rel-11 RAN1, low-cost MTC has a very clear business goal: LTE M2M devices are designed cheaper than GSM M2M devices so that M2M traffic can be shifted from GSM to LTE. To be more competitive, LTE M2M devices also need to be energy efficient and have enhanced coverage. Moreover, low-data rate channels of LTE M2M devices, such as channels with 118 kbps in the downlink and 59 kbps in the uplink, have to coexist with other LTE channels. The reference for the study is LTE category 1 UE for MTC devices. Assuming a single-band operation, six areas are studied:

- reduced maximum bandwidth supported by a UE. Both RF and baseband bandwidth can be reduced, for example, to 1.4 MHz at the cost of reduced frequency diversity. ePDCCH can be used when the network operating bandwidth is wider than that of M2M low-cost devices.
- single RF chain receiver. This reduces coverage for various downlink physical channels by 3 to 5 dBs.
- reduced peak rate. This can be achieved by limiting the maximum block size, i.e., < 1000 bits, or the number of physical resource blocks (PRBs) allocated each time, i.e., <= 6, or the modulation order, i.e, QPSK only.
- reduced UE maximum transmit power. This directly reduces the coverage.
- half-duplex operation. This affects scheduler implementation at eNB.
- reduced downlink transmission mode (TM), i.e., limited to TM1 and TM2.

In Rel-13, two physical-layer solutions are being standardized: eMTC and narrow-band IoT (NB-IoT). eMTC is an enhancement on top of low-cost MTC in Rel-12. Physical control channels and broadcast channels are all confined within 6 PRBs, so a building penetration loss greater than 20 dB has to be supported. Since most control channels are redesigned, much effort has been put into the specifications. NB-IoT was originally studied in GERAN with the purpose of using refarmed GSM bands for low-cost, good-coverage MTC devices. Narrow band similar to a 200 kHz GSM channel is used for extreme coverage. The two strongest candidates in the study were NB-CIoT and NB-LTE. Shortly after the standardization work was moved to the RAN, NB-LTE was accepted and NB-CIoT was abandoned.

Potential Technologies for 5G IoT

The most challenging requirement in this scenario is support for a massive number of devices. This means that the cost of a terminal should be significantly lower than that of a mobile device. The power consumption has to be low enough so that devices can be battery-powered for years without recharging. Also, coverage should be robust enough so that even devices inside basements can connect to the network. New enabling technologies for IoT are non-orthogonal access and control channel optimization, advanced channel coding, and short radio frames.

Non-Orthogonal Access and Control Channel Optimization

Non-orthogonal access enables multiple users to simultaneously access the network using the same frequency

The most challenging requirement in IoT scenario is support for a massive number of devices. New enabling technologies are non-orthogonal access, control channel optimization, advanced channel coding, and short radio frames.

——Wang Xinhui, Director of ZTE Wireless Standardization

resources. The access can be contention-based, which significantly reduces control overheads for granting the resource and indicating the transmission format. Control channel optimization can reduce signaling overhead when many devices connect to the network.

Multi-user shared access (MUSA) is a non-orthogonal multiple-access scheme in the code domain. Conceptually, each user's modulated data symbols are spread by a specially designed sequence that enables robust successive interference cancellation compared with the sequences employed by traditional direct-sequence CDMA (DS-CDMA). These spread symbols are then transmitted concurrently on the same radio resource by means of shared access. Finally, each user data from superimposed signals can be decoded at the base station side using SIC technologies. The design of spreading sequence is crucial to MUSA because it determines system performance as well as the interference between users. Short-length spread sequence with multi-level complex values can have low cross-correlation, which is helpful to MUSA.

Grant-free transmission can be used

to minimize control signaling overheads where users generate the spreading sequence locally without coordination by base stations. To keep signaling overhead low, no closed-loop power control is implemented. Such control is usually implemented to compensate for fast fading.

Advanced Channel Coding

Small-packet transmission is a characteristic of M2M communication. However, during the standardization of 3G and 4G cellular systems, much effort is spent on designing codes that approach the Shannon limit and perform well when the block is large. When the block is short, CRC bit reduction is an effective way of reducing overhead and can be used for both turbo and polar codes. A small block is often associated with low SNR, and advanced coding schemes can provide more powerful error protection in extreme coverage scenarios. Those coding schemes not only optimize code structure but also enhance hybrid acknowledgment repeat requests (HARQ) to better combat channel fading.

Short Radio Frames

5G-enabling technologies are new physical channel design that can reduce a single transmission delay. Such new design focuses on short radio frames that require a whole new set of subframe structure including reference signals, resource mapping, and HARQ.   **ZTE TECHNOLOGIES**

CHINA MOBILE ROLLS OUT PRE5G 3D-MIMO IN GUANGZHOU

By Gao Qin

Gao Qin

Product and Solution Manager of
TDD Product Team, ZTE

As China's urbanization accelerates, high-rise buildings are springing up in many cities. Poor coverage and call quality in these buildings have become a common issue that affects the quality of mobile networks. According to China Mobile, complaints about network coverage accounted for 41% of all complaints, and more than 70% of coverage-related complaints were related to indoor coverage. Therefore, improving indoor coverage is strategically important for China Mobile. In practice, China Mobile has had difficulty with site acquisition, property negotiation and indoor distribution project deployment.

China Mobile has adopted ZTE's innovative three dimensional multiple input multiple output (3D-MIMO) solution to solve the indoor coverage issue. In a commercial network, 3D-MIMO enables transmission rates to reach more than 300 Mbps, increasing throughput 300% to 500%. The most impressive case is the indoor coverage for Evergrande Center in Zhujiang New Town, Guangzhou. The Evergrande Center surrounded by numerous skyscrapers has 47 floors, four of which are underground. The surrounding wireless environment is complex, which makes indoor coverage and property management quite difficult. China Mobile deployed 3D-MIMO base stations at 30 m high that could cover the entire center. The cell capacity was significantly increased. Compared to China Mobile's existing large-angle-antenna macro stations, the average downlink

throughput gains were 394%. Cell-edge user experience was also greatly enhanced. The test showed that the average downlink and uplink rate gains at the cell edge were 583% and 819% respectively. 3D-MIMO has flexible beam adjustment that enables vertical wide-angle coverage through the configuration of antenna weight. With wider and deeper coverage, 3D-MIMO is an ideal solution for high-rise buildings in central business districts.

Another core competitiveness of China Mobile's network is its macro coverage for heavy-traffic hotspots. On average, 65,000 passengers pass through Guangzhou East Railway Station Square every day, which demands more in capacity and coverage. China Mobile also adopted

ZTE's 3D-MIMO to cover the railway station square. Compared with existing eight-antenna macro base stations, the test showed that the average downlink gain of a 3D-MIMO cell was 350% and its uplink gain at the cell edge was 357%. Moreover, in the test for a single UE, 96% of the areas can reach more than 5 Mbps throughout. 3D-MIMO base stations outperform traditional eight-antenna macro cells in terms of coverage, uplink and downlink throughput, and anti-interference. Therefore, 3D-MIMO works perfectly for large-capacity business scenarios.

"3D-MIMO is a promising technology that helps the evolution to 4G as well as the development of 5G. We are pleased to partner with ZTE

in completing commercial 3D-MIMO test on a live network in Guangzhou," said Dr. Liu Guangyi, CTO of Wireless Department, China Mobile Research Institute. "All test results showed that 3D-MIMO can significantly enhance 4G user experience no matter in high-rise buildings or macro coverage scenarios. This further boosts our confidence to widely deploy 3D-MIMO."

3D-MIMO has:
- 128 antenna array elements and advanced baseband vector processing chipsets that increase network throughput by two to four times
- 3D-MIMO beamforming that expands coverage space from 2D to 3D and achieves seamless coverage
- precise terminal tracking that enhances user experience
- integrated antenna, RF, and baseband units that can be easily and flexibly deployed for various scenarios
- full compatibility with existing commercial 4G terminals and networks.

3D-MIMO is a key component of ZTE's pre5G core technology that allows 4G users to enjoy 5G-like experience without changing their terminals. ZTE is a leader in developing 3D-MIMO that is expected to be commercially available in China in 2016 and will leverage its advantages in practical business environments. Pre5G 3D-MIMO brings 5G networks closer to us.

ZTE TECHNOLOGIES

SMARTFREN LEADS 4G DEVELOPMENT IN INDONESIA

By Song Bin

Song Bin

Solution Manager of
TDD Product Team, ZTE

On August 19, 2015, Indonesian mobile operator Smartfren held a press conference in Jakarta to announce the commercial launch of 4G LTE-A in 22 cities across Indonesia. This announcement marked the arrival of Indonesia's first nationwide official 4G LTE-A network. ZTE provided Smartfren with a complete range of end-to-end 4G LTE-A solutions including EUTRAN (TDD and FDD), EPC, IPBB, VAS, and BOSS software and hardware as well as cloud radio, TDD+FDD CA, eMBMS, VoLTE, and eHRPD solutions.

As Indonesia's largest CDMA operator and the fourth largest mobile operator, Smartfren officially started operations in 2002 and became the world's first commercial EV-DO Rev. B CDMA operator in 2011. By the end of the second quarter of 2015, Smartfren had 11.9 million users. Smartfren was assigned 850 MHz and 1.9 GHz CDMA spectrums. The license for 1.9 GHz CDMA spectrum will expire at the end of 2016, and the 850 MHz spectrum will also be phased out as the LTE network is commercialized and users are migrated.

Smartfren started deploying TDD and FDD networks in 22 major cities across Indonesia at the beginning of 2015. More than 4,000 TDD sites have been deployed. ZTE was responsible for constructing networks in the country's east. The networks built by ZTE on Bali and in other regions were

"Smartfren just launched the widest LTE-A service in Indonesia. We leverage both TDD and FDD to get best of both technologies: high capacity and throughput on TDD at 2300 MHz and large coverage with FDD at 850 MHz. With this combination, we offer the best broadband experience. We have chosen ZTE for this deployment due to our long time relationship and their leadership with TDD networks," said Smartfren CTO Christian Daigneault.

commercialized in June, two months earlier than the commercial launch of the national network. Smartfren is determined to become the largest LTE operator in Indonesia, and it plans to build LTE-A networks with seamless coverage throughout the country.

In the CDMA era, ZTE was chosen as Smartfren's major equipment supplier who played an important role in helping Smartfren break into the mobile communication market from scratch and quickly grow into the largest CDMA operator in Indonesia. ZTE secured an 81% share of Smartfren's CDMA RAN equipment, which was deployed in Indonesia's core areas.

LTE networks are widely deployed around the world, so Smartfren has encountered great difficulties in developing and evolving its CDMA network. The main problems are:

- As the entire CDMA industry

chain declines, there is no technical evolution. The style and costs of CDMA terminals have also suffered a sharp decline in comparison with other terminals.

- The Indonesian government will take back the 1.9 GHz CDMA spectrum licence assigned to Smartfren at the end of 2016. The 850 MHz spectrum will also be phased out as the LTE network is commercialized and users are migrated.
- The competition in Indonesia's wireless market intensifies, and users are more demanding on bandwidth. This presents a huge challenge to 3G CDMA EV-DO Rev. B network.

Facing these difficulties, Smartfren has not stopped moving forward. By drawing upon its strengths, Smartfren finally obtained a license to use the TDD 2.3 GHz and FDD 850 MHz spectrums to develop LTE-A networks

and expand its user base. ZTE has also supplied a complete range of LTE-A solutions for Smartfren to address its future development issues. The solutions include:

- TDD/FDD dual-mode. A TDD/ FDD dual-mode network can be implemented through a single master control board and a shared shelf. This helps Smartfren minimize both capex and opex.
- TDD-FDD CA. As the demand for downlink traffic grows, user experience has become a major concern for operators. TDD-FDD carrier aggregation (CA) can fully use existing spectrums to meet user needs. ZTE's TDD/FDD BBU sharing solution helps Smartfren quickly implement TDD+FDD CA and capture more market share.
- Cloud radio. Base stations are more densely deployed in an LTE network than in a 2G or 3G network. The co-channel networking of TD-LTE also

results in more interference. Therefore, LTE networks urgently need an effective way to remove interference, especially interference at cell edge. Cloud radio was specifically developed to address these problems. It provides collaborative anti-interference and improves network throughput. This helps operators reduce inter-eNB interference, improve user experience at cell edge, and reduce the uncertainty around investing heavily in backhaul networks.

- eHRPD. On the route to 4G, protecting the original investment in 3G networks is a major concern of operators. eHRPD is introduced for smooth evolution from CDMA to LTE.
- VoLTE. Smartfren has pressed for VoLTE because the Indonesian government will take back all CDMA spectrums by the end of 2016. Through reasonable terminal policies and the use of VoLTE, Smartfren can quickly migrate

users to LTE-A network. In the long run, this will create value for Smartfren in two ways. One is to increase radio spectrum efficiency and reduce network costs. For voice services, an LTE network has far higher spectrum efficiency than traditional networks. The other is to enhance user experience, because VoLTE provides better voice quality and faster call connection speed than traditional 2G or 3G CS voice services.

- eMBMS. As Smartfren enters the LTE era, video services will have more development opportunities. Multimedia broadcast multi-service (MBMS) can help operators expand new services more conveniently because of its timeliness and low cost. In August 2015, eMBMS debugging of the Smartfren LTE project was completed and the service was successfully demonstrated to top leaders of Smartfren. ZTE was highly recognized by Smartfren for

its excellent service quality.

The official launch of LTE-A services enabled Smartfren to become Indonesia's first multinetwork operator operating both an LTE TDD+FDD hybrid network and a CDMA network. Since the third quarter of 2015, Smartfren has rolled out 4G LTE-A services nationwide. This demonstrates that Smartfren has made strides towards becoming the largest mobile operator in Indonesia.

With ZTE's powerful universal subscriber profile platform (USPP), policy and charging rules function (PCRF), and online charging system (OCS), the core NEs of both CDMA and LTE networks are highly integrated to provide a unified user database and policy control and charging policies, allowing the LTE network to be deployed rapidly. This enables maintenance and operation of 3G and 4G networks in the future and lowers operational costs. Smartfren can take advantage of the sophisticated OCS to launch flexible tariff packages in the market and attract upscale users with an urgent need for mobile broadband services. **ZTE TECHNOLOGIES**

Magic Quadrant for Small Cell Equipment

The macrocellular networks that communications service providers (CSP) deploy often fail to meet the needs of users, mobile operators and location owners. We assess 16 vendors of femtocell, picocell and carrier Wi-Fi equipment that can remedy this shortcoming and give guidance to network planners.

Market Description

The small cell market, including carrier Wi-Fi equipment, is growing in terms of interest, numbers of connected users and product revenue (up 44% year over year).

Increasing numbers of smartphones, tablets and similar devices, together with the proliferation of video consumption and the transition from 3G to LTE networks and services, are contributing to high growth in data traffic. A common short-term approach to coping with this growth has been to offload this traffic onto unmanaged Wi-Fi networks. However, CSPs should look to improve customer experience by keeping subscribers on their cellular networks, an aim they could achieve using a combination of picocells, femtocells and carrier-class Wi-Fi equipment.

Usage of small cells is driven by changing patterns of user traffic. The vast majority (70% to 90%, depending on the geography) of subscribers' data traffic arises when they are indoors, but many LTE and 3G frequencies are poor at macrocellular indoor coverage, which means subscribers receive a "cell edge" experience that reduces effective cell capacity and bandwidth and also significantly shortens device battery life. In most cases, increasing the density of macrocells is not a cost-effective solution, and traditional distributed antenna systems are cost-effective for only the largest venues and solve the coverage issue rather than the capacity issue. Hence, CSPs are increasingly interested in small cells.

The small cell market comprises outdoor picocells, indoor picocells, residential femtocells, enterprise small cell solutions and carrier Wi-Fi equipment, about which the following points may be made:

- CSPs will use outdoor picocells to augment macrocellular networks in city centers and other points of network congestion. Outdoor picocells can also improve cellular coverage in rural areas much more cost-effectively than macrocells.
- Public Wi-Fi access has become more popular in locations such as shopping malls, transportation hubs and hospitality centers, and CSPs are starting to complement this with indoor picocells.
- CSPs continue to deploy residential femtocells in areas of poor coverage.
- Deployments of enterprise picocells and femtocells have started to grow in 2015 as bring your own

device (BYOD) schemes and secure cloud services fuel demand for improved cellular services in office environments. Gartner's research shows that 30% of calls made by enterprise employees at their desks are on mobile phones, but many LTE and 3G frequencies are poor at macrocellular indoor coverage, with the result of patchy coverage and shortened device battery life.

CSPs are starting to see opportunities in value-added services delivered over small cell infrastructure, such as managed unified communications (UC), IP PBXs, presence sensing, real-time analytics and caching. Most CSPs now require integrated Wi-Fi in their femtocell and picocell deployments.

Many CSPs agree that there is no single technical solution for all requirements, so most plan to take a multivendor approach. However, other CSPs are concerned about integrating a third party's network equipment into their existing macrocell and core network, so they tend to take a single-vendor approach, which, in turn, can limit their small cell designs. The vendors in this Magic Quadrant offer a range of features. Some focus on one or two market areas, while others try to cover all options. Some provide a suite of professional services, ranging from optimizing cell locations, network planning and installation through to neutral hosting, while others focus on equipment sales.
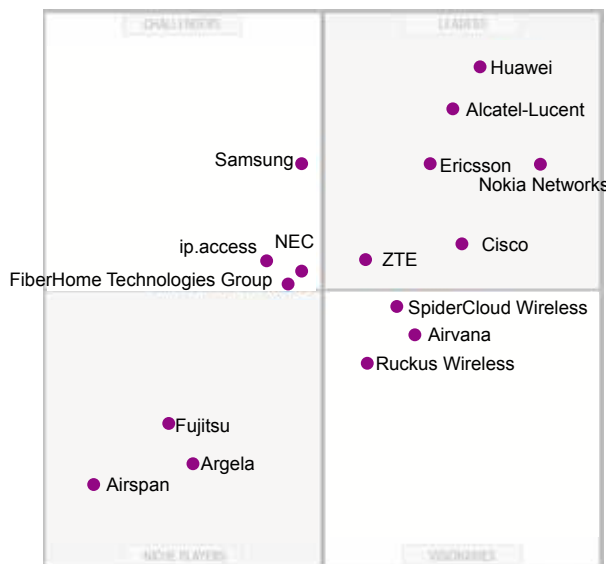

Figure 1. Magic Quadrant for small cell equipment.

Different types of equipment have different features, options and requirements with regard to networks and integration; however, power consumption, size, ease of installation, integration into the macrocell network, user capacity and frequency bands of operation are common considerations:

- Femtocells used by CSPs for residential and small or midsize business (SMB) settings are often self-organizing networks and "plug and play", and have highly scalable femtocell gateways. Competitively priced and reliable products are key. CSPs should also consider whether they need features such as presence sensing and processing capability to support additional services.

- Enterprise small cells can be single cells or multiple distributed cells. They can be stand-alone and self-organizing or synchronized with a macrocellular network. They may also be able to operate on existing LAN infrastructure, or they may require specific cabling, such as CPRI fiber connections. Features such as multiple frequency band support, multioperator support, and support for applications such as presence sensing and local analytical processing are among the available options.

- Outdoor picocells can be either parts of a heterogeneous network or stand-alone products.

- Wi-Fi equipment can be stand-alone, or can be integrated into femtocell and picocell equipment. Carrier-class features include cloud controllability, dual-band operation and support for Hotspot 2.0. CSPs should choose highly scalable gateway controllers to integrate Wi-Fi traffic into their core networks.

Please note that vendors disclose the number of customer engagements in different ways, and the numbers given in some of the vendor profiles within this report should not be directly compared. Numbers are as of September 2015 but can be expressed as either number of CSP customers or number of small cell projects within CSP customers. Numbers may include regional projects and may or may not include carrier Wi-Fi deployments.

Vendor Strengths

ZTE

ZTE has made significant advances in its small cell products and strategy since last year's Magic Quadrant, and as a result, it has accelerated its product shipments. China, its home market, is a strong source of sales, but the company also has had success in Europe, Japan and Malaysia. ZTE has a product range that includes home and SMB femtocells, indoor and outdoor picocells, and its Qcell distributed radio solution for large enterprises and venues. ZTE's products support 3G and LTE, FDD and TDD, Wi-Fi and LTE-A carrier aggregation, and up to 256 QAM. ZTE supports HetNets and plug-and-play installation for its indoor products. The company now understands the need for new business models for the indoor small cell market, and it is building industry partnerships to help facilitate growth in installations. ZTE's services can provide an end-to-end small cell solution.

ZTE has a wide range of small cell solutions, and its Qcell has been well-received and is deployed in shopping malls and universities. The product can support four frequency bands and up to two CSP networks per CPRI cable.

Inclusion and Exclusion Criteria

To qualify for this Magic Quadrant, a technology provider must satisfy one of the following two criteria:

- The technology provider must have shipped small cell products to CSPs during the 2014 to 2015 period.
- The technology provider must have achieved significant mind share in the small cell market segment, either through its visibility in terms of publicly announced small cell contracts or through its new innovative small cell products.

Evaluation Criteria

Ability to Execute

In this Magic Quadrant, we assess vendors' products and professional services, and their ability to meet the needs of today's market. We rate the overall viability of a vendor's small cell business unit and the company as a whole, to provide an opinion on the relative merits of the vendor as a supplier. We gauge how successful the vendors' product sales have been, as well as the merits of their sales structure. We also consider vendors' responsiveness to customer requirements, together with feedback from reference customers.

Completeness of Vision

We evaluate the vendors' understanding of the market's dynamics and the changing needs of service providers, partners, channels to market, subscribers, enterprises, property owners and other parties that are becoming part of the small cell ecosystem. We also assess how well vendors' marketing strategies align with their core strengths. The vendors' approach to product and service development is an important consideration, together with the features they plan for next-generation solutions. Innovation is a key aspect on which we measure vendors, along with the solutions they propose to differentiate themselves in the market, and how they plan to overcome the obstacles and issues that hinder market development and customer satisfaction. Finally, we take into account vendors' geographical strategy and how they address a global market. **ZTE TECHNOLOGIES**