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VIP Voice

Telefonica: On the Path to 5G

Expert Views

MEC Empowers Network Architecture for Operator Transformation

Special Topic: 4G&5G Co-Evolution

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Cover Figure | Telefonica CTIO Enrique Blanco

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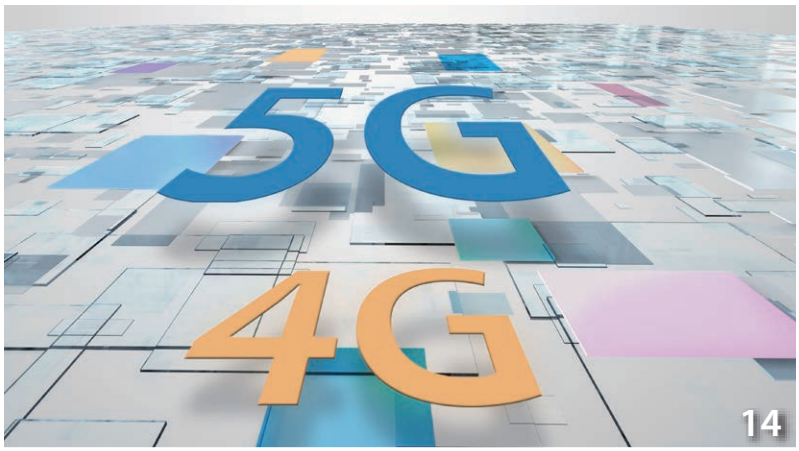

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Telefonica CTIO Enrique Blanco

Telefonica:
On the Path to 5G

Reporter: Liu Yang

While 5G is transitioning from concept to reality, there are still many challenges that need to be overcome. The main problem that we have today with 5G is that it is very difficult to visualize where the killer applications are coming from, said Telefonica CTIO Enrique Blanco, who shared with us his insights on implementing 5G. Telefonica, a Spanish multinational telecommunications company, is one of the largest telephone operators and mobile network providers in the world.

"You cannot plan, deploy and think 5G as we were doing before in 4G."

5G is an entirely new network architecture. What do you think are the major challenges facing 5G deployments?

You need to take at least two different points of view. The first one is a technological approach. I think the first major challenge is how we read the final architecture in the evolution of the 5G core and how you can get that evolution of the evolved packet core (EPC) so that 5G core will be done and will be built. Telefonica is considering this trend to guarantee that all the different businesses of the core will be built with a specific architecture following the critical infrastructure. This means how we can guarantee that the end-to-end approach is safe and we can guarantee that the failure in the core would be stopped in the society, which is the main difference in 5G against 4G. This is from the point of view of the 5G deployment architecture that we need to build in the core.

From the point of view of the massive 5G deployments, the main challenge that all the operators would face is developing the use cases. What would be the main engine that would be pushing the massive 5G deployments? There needs to be use cases that would be helping us try to monetize the spectrum, the equipment, and network development and evolution. These are the two main challenges to be solved.

Telefonica has been carrying out 5G trials. Can you tell us what have you learned from 5G trials?

We've learned a lot. We've learned how different the 5G evolution is going to be in relation with 4G, how different the planning is going to be, how different the deployment is going to be, and how different are all the tools you need to get because it is necessary to amass the AI tools, trying to guarantee that we are doing the right planning and deployment of 5G. We've been learning to go back to the previous, that the core is the key trend to guarantee the successful massive deployments. 5G is going to be the main engine in the evolution of the society.

The possibilities of 5G are amazing. It's a new different paradigm. You cannot plan, deploy and think 5G as we were doing before in 4G.

"This is not conservative nor ambitious. It is absolutely realistic."

How have these trials helped shape your 5G strategy for the future?

They have been oriented. We are building the trials and have been learning how these would be finally serving the massive deployment of IoT, how we need to build, how we need to maintain these kinds of services, how we can link 5G with use cases, how we can combine 5G with our platforms, so how we can combine with the automation of the industry 4.0, and how we can apply this to B2X. We are a very strong provider of IoT. We are trying to see how the 5G evolution will be helping us offer better services to customers.

These are our trials—more oriented than demonstrations. We can offer our customers strong capabilities using the Massive MIMO and carrier aggregation. This is absolutely relevant. But this is not the key of 5G deployment. So when we are thinking 5G is higher velocity and better latency, maybe we are making a big mistake.

How do you characterize your 5G strategy?

Realistic. We are not thinking 5G as an iconic technology as many people are thinking. We are thinking how 5G can help Telefonica compete in all the countries we are operating, how 5G can help us try to be competitive and offer better services to our customers. This is not conservative nor ambitious. It is absolutely realistic. This is what we are thinking from the start. This means that we are building all the capacities we need and trying to do it fast.

The main problem that we have today with 5G is that it is very difficult to visualize where the killer applications are coming from, where the services and use cases are coming from that would be helping us try to grow the revenues. This is the key topic we are trying to cover

Telefonica's new business campus in Spain.

country by country. But the fact is that if the commercial team in one country is asking us to deploy 5G, we can deploy it immediately. In fact, we will.

What is your comment on ZTE's innovation capability in the 5G field?

ZTE is one of our main partners helping us trying to define the final architecture and trying to build a critical infrastructure linked to the 5G deployment. This is happening because ZTE was helping us years ago trying to virtualize the main platform and trying to build VoLTE. Because of this, ZTE and Telefonica are working very closely, trying to guarantee that the final core architecture evolution will be done as Telefonica will need to do, protecting the security and guaranteeing all the integrity of the customer's information and all the control of all the core that is serving to the societies. It will not be managed by a single partner. We need to build one core with pieces that avoid that any one is controlling all the added value chain for the 5G services. I am fully convinced that finally it would be one of the key technology providers in the core and later on if we are doing the right things in the radio specific country by country.

"We are building different pieces with the final puzzle."

The global telecom industry is changing faster than ever. How do you foresee the global telecom market over the next few years?

This is an extraordinary question. We are in a change of cycle because at this moment the FTTH is going to be 3G PON to 10G PON. Telefonica is leading FTTH in Europe and Latin America. The evolution to 10G PON offering our customers 9-10 Gbps symmetric is going to be a radical evolution of customer behavior. We can offer our customers different experiences in video, offering them capabilities in terms of AR/VR. This is happening now. In all the technological capabilities of Telefonica, it is absolutely an extraordinary position because all we need to do in the external plan, in the fiber, in the migration from copper to fiber had been done. Our position is very strong. By the end of this, we are finishing the 4G deployment in all our countries. We are working with 5G. This means that we are offering our customers velocities up to 1 Gbps, up to 5 Gbps, up to 9 Gbps, one by one. All the possibilities that we are offering to our customers in the access, and all the necessities that we are covering in the backhauling capabilities, in the core capabilities, and in all the service layers that we are offering are amazing.

But if you put these together with the experience of Telefonica in the four platforms—offering our customers the possibilities in the cognitive AI and giving them the possibility to speak with the network. It is the network that needs to be learned. It is not the people who need to be learned. It is the network that is learning how you can interact. By the hand of this capability, we can build real end-to-end digitization because the customers have all the assets to try to do it.

So in the next 5-10 years, the customers one by one in the societies will be managing the technology in a very simple way that today is just impossible to imagine. This is going to be amazing. This is happening. We are building all the different pieces we need in the full stack, in the 5G, in the 10G PON, and in the robotization, automization, and BSS evolution. We are building different pieces with the final puzzle. ZTE TECHNOLOGIES

MEC Empowers Network Architecture for Operator Transformation

Zhang Weiqi
FDD Product Planning Director, ZTE

In recent years, the traffic of telecom operators has increased very rapidly, but in contrast, the income of telecom operators is still growing at a low rate, and the scissors gap between the two is getting bigger and bigger. With the advent of 5G and the development of cloud computing, IoT, AI, VR/AR and smart driving, digital transformation of the entire industry has entered a new stage. The increasing real-time computing capability not only raises ultra-low latency and higher bandwidth requirements for telecom networks, but also poses new challenges to the current cloud computing model. There is also an urgent need for integration of information and communication technology (ICT) and operational technology (OT).

Edge computing is the support and enabling technology for integration of ICT and OT, and the industry will enter an important period of opportunities. Edge computing is an inevitable choice for operators to expand the application value of industrial internet.

Introduction of MEC

As networks continue to expand, more and more connections need to be analyzed, processed, and stored on the edge side. With the continuous improvement of terminal capability and the further reduction of traffic tariff, high-traffic services will have a direct pulling effect on the average data traffic per user per month (DOU). It is estimated that when 5G is put into large-scale commercial use, the average traffic bandwidth of a single user will reach 5 to 10 times that of the 4G network, putting great pressure on the backhaul network.

The current network architecture and mobile technologies fail to fully optimize the network. The distance between base stations and the core network is often hundreds of kilometers, through multiple convergence and forwarding devices, coupled with unpredictable congestion and jitter. It is difficult to guarantee the scenarios of industry users with high requirements for delay and reliability.

Edge computing is a distributed computing architecture that processes data physically close to the data source. It can further reduce transmission delay, increase network efficiency, improve service distribution and transmission capabilities, and enhance user experience, thus meeting the key needs of industry users in the process of digital transformation, such as

real-timeliness, intelligence, data aggregation and interoperability, security and privacy protection. This is highly consistent with the concept of being service-oriented and expanding 5G into vertical industries. Edge computing, as a native 5G function, will help to implement application localization, content distribution, and edged-based computing.

Different organizations give different definitions of edge computing. As defined by ETSI, multi-access edge computing (MEC) is a product of ICT integration and also a key technology to help operators transform their operations. Tens of thousands of edge DCs are excellent resources of operators over OTT, which makes MEC have a wide application space.

As an innovation in network architecture and business model, MEC can be a sharp tool that uses the network to serve vertical industries. It can also be an opportunity for operators to enhance network value and will probably promote the redistribution of industry chain values.

MEC Empowers Network Architecture

MEC will change the state of infrastructure in almost all enterprises, from the highly centralized to a mixture of centralized and distributed, that is, the combination of cloud computing and edge computing. With the emergence of MEC, operators have changed their pipes into intelligent ones. MEC can not only optimize pipes and services but also assist enterprises in interworking with their applications, thus solving the problem of dealing with massive connections and large data traffic. Moreover, MEC can be integrated with the field operation technology to achieve the integration of the whole OICT, that is, with the ICT-based operation technology, operators can help enterprises complete digital operation and better serve vertical industries.

The MEC-based future network architecture allows computing, storage, and network functions to be moved down to the

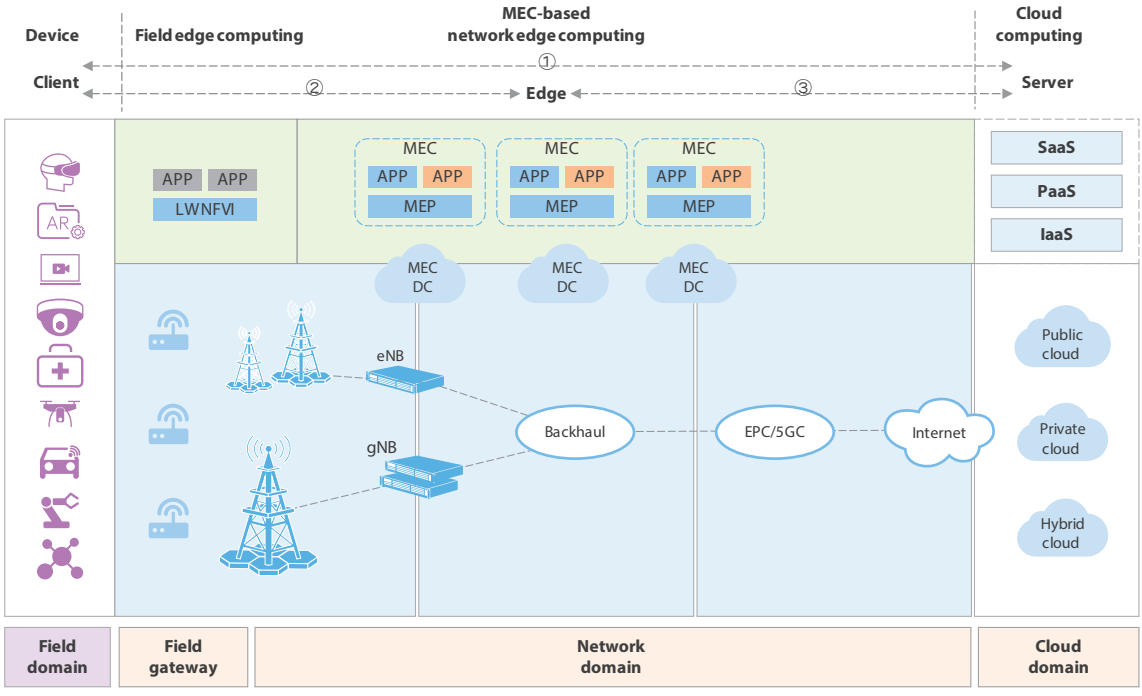


Fig. 1. MEC-based future network architecture.

pipes of the network domain, and can be deployed in the desired locations according to the service requirements of industrial applications (Fig. 1). These MECs deployed in different locations form a MEC cloud that supports real-time computing while making existing network pipes intelligent. The MEC cloud can not only be deployed based on existing 4G LTE networks, but also evolve seamlessly to support 5G and enable three major 5G application scenarios: eMBB, mMTC and uRLLC.

In the era of cloud computing, internet terminals are connected to the cloud through network pipes for services, which is a typical C/S computing mode. When MEC is introduced, the edge computing layer is available in the network pipes. The original C/S computing mode is transformed into the C/E/S computing mode. The MEC-enabled network architecture based on the SOA architecture, micro-service model, and cloud native applications can meet the digital transformation of enterprises.

MEC Helps Operator Transform

Because of its proximity, large bandwidth, low latency, and localized computing, MEC brings the following typical advantages:

- Through efficient computing at the network edge, the backhaul traffic of the cellular network can be reduced greatly and the transmission cost can be reduced.
- For delay-sensitive applications, edge computing is implemented to reduce the delay and improve the quality of experience (QoE).
- Edge data will become more private (personal health, facial or voice recognition data, private place interaction) or confidential (key factory internal data). Edge computing meets privacy regulatory needs by processing, storing, and/or discarding appropriate data, reducing the risk of data leakage.

Through low-cost edge solutions, telecom operators can interconnect or integrate and optimize enterprise infrastructure to facilitate digital transformation in vertical industries, thus increasing revenues. They can develop emerging B2B business models to provide edge cloud managed services for many third-party cloud service providers, thereby creating business opportunities and increasing revenues. Based on the MEC-enabled architecture, telecom operators achieve ICT integration. Also, they can successfully transform their operation mode from serving public customers with 2C services to serving vertical industry customers with 2B services in the mobile internet era.

MEC Based Transformation Road

ITU has defined three application scenarios for 5G: eMBB, mMTC and uRLLC. The vision and needs of 5G are to meet the explosive growth of mobile data traffic, massive device connections, and emerging new services and application scenarios in the future, while deeply integrating with the industry to meet diverse needs of terminal interconnection in vertical industries, achieve real internet of everything, and build the cornerstone for digital transformation of the social economy.

As 4G networks still serve as basic coverage networks for a long time, operators can transform MEC on existing 4G networks and continue to operate it after building 5G networks in the future. MEC can be applicable to both 4G and 5G networks. It enables telecom operators to make full use of the fully-covered 4G LTE networks and the upcoming 5G networks to achieve integration of mobile communication network and industrial internet services,

enhance the added value of networks, and facilitate operation transformation.

From a business perspective, operators can transform from 2C and 2B services respectively. The transformation of 2C services can be based on existing 4G networks, and the QoS management and control capability can be improved through MEC in addition to original package services. This scheme improves user experience and thus increases the revenue. Transformation of 2B vertical services that require very low delay can be provided based on 5G networks. In a scenario not requiring low latency requirements, existing 4G networks can be used with MEC to provide office and production operations in an enterprise campus. As there are few uplink services on the 4G networks, 4G video services can also solve the problem of difficult video surveillance deployment.

Flexible security services are required. Because MEC is deployed inside network pipes and needs to provide localized computing and coordination with cloud computing, the privacy and security of enterprise data need to be considered. Based on the isolation implemented through virtualization, data security and security collaboration with cloud-based and on-site edge computing need to be further considered.

In terms of technology evolution, MEC transformation needs to consider plug-and-play infrastructure, flexible and reliable MEC platform, cloud native applications, automatic service orchestration, and building open MEC application capabilities.

The deployment of MEC is based on service requirements and scenarios, combined with network requirements, edge infrastructure, operation model, and maintenance and management needs, which is a balance between performance and investment. A strong ecosystem is the guarantee for MEC development. Perfect infrastructure, flexible network and platform capabilities, and abundant edge applications are the key to prosperity of the edge ecology. ZTE TECHNOLOGIES

Exploring NB-IoT Network to Boost 5G IoT Development

Hao Ruijing
Senior System Architect, ZTE

Narrowband IoT (NB-IoT) is a low-power wide-area (LPWA) technology working at the licensed frequency band and widely supported by the world's leading telecom operators and vendors. Compared with other IoT technologies, NB-IoT covers a wider area, consumes less power for its terminals, and has larger number of connections and lower cost. As an important component of candidate 5G technologies, NB-IoT is one of the most important access technologies to meet the requirements of the 5G massive machine type communication (mMTC) scenario. The 3GPP NB-IoT standard evolution (Fig. 1) and the coexistence capability of NB-IoT and NR in the air interface and core network provide important technical guarantee for protecting operators' investment and ensuring the continuity of diverse LPWA services in the 5G era.

Developing NB-IoT Well From Technology to Industry

NB-IoT is being implemented at a rapid speed on a global scale with different paces in different regions. By June 2019, the number of commercial NB-IoT networks worldwide had reached 98, and NB-IoT has become one of the most widely used IoT technologies in the world. By the end of 2019, the number of global NB-IoT connection users is expected to exceed 100 million, a combination of GSM based IoT users over the past six years.

NB-IoT industry has a mature and complete ecosystem, ranging from component vendors to terminal manufacturers. Currently, there are 25 Cat-NB1/Cat-NB2 chipsets provided by MKT, Hisilicon, and Qualcomm, and more than 100 modules are ready for commercial use. With the maturity of NB-IoT ecosystem and the number of chips and modules growing at high speeds, the cost of modules gradually decreases to the level of 2G modules. It is expected that the cost will be less than RMB 12 by the end of 2019.

Many operators strongly support and promote the development of NB-IoT. China Mobile has implemented continuous NB-IoT coverage in 346 major urban areas across the country. China Telecom has built 400,000 NB-IoT base stations throughout the network. China Unicom has run commercial NB-IoT trials

in dozens of cities across the country, and more than 300 cities have the capability of fast access to NB-IoT.

The support of all kinds of policies opens up a new world for the expansion of NB-IoT. NB-IoT continues to expand the scope of vertical service applications, and the market application scale has developed multi-millions or tens of millions of connection-level services. NB-IoT services have gradually expanded from the smart meter reading, smart manhole covers and smart smoke sensors in early days to today's shared white household appliances, smart electric vehicles, logistics tracking and smart wearable devices. As the industry chain matures, the development of NB-IoT will evolve from policy-driven to service-driven in the future.

Exploring NB-IoT to Improve IoT Performance

With the prevalence of commercial 5G, IoT technologies have been greatly improved. The NB-IoT network has put forward higher requirements for network performance, which needs to be improved in many aspects such as coverage, user rate, capacity, terminal energy consumption, O&M, and location service.

In-Depth Coverage Solution to Enhance Coverage Performance

The focus of NB-IoT coverage is gradually shifting from wide area to indoor in-depth coverage. Compared with GPRS, by deploying power spectrum density enhancement and repeated transmission, NB-IOT has a coverage gain of 20 dB to effectively improve the penetration ability from outdoor to indoor scenario. However, as there are increasing demands for indoor in-depth coverage, the access requirements of terminals cannot be met only through the enhanced coverage from outdoor macrocells. The indoor distribution system and Qcell solution can be introduced in the wireless network to extend the indoor coverage, and other low-cost in-depth coverage solutions including IoT cells and passive antennas are used for special scenarios such as elevator wells and underground pipeline wells.

NB-IoT	eNB-IoT	FeNB-IoT	NB-IoTenh3	NB-IoTenh4 (TBD)
Release 13	**Release 14**	**Release 15**	**Release 16**	**Release 17**
• Cat-NB1 • Stand-alone/Guard-band/In-band • Coverage extension • UL 3.75 KHz/15 KHz • UL single-tone/ multi-tone • CP/UP • eDRX • PSM • Multi-carrier	• Cat-NB2 • Enhance TBS/Dual HARQ • Non-anchor carrier • Release assistance indicator • Re-connection with RLF • Positioning • CQI report • Measurement report • Maximum Tx power 14 dBm • Single-cell multicast	• Mixed mode multi-carrier • SR report • Wakeup signal • Early data transmission • UE differentiation • Reduced system acquisition time • New PRACH format • Small cell support • TDD support	• Coexistence with NR • connection to 5G Core • Improve multi-carrier operation • UE-group wake-up signal • Mobile-terminated (MT) early data transmission • Enhancement of SPS • Inter-RAT cell selection • SON	• Increase of data rates: DL16QAM/ 64QAM or carrier aggregation • Power enhancements

Fig. 1. 3GPP NB-IoT standard evolution.

User Rate Enhancement to Adapt to More Services

The continuous improvement of single user rate in a NB-IoT network expands new service requirements and enhances user experience. The initial NB-IoT service applications focus on small-packet IoT services such as meter reading and smoke sensor. However, as IoT services extend to white household appliances and wearable devices, the low rate of 3GPP R13 is unable to meet the service requirements. Therefore, 3GPP R14 introduces Cat-NB2 and dual HARQ functions. The maximum uplink rate of a single user is 2.5 times that of R13, and the maximum downlink rate of a single user is 4 times that of R13. In terms of a single user rate, the Cat-NB2 and dual HARQ functions can completely replace GPRS applications. To further improve the single user rate, R17 plans to introduce downlink 16QAM/64QAM and carrier aggregation (CA). Compared with R14, the peak rate of a single user can be increased by six times.

Multi-Carrier Solution to Improve Network Capacity

The expansion of the NB-IoT network from single carrier to multi-carrier can meet the rapid growth of massive terminal demands. Multi-carrier deployment has become an inevitable trend of capacity improvement. Due to random access and paging constraints, the multi-carrier function in 3GPP R13 cannot double cell capacity. After multi-carrier enhancements are introduced, 3GPP R14 can access terminals on non-anchor carriers or send paging messages, so that the cell capacity can be multiplied in a real sense. According to the test results of two-carrier inter-frequency deployment, the overall cell capacity can be increased to three times. 3GPP R15 continues to introduce combination modes such as SA+IB and SA+GB, so that multi-carrier deployment can be expanded to improve network capacity.

Energy Saving Technology to Extend Terminal Life

NB-IoT constantly optimizes the terminal power consumption technology, greatly extending the life of terminal battery. 3GPP R13 introduces eDRX and PSM; R14 introduces release assistance indication (RAI), uplink power control enhancement and 14 dBm terminals; R15 introduces early data transmission (EDT), wake-up signal (WUS) and SR enhancement; and R16 introduces MT-EDT and UE-group WUS. All these help to extend the terminal life and reduce battery replacement.

Intelligent O&M to Improve Network Efficiency

It is an inevitable trend for NB-IoT to evolve from manual O&M to intelligent O&M. Although the NB-IoT service has a short online time and a small amount of data, it has a large number of terminals, a variety of service types and different requirements for network performance. This results in great difficulty in network O&M. Although 3GPP R13 does not support MR reporting at the terminal side, BTS can estimate the downlink NRSRP according to the uplink measurement information, with the deviation between the actual effect and terminal NRSRP not exceeding 2 dB. In R14, MSG3 reports QCI and MSG5 reports RSRP/RSRQ, which can further improve the accuracy of MR reporting. R16 introduces the SON ANR function to implement automatic network optimization. In the future, AI-based intelligent O&M can automatically report problems, locate causes, and optimize networks, and AI will also help the overall resource management based on service types to ensure maximum user satisfaction.

Location Service to Expand Applications

The NB-IoT location service is the basic requirement among other IoT services. Many value-added services can be derived from the location information. Observed time difference of arrival (OTDOA) and enhanced cell identity (E-CID) are introduced to 3GPP R14. However, the field test shows that the positioning accuracy is low (more than 100 meters), which cannot meet the requirement for commercial use. The enhanced solution of E-CID and fingerprint database is therefore introduced, whose positioning precision can reach 50 meters. In some scenarios, the solution can replace GPS to address high power consumption when IoT terminals use the location service.

Great Prospects for Future-Oriented NB-IoT

Evolution of NB-IoT to 5G

As one of the mainstream LPWA technologies, NB-IoT has been evolving to 5G. At the 79th plenary session of 3GPP RAN held in March 2018, 3GPP made it clear that 5G NR mMTC scenario would not involve LPWA in R16, while eMTC/NB-IoT would still be the main application technology in the LPWA scenario. At the ITU-R WP5D#32 meeting in July 2019, NB-IoT was officially recognized as a 5G candidate solution to meet the technical requirements of large-scale mMTC scenarios. This indicates that NB-IoT has the ability of smooth transition to 5G and will continue to evolve as an important scenario standard in the 5G era. This also provides a solid guarantee for future NB-IoT development, allowing operators, equipment vendors, chip manufacturers and vertical industries to be more innovative in technology R&D and business model exploration.

Future-Oriented Development Strategy of NB-IoT

To support co-site deployment of 5G NR, LTE and NB-IoT at the same spectrum, the site co-existence and spectrum sharing are necessary tools to improve spectrum utilization while ensuring existing NB-IoT terminal services are not affected after 5G deployment. If LTE exclusively uses the spectrum resource, NB and LTE co-existence and spectrum sharing are preferred. If the NR and LTE spectrum are fully shared, it is recommended that NB-IoT anchor carrier exclusively occupy one spectrum resource, and non-anchor carrier shall consider sharing the spectrum with NR dynamically.

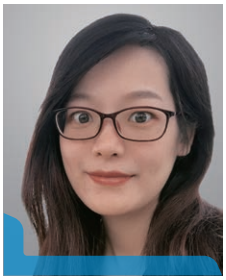
For future smooth migration from NB-IoT sites to a 5G network, NB-IoT wireless access to 5GC is a problem that must be solved. When combined with the 5G slicing solution, NB-IoT can separate CU and DU to achieve more flexible network deployment. To extend the application in the enterprise or private network market, NB-IoT can combine the 5G MEC solution to realize the localization of enterprise applications.

Conclusion

The arrival of 5G has significantly boosted the development of IoT technologies. The IoT world will be greatly enriched with further 5G commercialization. 5G brings not only faster network speeds but also the possibility of smart internet of everything (IoE). NB-IoT is a pioneer in 5G commercialization. No matter in terms of technology evolution, or global operator network construction, or vertical industrial application, NB-IoT has a good momentum of development that helps 5G explore its way in vertical industries in advance.

It is believed that in the future when 5G will be widely commercialized, NB-IoT as a mainstream candidate technology for 5G mMTC scenario will have a promising prospect in the smart IoE era. ZTE TECHNOLOGIES

ZTE STARS Solution Facilitates 4G&5G Co-Evolution



Ni Yanzi
FDD Product Solution Manager, ZTE

Zhang Jiong
FDD Solution Director, ZTE

The global race to 5G is now speeding up. However, the development of 5G cannot be achieved overnight. In order to achieve its full potential quickly, 5G needs strong support and coordination of 4G, as it is widely recognized in the industry that 4G and 5G will coexist and co-develop in the next 10 years. Therefore, it is necessary for operators to consider how to modernize their existing 4G network, build a high-quality co-evolvable 4G/5G network and reduce the overall O&M costs.

ZTE STARS solution addresses the five aspects that operators are most concerned about: Spectrum sharing, TCO optimization, Ace experience, RAN simplification, and Smart O&M, to achieve flexible and efficient network deployment and build an efficient 4G/5G collaborative network.

RAN Simplification

To start with the most basic yet fundamental aspect of building a network, RAN simplification is among the biggest challenges the operators are facing. First, site deployment is becoming increasingly complex. Second, insufficient site space makes it difficult to add equipment on site. Third, as the prime source of cash flow, 4G high-load sites need to be expanded to meet the increasing traffic requirements. Fourth, more users can benefit from 5G if its deployment can be done faster, more efficiently and with lower cost.

To address all these challenges, ZTE has launched the UniSite solution to help operators build a more powerful and efficient 4G network and enable faster 5G deployment. It offers a variety of high-performance, highly integrated innovative products, including ultra-broadband radio (UBR) and combiner-embedded RRUs that save antenna ports, thus achieving efficient site deployment and realizing "one antenna for 2G/3G/4G/5G". While network capacity can be greatly enhanced, the number of equipment required for a radio site can be dramatically reduced. For example, ZTE's tri-band UBR that integrates 900 MHz, 1800 MHz and 2100 MHz can reduce the number of site equipment by more than 60%.

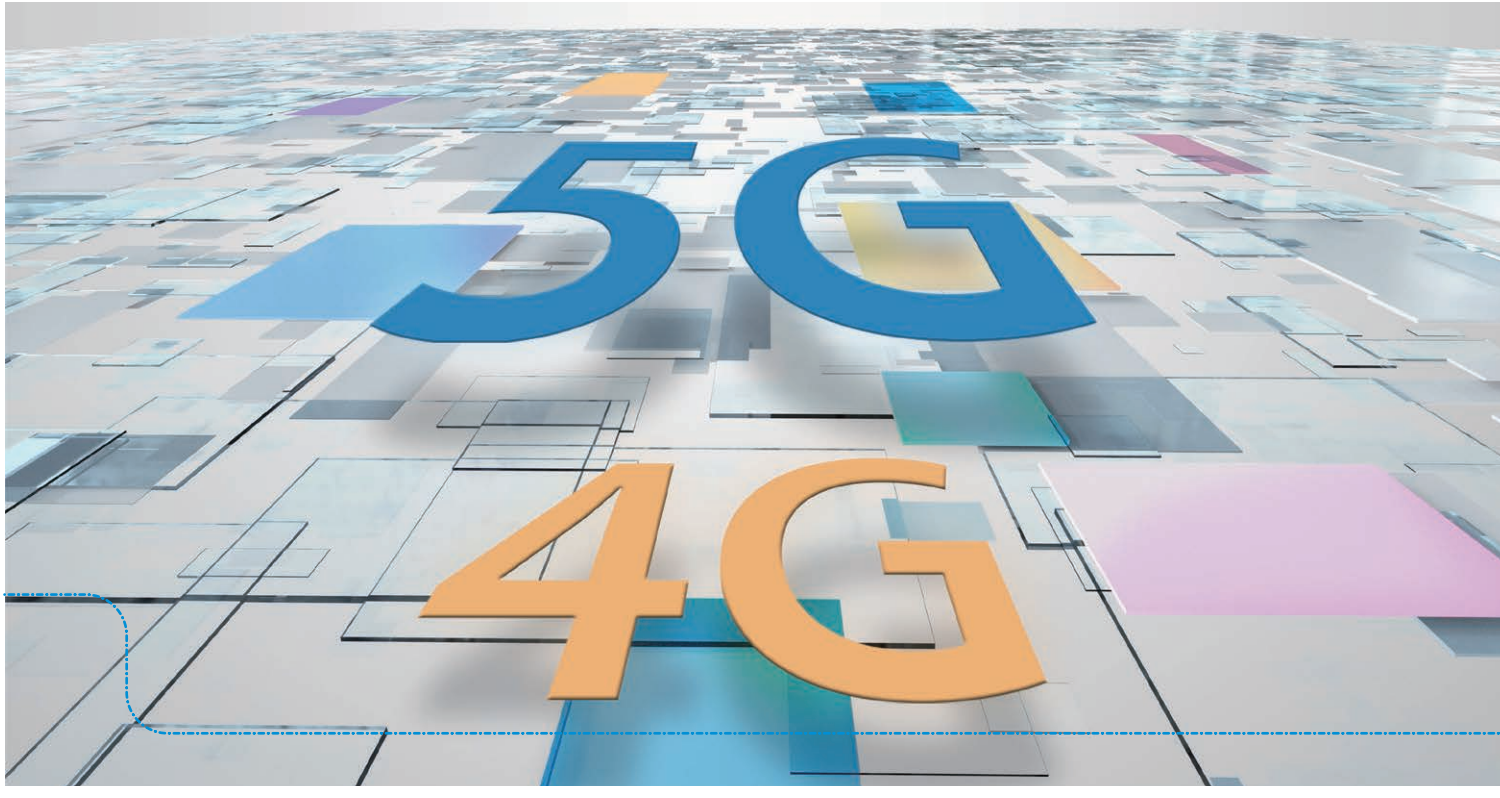
Dynamic Spectrum Sharing

With the rapid development of mobile broadband services, the existing 2G/3G/4G spectrum will have to be refarmed for 5G. It is however a tricky and often painful thing to manage for many of the operators. The challenge here is to implement smooth evolution of services between multiple systems, and adapt to unpredictable penetration rates of 5G terminals and regional differences, and reduce the negative impact of spectrum refarming on existing users. ZTE offers a two-fold complete solution, including both hardware and software, to make it easy for the operators. First, ZTE's existing sub-3GHz 2G/3G/4G equipment all supports smooth evolution to 5G NR by software upgrade. Second, with its rich experiences in deploying, analyzing and optimizing spectrum sharing solution for a huge set of different 2G/3G/4G network scenarios around the world for many years, ZTE has taken the lead in launching its Magic Radio Pro solution that allows dynamic spectrum sharing (DSS) between LTE and 5G NR. It supports TTI-level spectrum sharing, maximizes the spectrum efficiency, and facilitates smooth evolution from 4G to 5G.

Ace Experience

5G in its initial stage will focus on eMBB services, and due to limited 5G coverage, the early 5G services and user experience will rely on the 4G network. Therefore, 4G MBB as an underlay network is expected to evolve and develop over a long period of time with 5G for better user experience and service continuation.

The STARS solution ensures the service experience through the all-round LTE MBB capacity enhancement solutions. In the



"hotspot area", a full range of small cells are available for solving specific capacity requirements. In the "high traffic" area, the flexible X-Site sector-splitting solution can improve site capacity by as much as 40%–70%. In the "extreme traffic" area, Massive MIMO is used to greatly enhance cell throughput and further tap the network's potential.

IoT is recognized as the next trillion-dollar sector. The IoT, especially the mobile IoT, will have tremendous development in the next decade. According to GSMA, there will be 25 billion IoT connections worldwide by 2025, but 5G mMTC will not be standardized by 3GPP until Release 17, which is why 4G NB-IoT/eMTC is currently the best way for the operators to engage with IoT. ZTE provides end-to-end cellular IoT solutions with deployment of over 20 NB-IoT networks worldwide. ZTE also leads in IoT network performances with features like NB-IoT R14 data rate enhancement, multi-carrier enhancement and positioning, and has extensive collaboration with various vertical industries for materializing new services, including smart metering, home appliance sharing and intelligent bicycle management.

MEC is believed to be an "ideal partner" of 5G as the application of it in the vertical industries would often require support of MEC. But while it takes time to get 5G ready on a large scale with all the involved industries, it can be convenient and beneficial for some of the industries with urgent demands to leverage 4G MEC, which can also support both 4G and 5G later via software upgrade. Therefore 4G+MEC can integrate, at any time, with 5G base stations to achieve seamless evolution and flexible expansion of services. ZTE has been working very actively on MEC deployment, moving cloud computing to the edge and realizing low-latency services. For example, ZTE deployed MEC servers in the smart Tianjin port project, providing video streaming and virtual private networks based on 4G network, and enabling remote operations of unloading, shipping and stacking goods, the three key operations of the port, and also autonomous driving using 5G technology. The applications of MEC in 4G can open up brand new business models, even when 5G has just started, so that more and more differentiated new use cases can contribute to the financial statements of the operators.

Smart O&M

Following the pace of 5G network deployment, ZTE has launched UME network management system with support for unified management of 2G/3G/4G/5G and NB-IoT networks. Powered by the latest big data and artificial intelligent technologies, our full range of O&M tools further improve O&M efficiency by 25% and help operators improve network quality from coverage, capacity to user experience with lower cost. For instance, the tools can help monetize network infrastructure resources, based on deep analysis of massive data from network operation, with great features like intelligent forecasts for changes in user perception and forewarnings of any adverse impact on the payload of base stations. Furthermore, the insights into network value based on 4G big data can be crucially useful for 5G network planning, which can make 5G deployment well prioritized for precisely targeted areas with optimal return on the investment.

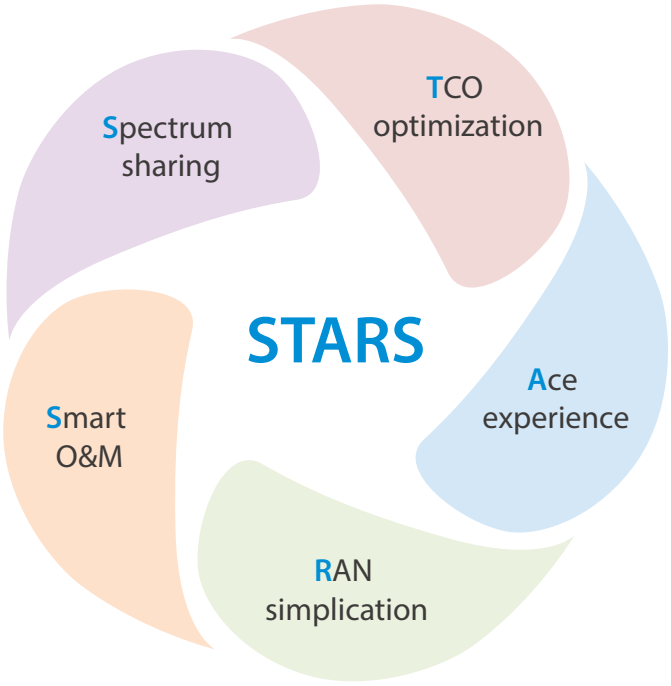


Fig. 1. ZTE STARS solution addresses the five aspects that operators are most concerned about.

TCO Optimization

5G would require huge investments, which makes it a big challenge for the operators to deploy 5G and to further modernize 4G with cost efficiency. TCO optimization is one of the core elements of STARS solutions. All the aforementioned aspects, including RAN simplification, full dynamic spectrum sharing, ace experience, and smart O&M, help reduce TCO in various ways.

In particular, ZTE provides comprehensive energy-saving solutions, including a next-generation hardware platform, software features, and AI-based energy management, to help operators build greener networks. The hardware design aims at low power consumption. The software features support for energy saving coordination among GSM/UMTS/LTE/NB-IoT, implementing savings flexibly on different levels (from carrier to channel and even to symbol levels) to accommodate different network traffic and energy saving contexts, and generally 5%–30% energy would be saved in different cases. In addition, based on our experience in helping many operators around the world in saving energy under diverse and often complex network conditions, ZTE has now brought it to the next level with big data and AI to find the optimal combinations of policies, time, and other settings of energy saving through analysis, prediction and closed-loop optimization, which improves energy saving activation probability and accuracy.

5G will undoubtedly change our life, business and the world for the better. ZTE STARS solution helps operators in a wide range of different ways enjoy the ride by allowing them to deploy 5G faster and at the same time modernize 4G better, and all with improved cost efficiency. ZTE TECHNOLOGIES

Magic Radio Pro: Dynamic Spectrum Sharing for Faster 4G to 5G Transition

Zheng Lingxia
FDD Product Solution Manager, ZTE

With the introduction of 5G, more spectrum can be utilized for different applications, such as sub-6G spectrum and high-band mmWave. Operators need to make the best use of each band to fulfil their business strategy while allowing coexistence with all technologies of legacy spectrum deployed in the network. 5G can greatly benefit from leveraging much higher frequency bands than 4G, like mmWave, but high-band mmWave is not always the fastest or most cost-efficient way to deploy 5G on a large scale. 5G will also use sub-3G bands that may be unfortunately used by 4G. Therefore, spectrum re-farming from FDD to 5G is obviously easy, but not the best option as the light load in the 5G initial stage will increase TCO. It is quite difficult to launch a 5G network with the highest ROI and an optimized TCO in the shortest time. This is a challenge posed to global operators and also the reason why dynamic spectrum sharing(DSS) becomes important. DSS enables 5G signals to share 4G lanes without introducing extra lanes, which is no doubt the best choice.

Why DSS?

Even though there is no extra application or best user experience comparing with 4G, the first 5G launch is still attractive to operators because it means the market share of first 5G users and higher user stickiness. When 5G is widely deployed, its cost and performance are key to operators.

In the Asian market, spectrum is very limited, and the introduction of new bands such as n78 and n79 are costly. Operators expect to launch 5G based on legacy FDD spectrum with the least cost. With 4G/5G DSS, 5G can be enabled on legacy FDD spectrum without introducing additional spectrum. 5G network coverage is a common concern of European operators as it is hard for them to provide a continuous coverage at the initial stage of 5G deployment. 4G/5G DSS can bring 5G users a continuous experience based on the legacy FDD network.

What's DSS?

Without DSS, an operator that has 20 MHz of low-band spectrum would have to split that spectrum in two. In other words, they would have to allocate 10 MHz of spectrum to FDD LTE and another 10 MHz of spectrum to 5G, even though initially there would only be a minimal number of 5G users.

With DSS, an operator doesn't have to split the spectrum or have dedicated spectrum for either FDD LTE or 5G. Instead, they can share that 20 MHz of spectrum between these two technologies. This helps operators deploy 5G in a fast and agile way. 4G and 5G can be implemented on the same spectrum as required by traffic needs in each millisecond, that is, 4G and 5G are running on the same lane with delicate scheduling algorithm to avoid hitting each other. In each millisecond, based on the understanding and analysis of 4G and 5G control channel characteristics, these control channels can be scheduled in such a smart way with minimum interference to each other, whereas 4G and 5G service channels are allocated based on frequency division method. As a result, resources required by 4G and 5G can be adjusted to adapt to an optimal performance with less spectrum waste, higher ROI and better 5G experience.

Before the 4G and 5G spectrum sharing, ZTE has observed dynamic traffic trend in field networks for many years and gained rich experience in GSM/LTE, GSM/UMTS and UMTS/LTE DSS, which gives rise to the Magic Radio solution. With the development of 5G, ZTE has further explored the spectrum sharing possibilities and rolled out Magic Radio Pro that enables spectrum sharing among GSM, UMTS, LTE, 5G and even NB-IoT. With global success in spectrum sharing among FDD modes, ZTE can offer operators a faster transition from 4G to 5G with a guaranteed coverage and an optimized TCO.

To date, ZTE has widely deployed its Magic Radio Pro solution in the global market with more than 40,000 sites, especially in Asian market. In Europe's market, ZTE has cooperated with operators in developing LTE/NR DSS and has reached agreement on commercial application in the near future.

Case Study

In a FDD multi-band multi-mode mode, Magic Radio Pro also addresses the issue of better LTE performance and stable GSM performance. In general, spectrum is statically allocated to GSM, UMTS and LTE, while traffic load changes dynamically. Since voice and data traffic in busy hours do not completely overlap, it is obvious that static spectrum allocation is unable to deliver on-demand allocation or make efficient use of the available spectrum in a dynamic traffic scenario. Magic Radio Pro enables dynamic spectrum sharing between GSM, UMTS and LTE, which maximizes spectrum efficiency by adapting to dynamic traffic load, and implements flexible scheduling of GSM, UMTS and LTE on the same band. Magic Radio Pro is a powerful solution for operators with multi-mode networks, as it greatly enhances spectrum utilization and ultimately improves user experience.

To date, ZTE has widely deployed its Magic Radio Pro solution in the global market with more than 40,000 sites, especially in Asian market. In Europe's market, ZTE has cooperated with operators in developing LTE/NR DSS and has reached agreement on commercial application in the near future.

Case1: Helping Operator Secure No.1 with Better User Experience

GSM and LTE are traditionally two separate systems in any given network, which now becomes an increasingly serious issue in terms of spectrum utilization and monetization when spectrum resources are becoming limited against rapidly growing data demands. When Magic Radio Pro comes into play to offer dynamic and flexible coordination between not-so-efficient GSM and data-hungry LTE, LTE can enjoy more bandwidth and attract more user without affecting GSM users. This can greatly improve user experience and enhance brand image.

In Nepal, with the Magic Radio Pro solution, the operator's LTE bandwidth can be extended from 5 to 10 MHz using GSM real-time dynamic sharing within the 10 MHz LTE bandwidth. As a result, LTE user experience is significantly improved, and available downlink PRB resource is almost doubled in GSM low-traffic scenario. While keeping stable GSM key KPIs, the downlink throughput of LTE users is improved by 100% and the cell downlink throughput has 43% improvement. Based on the performance improvement of LTE users, Magic Radio Pro solution helps the operator strengthen market position and improve its brand image.

Case2: Reducing User Churn Rate for Better Competence

GSM traffic reduces, but a large amount of low-end GSM users are still in the network and contribute little to revenue with low ARPU. LTE users still increase while its user experience is limited due to static spectrum allocation. The contribution of revenue from data usage to total ARPU continues to increase. Therefore, it will be reasonable to transfer GSM bandwidth to LTE dynamically to maximize the spectrum ROI.

In India, GSM/LTE static sharing is used for an operator at the first stage where there are a large amount of GSM service needs. The 10 MHz LTE band is shared with GSM (8 MHz LTE plus 2 MHz GSM). In the second stage, GSM/LTE dynamic sharing is applied for better LTE user experience, where 10 MHz LTE is shared with GSM in real time. The dynamic sharing solution enables LTE to have more available PRB usage compared with static sharing. Since June 2019, even if LTE bandwidth has not been extended before and after dynamic sharing, LTE downlink PRB resource still has been increased by 4 PRBs, and LTE user downlink throughput has been improved by 15%. GSM key KPIs keep stable throughout the process. In this way, Magic Radio Pro improves LTE user experience and thus helps the operator reduce user churn rate.

Case3: Improving User Experience to Boost Brand Image

GSM still dominates voice service while LTE service keeps increasing. Compared with LTE user experience improvement, GSM user experience can be squeezed a bit based on user behavior. So determining the period when GSM bandwidth can be occupied by LTE without user complaint is a delicate and important technique for operators.

In Pakistan, through the Magic Radio Pro solution, ZTE carefully studied GSM and LTE traffic distribution based on big data analysis and defined the available time for LTE bandwidth extension or GSM bandwidth reduction. When GSM traffic was low, a small bandwidth would be occupied; then LTE could be extended to a larger bandwidth. The larger the LTE bandwidth, the better the user experience. Since September 2017, LTE bandwidth has been extended from 3 to 5 MHz in a given time. LTE users have increased by around 80% after the throughput improvement. Consequently, the operator can prolong the defined time for LTE and gain better feedback from the market to improve brand image.

Future-Proofness

ZTE's Magic Radio Pro has found favor among operators for it can not only allow smooth phase out of the legacy mode and smooth transition to the new mode, but also greatly improve user experience and protect legacy investment. As the AI technology develops, AI-based spectrum sharing solution will further boost network performance and user experience in the future scenario of 4G and 5G dynamic spectrum sharing. ZTE TECHNOLOGIES

Sub-3GHz UBR UniSite for Modernizing 4G RAN in 5G Era

Yang Lisha
FDD Wireless Solution Manager, ZTE

34 countries have recently completed 5G-suitable allocations or licensing procedures in at least one spectrum all over the world. Another 40 countries have announced formal plans for allocating 5G-suitable frequencies between now and end-2021. Over 20 countries have offered commercial 5G services this year. Whether in SA or NSA mode, 5G construction usually starts from hotspots to urban and suburban areas, from macro sites to micro sites. The introduction of 5G network brings great challenges to existing 2G/3G/4G sites.

- **Overloaded legacy sites:** After several 2G/3G/4G deployments, multi-band and multi-standard wireless sites have become normal practice. However, the site infrastructure systems including towers and poles have been increasingly congested and overburdened. The top priority for upgrade is to simplify existing sites and reserve space for 5G NR.
- **No evolution capability:** Based on spectrum analysis, the LTE band in sub-3GHz is an ideal resource for 5G NR in the future. If existing 2G/3G/4G sites cannot be upgraded smoothly, they will become a huge obstacle to 5G evolution.

During the rise of 5G NR, 4G network development has some key features.

- **Continuous LTE evolution:** The development of global LTE has not yet reached its peak. 2G/3G users are being handed over to 4G, and 4G still has expansion expectations and a long-term development window.
- **Multi-band combination to expand services:** With years of development, operators often have multiple bands. More spectrum means more chances. For example, the 700 MHz band is popular in 5G around the world. More countries have added the 700 MHz band to their 5G spectrum. In Europe, 700 MHz is introduced as a new frequency band. Integrating the new spectrum into existing networks without increasing the site load is the concern of operators.
- **5G evolution and dynamic spectrum sharing (DSS):** The DSS feature in 3GPP R15 allows frequency resources to be shared between LTE and 5G NR. This can balance the residence of existing 4G users and the attraction of new 5G

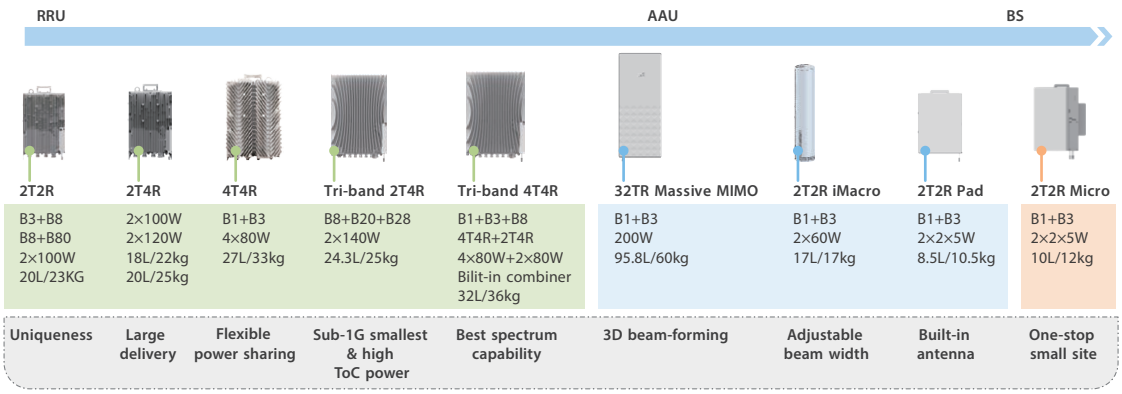


Fig. 1. ZTE's UBR product family.

2G/3G/4G/5G Co-Site	Legacy Site (2G/3G/4G)	UBR UniSite (2G/3G/4G)
Number of RRUs	18	9
Number of Feeders	18	9
RRU 1800 MHz/2100 MHz	Two-transmit	Four-transmit
Evolution capability	To be evaluated	Support 5G NR and DSS evolution

Table 1. Comparison of site data before and after network modernization.

users. 5G evolution and DSS capabilities are powerful tools for operators.

Modernizing 4G networks is therefore the best and necessary choice for operators in the process of 5G deployment. ZTE has developed its ultra-broadband UniSite solution that can help operators continuously optimize 4G network coverage and capacity while enabling the simplest wireless sites to evolve quickly and smoothly to 5G.

As early as 2014, ZTE launched the industry's first innovative ultra-broadband radio (UBR) products. Over the years, ZTE has been innovating its UBR products to fulfill the requirements on frequency bands, power, and performance in various regions. ZTE has rolled out nine UBR device types, covering RRU, AAS, small cell, and micro eNodeB (Fig. 1). More than 150,000 UBR devices have been used in over 20 networks around the world.

ZTE has also released two types of tri-band UBRs with industry leading performance. One is sub-1GHz UBR that works at 700 MHz, 800 MHz and 900 MHz and can be used for large-capacity applications in ultra dense urban or network sharing scenarios, and the other is sub-3GHz UBR that works at 900 MHz, 1800 MHz and 2100 MHz. The tri-band UBRs have the following attractions.

- **More powerful but smaller RRU:** Compared with traditional three equivalent RRUs, a tri-band UBR reduces in size by 20% and in quantity by 66%. It saves footprint, rental, transportation and installation fees, and O&M cost, and reserves space for high-frequency 5G.
- **Dynamic spectrum sharing:** The tri-band UBR supports DSS through software upgrade. The DSS function allows dynamic spectrum sharing between LTE and 5G NR. It attracts new 5G users while ensuring 4G user experience in the existing network.
- **Large capacity to meet multi-mode configuration:** The sub-1GHz tri-band UBR supports large capacity in GSM/UMTS/LTE/NB-IoT/NR multi-mode configuration. 2×140W ToC output power can be dynamically distributed to three frequency bands. The other sub-3GHz tri-band UBR features 6×80W ToC output power, multi-mode configuration, large capacity, and 4T4R in both B1 and B3. The UBR product family can meet the requirements of high-speed data traffic in dense urban scenarios.
- **Environment-friendly RRU:** To reduce energy consumption, the latest sub-3GHz tri-band UBR adopts the power amplifier with higher efficiency. The system efficiency improves from 26% to over 32%.

In one project in Europe, for example, an operator plans to introduce the 700 MHz band into a 5G network, while its devices that work at 800 MHz, 900 MHz, 1800 MHz, 2100 MHz and 2600 MHz bands in the existing network are restricted by the evolution capability and installation space.

In this scenario, ZTE's UBRs can be used to transform the site to a full capable compact one that supports multi-band operation, smooth 5G evolution, LTE/NR DSS, and carrier aggregation (CA). In this way, spectrum resources can be flexibly allocated to attract new 5G users.

ZTE's sub-3GHz UBR UniSite solution take into full consideration the site deployment requirements during the transformation in early 5G era. The industry-leading UBR series help operators rebuild high-quality 4G networks that provide multi-mode, multi-band and full-scene coverage. The solution aims at the long-term operation of 4G networks and supports DSS as well as 5G smooth upgrade in terms of device capabilities and network architecture, laying a solid foundation for a smooth migration to 5G. ZTE TECHNOLOGIES

ZTE FDD Massive MIMO: A Sharp Tool for Solving Network Capacity Bottleneck

Li Ting
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Ren Jie
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Urgent Need for Improved Spectrum Efficiency

5G opens up infinite possibilities for applications, promising ultra-high-speed broadband, internet of everything (IoE), and ultra-low latency services. Ultra-high-speed broadband has commercial availability, but is constrained by network capabilities whereas IoE and ultra-low latency services need the development of the entire industry chain to become commercially available on a large scale. The arrival of 5G still requires a period of transition since large-scale deployments of 5G are expected to take place after 2022. Therefore, we need to look at the new 5G era from the perspective of a span of a decade, not just the ideal vision at the initial stage. Currently, upgrading the 4G network to the Gigabit network is a more direct way to bring benefits.

The rapid growth of wireless network traffic is self-evident. In the past few years, many mobile operators have deployed a series of functions to make 4G networks reach higher speeds, which mainly relies on three technologies: CA, 256QAM and high-order MIMO (including 4×4 MIMO and higher-order Massive MIMO). Among them, 57 operators have employed high-order MIMO (greater than 4×4 MIMO) in different regions around the world. It can be seen that the commercialization of Massive MIMO is accelerating, and it has become a powerful tool for carriers to solve the network capacity bottleneck.

Key FDD Massive MIMO Technologies

As one of the core 5G technologies, FDD Massive MIMO provides a site throughput much larger than that of the existing multi-antenna base station and greatly improves spectrum efficiency. The FDD Massive MIMO solution directly applies the key 5G technology to the 4G network and is compatible with the existing 4G terminals.

It has two benefits: First, multiple antennas used at the transmitter can improve the SNR at the receiver with the application of beam forming; second,

through the use of multi-user spatial division, more parallel channels are generated to break the restriction of spectrum and greatly improve the spectrum efficiency.

In theory, the channel capacity can keep a linear growth relationship with the number of antennas to avoid data rate saturation. This is a common SDMA technology. The greatest advantage of Massive MIMO is to use the multi-dimensional space information of multiple antennas to realize a better multi-user spatial division technology. The implementation of Massive MIMO technology relies on two main factors: first, the multi-antenna hardware design, and second, the implementation and improvement of channel estimation and scheduling technology on software.

ZTE will make a new-generation Massive MIMO product ready for commercial test by the end of this year, which has stronger hardware capabilities, such as dual band and power sharing function, and higher performance gains. This will make ZTE continue to take the lead in the industry.

Application Scenarios of ZTE FDD Massive MIMO

As soon as ZTE's FDD Massive MIMO solution was introduced, it quickly attracted great interest of the operators and was the first to successfully complet the lab and field tests in China. After two years of hard work, the solution has been applied across the world, verified by a series of joint pre-commercial field tests with operators in Southeast Asia, Europe and Australia.

In September 2017, ZTE, in cooperation with operator A in Thailand, applied 3D MIMO technology to the campus of a local university to increase the capacity of a single cell by five times. In the following October, ZTE expanded its FDD Massive MIMO field trials and obtained good testing results in both Belgium and Australia. In particular, the industry's first FDD Massive MIMO site based on hybrid transmission modes has been completed. In August 2019, ZTE and operator K in Ukraine jointly carried out the FDD Massive MIMO field test with 15 MHz bandwidth. After a month's test and comparison, the Massive MIMO cell was proved to have better performance in PDCP traffic, RRC connected users, and PRB utilization rate than the traditional FDD cell.

ZTE has been accelerating the commercial use of FDD Massive MIMO with its products performing well in many commercial networks. There are three major scenarios especially suitable for deployment of Massive MIMO.

Large-Capacity Hotspot Area

After replacing the ordinary macro

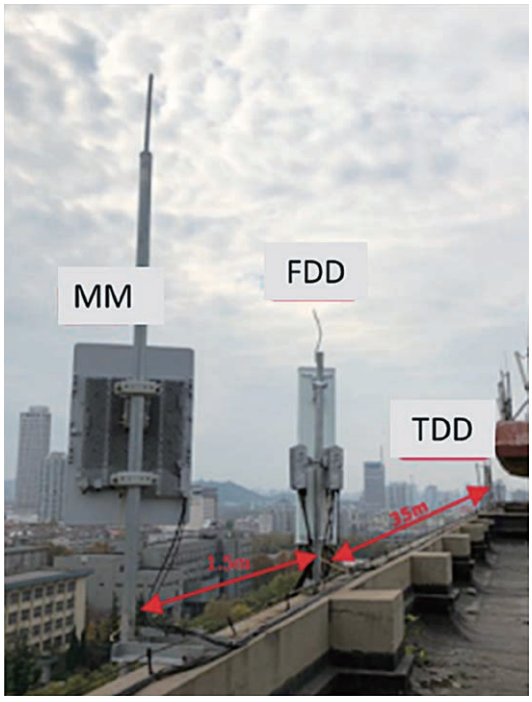


Fig. 1. FDD MM cell replacing the original cells on the site.

station with Massive MIMO site, the spectrum efficiency can be increased by up to three times and user-perceived throughput by up to 2.88 times.

- **Case 1:** In the network of operator T in Thailand, Massive MIMO was deployed in the residential area near a school. Through the FTP load testing in the commercial network, it can be seen that the Massive MIMO cell achieved significant gains in user throughout. Compared with the original ordinary cell, the rate of the TM4 user was increased by 2.49 times, and that of the TM9 user by 2.88 times. It solves the congestion problem of hotspot cells.
- **Case 2:** The FDD Massive MIMO deployment by a Chinese operator used another idea: The original ordinary FDD macro cell and three ordinary TDD macro cells were replaced by an FDD Massive MIMO cell on the site (Fig. 1).

After a period of operation, the KPI observation results in this area showed that the FDD Massive MIMO cell completely absorbed the users and traffic of the original four cells. Compared with the normal FDD macro cell, the traffic of the FDD Massive MIMO site is three times that of the normal FDD macro cell. This greatly saves the number of devices and the antenna space, and improves the ROI.

Coverage in High Buildings

The second major application scenario is coverage in high buildings, such as high-rise residential and office buildings. Especially for some old high-rise residential buildings, the indoor distributed antenna system (DAS) is difficult to be deployed physically or financially, so there is a need for FDD Massive MIMO. The FDD Massive

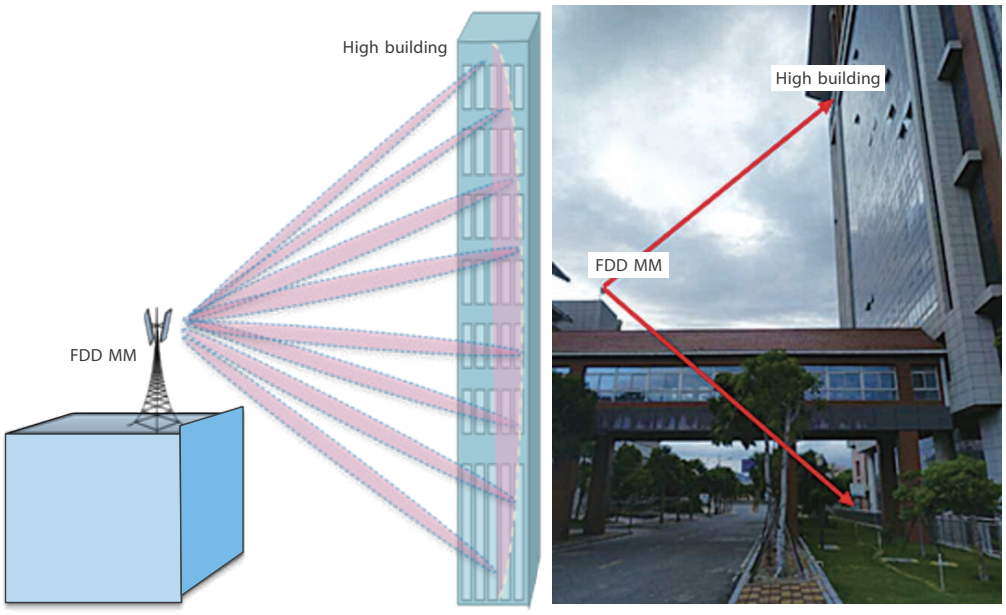


Fig. 2. FDD MM coverage in a high building.

Cell	Downlink PDCP Rate (Mbps)	Coverage Distance (m)
LTE cell	1.9484	103.1427
FDD MM cell	2.3281	116.9261

Table 1. In-depth coverage test results.

MIMO vertical antenna applies to scenarios with horizontal angles of no greater than 25 degrees and vertical angles of no less than 60 degrees. This meets the requirements of high traffic volumes in busy hours and also high-building coverage.

By testing the coverage and performance of the FDD Massive MIMO vertical antennas, and comparing them with the original indoor DAS, ZTE exhibited the advantages of the 3D-MIMO product in specific application scenarios. The test site for high-building coverage was a software garden complex, which has three indoor cells. The test scenario is shown in Fig. 2.

It can be concluded that FDD Massive MIMO can cover the entire main building and meet the basic service requirements. Compared with the indoor DAS on the same floor, FDD Massive MIMO provides significantly better coverage on Floors 10–18 and Floor 6. Below Floor 10, the indoor DAS has slightly better coverage with RSRP at 80% of the sampling points higher than -90 dBm. When comparing FDD Massive MIMO itself on different floors, the RSRP at 80% of the sampling points on Floor 18 and Floor 17 were greater than -100 dBm, and the RSRP at 90% of the sampling points on Floors 1–16 were greater than -100 dBm.

In-Depth Coverage

FDD Massive MIMO beam forming can be used to improve the SINR for a user, and provide in-depth coverage, especially enhanced edge user experience. ZTE deployed FDD Massive MIMO near a canteen in the Sichuan University for Nationalities, and performed a drive test around the canteen. Under the same edge rate requirement and along the same route, the FDD Massive MIMO cell could cover a longer distance, indicating increased depth of coverage. The detailed results are shown in Table 1.

Conclusion

With the gradual commercial use of FDD Massive MIMO, the FDD LTE operators who have 85% share of the global LTE connections can take the opportunity to apply Massive MIMO technology to improve the capacity, user experience and ROI of their networks and enter the high-speed network era. ZTE TECHNOLOGIES

Intelligent O&M Based on AI Power Saving

Fan Yingying
FDD Solution Manager, ZTE

High electricity charges have always been a big issue for operators. According to earlier data, the annual electricity expense of China's three major operators (China Mobile, China Unicom, China Telecom) even exceeded 30% of their employee' salaries. In the coming 5G era, more wireless base stations will be deployed. Test results from China Mobile show that the power consumption of 5G base stations is several times higher than that of 4G base stations, which may bring huge electricity costs. In the beginning of 2019, China Telecom made four measures to reduce costs, the first of which was to reduce electricity fees.

The number of base stations accounts for 70% of devices in a mobile network. With the increase in coverage, capacity, and the number of sites, the power consumption of base stations accounts for more than half of the mobile network, even up to 80%. Therefore, site energy saving is the top priority of power saving for operators. Reasonable network planning and NE-level power saving are two important aspects of ZTE's non-AI power saving solutions:

- Reasonable network planning means that through network planning and optimization, the minimum number of sites are deployed to meet the requirements of network capacity and power saving. Coverage efficiency is improved while invalid system overheads can also be reduced.
- NE-level power saving can be applied to more scenarios. Multi-layer shutdown including cell shutdown, channel shutdown, and symbol shutdown, which is widely used all over the world, is the most effective power saving solution for traditional network elements.

By June 2019, NE-level power saving solution had been commercially used in nearly 40,000 sites with China Telecom and China Unicom, and almost 20,000 sites overseas had also enabled the solution. According to statistics, up to 10% power consumption are saved, bringing a considerable Opex saving to operators.

However, challenges of the non-AI power saving solution are also obvious. First, the solution is not flexible. To simplify the deployment complexity, unified parameters would be configured in one region even the whole network without scenario identification, which may be poor matched to the real traffic variation. Second, the solution does not support sustainable evolution. Once there are changes in network architecture, such as the increase or decrease in the number of cells, the changes in neighbor cell relationship, or the changes in traffic, the previous power saving policy may be completely invalid. Third, the solution has poor adaptability. A large number of field or remote support personnel are needed. They speed much more time in analyzing KPIs, traffic load, and trial results.

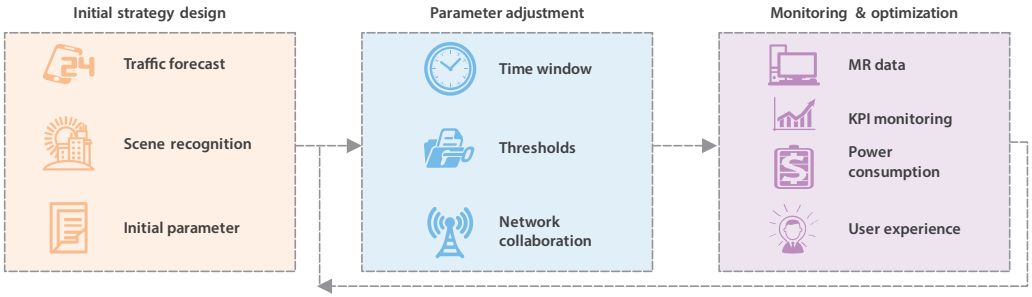


Fig.1. AI power saving procedure.

It is therefore necessary to develop an intelligent and self-adaptive power saving solution. With the help of three AI capabilities such as data perception, AI analysis, and intent insight, AI accelerators are introduced to provide rapid AI training and reasoning for intelligent O&M where power saving and network optimization are particularly important.

Through network prediction, strategy adjustment and optimization, and real-time KPI monitoring, the AI power saving solution forms a closed loop that can find a balance between power saving and network performance with little labor cost.

- **Time-based power saving:** Network load and user behavior can be predicted through historical data analysis. Autoregressive integrated moving average model (ARIMA), long short-term memory (LSTM) and Facebook's Prophet are used for time series prediction. Instead of setting up unified parameters, cell-based time window ensures more activation time for power saving.
- **Threshold-based power saving:** Different triggered thresholds are used for different scenario through prediction of RRC connected users and PRB usage. Comparing the predicted value with the real-time traffic based on 15 minutes granularity, the prediction accuracy exceeds 90%, which means strategy and scenario recognition cell by cell improves enforceability.
- **KPI-based power saving:** Network KPIs such as call setup success rate, drop rate, handover success rate and throughput, average power consumption and user experience are monitored in real time for policy optimization. Real-time policy roll-back is allowed in AI power saving. Gains of power saving improve with little impact on the network.

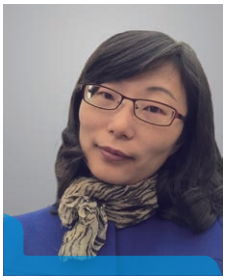
ZTE and China Unicom has deployed the AI power saving solution in Shandong, China, since June 2019. The commercial trial involves three phases. In the Phase I,167 cells including LTE single mode, GL multi-mode, and dual-band LTE enabled AI power saving. In the Phase II, more than 1,000 cells enabled AI power saving, both time window and threshold adjustment were trialed. In the Phase III, more than 10,000 cells will enable AI power saving in batches. Cell shutdown, channel shutdown, and symbol shutdown are all trialed based on site configuration.

The two trials verify that time for power saving activation has increased by 50% to 80%, and more than 10% to 30% power has been saved compared to the non-AI solution. Almost 3 kWh/day per site has been saved in Shandong, China.

Based on the trial results, we can make a simple calculation: With the AI power saving, 2 to 3 kWh/day per site would be saved in Shandong, China. When 10,000 cells (3300 sites) enables the AI power saving, 2.5 million kWh of electricity will be saved each year. If the average cost of commercial electricity is 1 yuan/kWh, 2.5 million yuan can be save to China Unicom in Shandong only. To operators, more real money is saved based on the AI power saving.

Of course, network-wide intelligence is difficult to achieve overnight, and it needs to go through a long-term development. However, with the continuous accumulation of commercial data samples, the best self-learning algorithm for AI power saving could be gradually approached. AI power saving will also be evolved to obtain more sample points and improve AI algorithms. It will help to reduce the network carbon footprint and create a greener intelligent network in the future. ZTE TECHNOLOGIES

NB-IoT Boosts 5G Oriented Applications



Yan Liping
FDD Solution Manager, ZTE

NB-IoT is Essential to 5G LPWA

NB-IoT, an IoT technology based on licensed spectrum, can quickly provide massive IoT connections on existing mobile hardware. With the evolution of 3GPP standards, NB-IoT will co-exist with 5G NR and have access to 5GC in R16. That means NB-IoT will provide IoT connections in low-power and wide-coverage area (LPWA) for 5G, like warehouse management in the industrial control IoT scenario and utility connection in the massive IoT scenario. All this is attributed to NB-IoT capability enhancement, large-scale NB-IoT deployment, maturity of industrial chain, and more vertical market engagement.

Capability Enhancement

To satisfy the requirement of 5G IoT deployment in LPWA, it is necessary to enhance capability of NB-IoT technologies. This involves data rate enhancement, capacity enhancement, mobility enhancement, capacity estimation, and intelligent operation and maintenance.

Data Rate Enhancement

A new device category, Cat-NB2, was defined in R14 to support larger TBS, and dual HARQ to allocate two data blocks one time. Thus, a single user speed is improved significantly up to 158 kbps in the uplink and 103 kbps in the downlink. That means NB-IoT has the ability to replace GPRS.

Capacity Enhancement

Multi-carrier was introduced in R13 and was enhanced in R14 with random access and paging supported in non-anchor carrier. Multi-carrier can provide larger capacity for diverse NB-IoT applications in an area with different intervals and traffic models.

Mobility Enhancement

According to field tests, with mobility enhancement defined in R14, NB-IoT services can be operated as normal in low and medium speeds. From stable to moving scenarios, NB-IoT technologies can be used in smart wristband, bicycle management and smart logistic. ZTE has been the first vendor in the industry to verify these features. To provide higher network performance, ZTE has also developed innovative solutions for NB-IoT capacity estimation and intelligent operation and maintenance.

Capacity Estimation

After a deep research on NB-IoT large capacity with different traffic models, ZTE has rolled out a

unique NB-IoT massive-connection and multi-service virtual-verification platform (NMVP) solution. NMVP makes it easy to simulate field services, estimate the quality of E2E services, and plan the networking. In the case of shared air-conditioner at the University of Shanghai for Science and Technology, NMVP was used to simulate and analyze user experience. In another case of meter reading of shared water heater in Guangxi University of Technology, NMVP played an important role in network capacity improvement and application process optimization. With the NMVP solution, operators can deliver better E2E IoT services.

Intelligent Operation and Maintenance

ZTE has been actively engaged in intelligent operation and maintenance of NB-IoT networks. Through the measurement reporting mechanism, the estimated value of downlink signal measurement can be reported accurately. This provides a reliable data analysis basis for network optimization. Northbound interfaces are also provided to realize the primary management of massive terminal access. With sustainable evolution of NB-IoT capability, NB-IoT network can meet requirements of diverse applications and massive connections in an easy and fast manner.

Large-Scale NB-IoT Deployment

As a preferred technology for operators, NB-IoT has been widely and rapidly deployed. According to the statistics released by GSMA in April 2019, a total of 148 operators worldwide are actively engaged in building NB-IoT networks. In the past nine months, the number of commercial networks has rapidly increased from 59 to 98. ZTE had deployed more than 350,000 NB-IoT sites in over 20 countries and regions around the world. Gartner predicts that by 2023, the total number of NB-IoT hardware deployments will be close to one-third of all global IoT deployments. The active participation of operators has promoted the incubation of NB-IoT applications and the creation of new business models.

Maturity of Industrial Chain

The NB-IoT industrial chain has developed rapidly in the past two years. 25 Cat-NB1/Cat-NB2 chipsets are provided by MKT, Unisoc and Qualcomm, and more than 100 modules are ready. In China Mobile's centralized module procurement last year, the price of most NB-IoT modules was 20 to 25 yuan (about $2.8 to $3.6). As the price is lower than $5 expected at the beginning, the NB-IoT industrial chain is maturing and the devices will explode.

More Vertical Market Engagement

With the maturity of NB-IoT industrial chain and the enhancement of network capability, more and more vertical industrial providers are engaged in NB-IoT. Differentiated and diverse NB-IoT applications are being introduced. Besides traditional smart meters, there are also a variety of applications such as smart smoke, gas, temperature and humidity monitoring, sharing appliances, and so on. At the same time, the mobility enhancement and positioning of NB-IoT makes it possible for smart logistics, smart wristband and smart warehouse management. Therefore, in an area, there are many kinds of NB-IoT applications that are deployed or being deployed, and the distribution of some applications is irregular and variable.

As NB-IoT applications grow, their traffic models are constantly optimized, and different industry standards are gradually taking shape. Recently, Haier, a home appliance company, has released industry standards for shared air conditioning systems with partners such as ZTE and China Telecom. This accelerates the development of the IoT ecosystem.

Conclusion

5G is coming, and there will be more abundant IoT applications in diverse scenarios. To lay the foundation of IoT, NB-IoT plays an important role in 5G IoT and is being used to deploy high-quality network to promote the development of IoT applications. Based on the LPWA ecosystem formed over NB-IoT, 5G IoT is going to provide us with more convenient and comfortable services. ZTE TECHNOLOGIES

Why Co-Evolution of 4G & 5G Matters, Suggestion on 5G Migration: ZTE

Source: RCR Wireless

ZTE considers that the co-evolution of 4G and 5G networks is a key issue as these two technologies will be sharing many resources and will be offering each other a strong support in the next decade.

This is why, ZTE believe that it is essential for CSPs to modernize networks as 5G-oriented as possible and at the same time achieving better 4G capabilities, to co-evolve the networks to a more technologically and financially promising 5G future.

According to Shen Jianda, VP of ZTE Corporation, the "fast deployment of 5G would give operators a big head start. For initial 5G rollout, high-value areas should be selected firstly, based on factors including high ARPU, high traffic, and high penetration rate of high-end smart phones. NSA has more endorsement at this stage, because it does not need 5GC so faster rollout could be more easily achieved". The executive highlighted that SA 5G networks are ultimate goal of 5G development, as these networks will be able to provide more attractive 5G new services.

"During the initial 5G stage, CSPs should make full use of the existing 4G networks, deploy 5G networks rapidly and efficiently, take into account the requirements on the existing network and subsequent 5G networks, adopt an efficient and comprehensive 5G evolution solution," the executive said.

ZTE highlights that the common view of the industry, including operators, is that 4G and 5G technologies will coexist and complement each other during a long period of time. 4G&5G co-evolution is also in line with the demand of operators at this stage. For operators, 4G is their strong revenue support, which will not change in a short term. It is essential for CSPs to factor in all these concerns with the best possible balance, with every dollar invested now providing much better 4G performance and 5G capabilities, ZTE said.

There are many resources that can be shared among 4G and 5G, and from RAN perspective, ZTE believes that RAN site and spectrum are the two most important things

Shen Jianda, VP of ZTE Corporation

4G and 5G technologies will coexist and complement each other during a long period of time. 4G&5G co-evolution is also in line with the demand of operators at this stage. For operators, 4G is their strong revenue support, which will not change in a short term.

to be taken into consideration. Site space in high-value areas is insufficient, it is difficult to add additional equipment, and more equipment also means more rental cost and TCO. While 4G sites with high load still need capacity expansion to meet the growing traffic requirements, it is also important to deploy 5G rapidly, efficiently, and cheaply. Therefore, it is essential for existing equipment to be both 4G-powerful and 5G-capable, to maximize the return on investment for CSPs.

"The existing 2G/3G/4G network is usually based on sub-3GHz spectrum. The spectrum is low, the coverage is good, and the cost of upgrading 5G is low. Therefore the existing 2G/3G/4G spectrum re-farming provides a cheap solution for 5G evolution. Spectrum sharing and flexible spectrum scheduling among GSM, UMTS, LTE, NB-IoT and 5G NR can improve spectrum utilization in an all-round way, and help 5G-oriented smooth re-farming of the existing spectrum," Shen said.

According to ZTE, operators should strive for the balance between critical investment in 5G to offer much better user experiences and guaranteed service in the existing 4G. "This is exactly why ZTE believes a comprehensive solution for both efficient 5G rollout and modernized 4G is in the core of facilitating operators' network upgrade and 5G implementation. ZTE's UniSite is such an integrated solution for multi-RATs, especially the long-term 4G/5G coordination, integration and evolution," Shen added.

UniSite is incorporated with some of ZTE's latest high-performance and high-integration products, such as ultra-broadband radio and combiner-imbedded RRU, realizing highly efficient site deployment, supporting 2G, 3G, 4G and 5G in all sub-3GHz bands with just one antenna. While network capacity can be greatly enhanced, the number of equipment required for a radio site can be dramatically reduced, which in turn saves precious space for 5G deployment. For example, ZTE's tri-band ultra-broadband radio product (for 900 MHz, 1800 MHz, and 2100 MHz) can reduce the number of radio units by up to 67%. ZTE's other innovative products, including Massive MIMO, Pad radio family, and multi-mode and multi-band QCell, offer a complete portfolio for all of the important deployment scenarios. UniSite can enhance network capacity and performance, simplify site deployment, and facilitate smooth migration to 5G, with lower TCO in multi-mode and multi-band network evolution. ZTE TECHNOLOGIES

ZTE Promotes 5G Commercialization Through Revolutionary B2B2C Model

Source: Telecom Review Asia

Having focused on research in the telecom industry in areas ranging from TDM to IP, then to Cloud for over 20 years, Jason Tu Jiashun, Principal Scientist of NFV/SDN Solutions, ZTE Corporation explained in an exclusive interview with *Telecom Review Asia* how the 5G Slice Store solution encourages vertical industries to participate in orchestration and life-cycle management of network slicing.

Could you please give our readers some insight on your position at ZTE Corporation and how your role has accelerated the development of the 5G Slice Store?

Principal Scientist is not a position in ZTE, it is an honorary title for those who make outstanding innovations in technology and marketing solutions. Based on ZTE end-to-end 5G slicing and slice store solution, in 2019 we have cooperated with China Mobile and introduced 3rd OTT such as Tencent Cloud Game to prove the concert of B2B2C successfully.

How important do you think the 5G Slice Store is for the wider commercialization of 5G technology? What can vertical industries gain from utilizing 5G slicing wholesale solutions as part of their successful innovation schemes?

With the development of 5G technologies, mobile operators will complete cloud-based transformation, these redundant cloud resources and network capabilities are potential

5G Slice Store solution aims at this B2B2C business mode in which the operator is trying to satisfy the individualized service requirements of the industry users and the vertical industry is responsible for end user experience. This business mode will hopefully greatly promote the process of 5G commercialization through win-win mode of end customers, operators and vertical industries.

Jason Tu Jiashun,
Principal Scientist of NFV/SDN Solutions, ZTE Corporation

revenue generators in the future. In addition, vertical industries and OTTs also need to deploy service applications in edge to meet low latency, privacy and security requirements to implement real E2E services. The slice store meets these problems, and helps operators integrate vertical industries and OTT applications to the edge telco cloud quickly, conveniently and economically. It helps vertical industry realize the comprehensive integration of real E2E service including network connection, while creating new revenues for operators. The end user just needs to pay one bill for the user experience to vertical industry, while vertical industry pays the operator for the network slice service.

5G Slice Store solution aims at this B2B2C business mode in which the operator is trying to satisfy the individualized service requirements of the industry users and the vertical industry is responsible for end user experience. This business mode will hopefully greatly promote the process of 5G commercialization through win-win mode of end customers, operators and vertical industries.

Considering that vertical industries each come with their own set of challenges, notwithstanding the fact that many of them have specialized needs, how then can the 5G Slice Store meet these different expectations?

At present, many big vertical industries are in security, service assurance and other reasons to build expensive physical proprietary networks. Renting a flexible, customizable network is clearly an attractive option, especially for vertical industries that do not have the capacity to build their own proprietary networks. 5G Slice Store has many pre-fabricated slice templates that can be easily ordered, while also providing powerful customization tools for fully personalized networks.

- **Customized design of network slicing:** The vertical industry users can select the slice template in the "Slice Store" according to industry characteristics, and design the slice by dragging and dropping based on the SLA parameters (such as number of users, latency, throughput, etc.). They can even select which DC the slice is deployed in. For example, network slices can be deployed in edge DCs, together with central public cloud platforms to meet low latency and low cost requirements.
- **KPI real-time monitoring of network slicing:** The vertical industry users can monitor network status in real time and formulate adjustment strategies according to SLA dynamically.
- **Enhanced billing:** The vertical industry users are able to select different charging modes based on industry needs (by time, traffic or user number, etc.).
- **Open capability of network slicing to vertical industry:** Through API gateways with security authentication, vertical industries can gain the capability of open networks such as location, terminal behavior, etc.

In your opinion, what do you think distinguishes ZTE's "Slice Store" from other network slicing solutions offered by your competitors?

Just like "APP Store" helps to find, buy, install and remove the APP simply and economically, "Slice Store" which was an initiative by ZTE, enables vertical industries to customize, purchase and integrate network connection to their service logic simply and economically. In this way, the vertical industry can provide a really E2E guaranteed service. ZTE "Slice Store" is doing POC with several major operators and vertical industries.

Can you outline what your primary goals are for the 5G Slice Store and do you have any future projects in the pipeline?

Although ZTE can provide comprehensive solutions including E2E slicing and slice store, ZTE will still push slice store as an open solution compatible with multi-vendors systems. At the MWC2019 Shanghai, ZTE worked with China Mobile and Tencent to demonstrate the industry's first 5G SA end-to-end slicing+MEC system for cloud games, showcasing the guarantee for bandwidth, latency and user experience.

Cloud games are based on cloud computing. Interaction latency depends on network communication latency, and multimedia transmission is more sensitive to network latency. 5G mobile edge computing and network slicing technologies guarantee high bandwidth and low latency for cloud games. ZTE, together with China Mobile and Tencent, made in-depth research on the service requirements and features of cloud games, formed an end-to-end intelligent slicing+MEC solution that provides assurance of high-level quality.

It can be seen from the scene that the game is smooth, the game players do not need to download the game, they can play online with 4K and 60 frame rate ultra HD experience with an average 30 Mbps bandwidth and 10 ms latency. In addition, users can watch live games on their mobile phones or computers. ZTE TECHNOLOGIES

Wind Tre Builds the Best Mobile Network in Italy

Wind Tre, an Italian mobile operator, has recently achieved excellent performance in the network quality evaluation organized by P3, a well-known third-party test organization in Europe. In the consolidated area, both voice and data got the best score. Wind Tre has grown into the largest and best-quality network operator in the Italian mobile market.

But back to 2016, before the merger, Wind and Three ranked third and fourth respectively in the overall ranking of the Italian mobile market. They lagged behind competitors whether in terms of user base, revenue, or profit margin. Moreover, as their networks had insufficient coverage, insufficient capacity and aging equipment, and could not support the evolution to 4G Pro and even 5G, they were in a unfavorable competitive position. They did not afford large-scale network modernization respectively relying on their own revenues, so network integration was the best way to solve the issue.

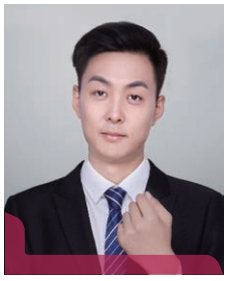
In December 2016, Wind Tre joined hands with ZTE to build a national wireless integration and upgrade project, achieving the goal of No. 1 operator in Italy.

Converging Networks for Simplicity

Before the network consolidation, the two operators were serviced by three main equipment vendors. There were hundreds of site models, most of which were old single-band single-mode devices that were too poorly integrated to support smooth 4G evolution. Wind Tre adopted ZTE's Uni-RAN solution for 2G/3G/4G network integration. The Uni-RAN solution used multi-band multi-mode devices that could support spectrum refarming by software upgrade,

Li Hao

Director of FDD European and American Marketing, ZTE



Zheng Chen

FDD Solution Manager, ZTE

flexible and fast adjustment of network spectrum system, and unified network O&M to achieve resource sharing and lower TCO for Wind Tre. Simplified network upgrade and smooth evolution extended the lifecycle of devices and improved network operation efficiency. All these helped Wind Tre maintain advantages in the fierce market competition.

The Uni-RAN solution uses ZXSDR B8200, a baseband processing unit based on ZTE's unique SDR platform. ZXSDR B8200 supports large-capacity configuration of GSM, UMTS, FDD-LTE and NB-IoT (abbreviated as GULN), helping Wind Tre greatly reduce its Capex and Opex and adapt to its strategy of long-term evolution at low costs.

The solution also uses ZTE's innovative RF units to help Wind Tre save antenna space and reduce network construction costs.

- **Ultra-wideband RF unit that saves 50% of RRUs:** R8892N is an RRU that integrates Band8 and Band20. One unit supports two frequency bands, thus saving 50% of RRUs and greatly reducing TCO for Wind Tre.
- **Industry's smallest 4T4R RRU:** R8854 is a 4T4R RRU that supports 4×4 MIMO and can provide 90% of network capacity gain at the most. With only 12 L in volume and 15 kg in weight, R8854 is the smallest 4T4R RRU in the industry, which can significantly reduce rental fees.
- **Active antenna system:** A8292A is an active antenna system that integrates the RF unit and the antenna. One module provides a maximum of 12 ports and supports five frequency bands and three systems. A8292A can fully meet the networking needs of Wind Tre, saving up to 30% of the antenna space.

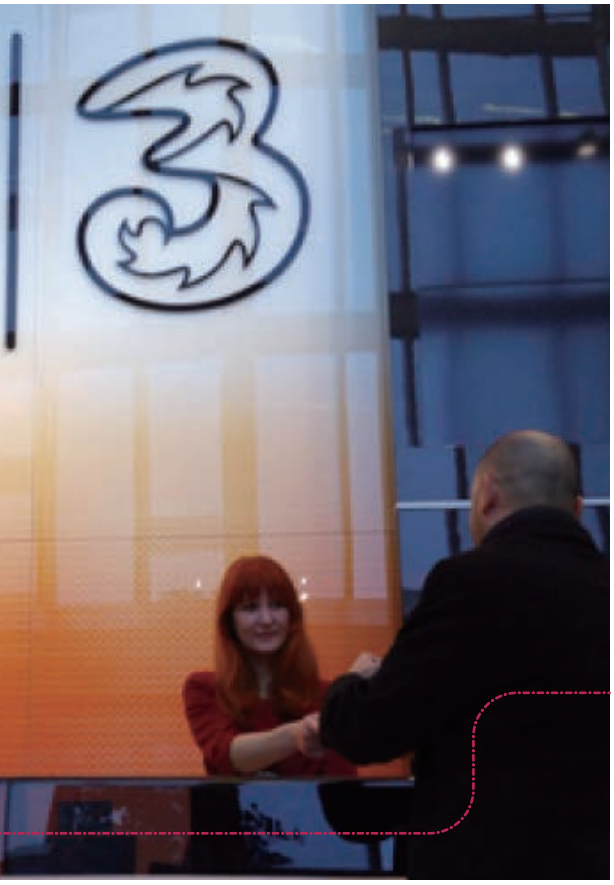
Working with ZTE to Build Quality Networks

Wind Tre expressed their expectation for the integrated network at the early stage

of consolidation: the network needs to meet the 4G capacity growth in the next five years, protect investment, and have the ability to evolve to 5G. The Pre5G solution proposed by ZTE can not only provide 5G-like user experience in the 4G era, but also support smooth upgrade to 5G network when 5G arrives, helping Wind Tre take the lead in the 5G era.

Experiencing the 1 Gbps+ Rate in Advance

Ultra-wideband experience has always been the most important user demands. Through the combination of several key technologies, Pre5G has increased the download rate to over 1 Gbps so that users can experience the 5G speed in advance. The commercial network deployed by Wind Tre and ZTE in Italy fully supports 4×4 MIMO, 256QAM and 4CC CA, achieving a data rate of over 1 Gbps.



Bringing Great Download Gains

As an indispensable technology in the 5G era, MEC can effectively meet the challenges of large traffic, large transmission bandwidth and multi-service type brought by 5G. Wind Tre chose ZTE to deploy the MEC platform in its commercial network in 2018. They tested the network acceleration function set of MEC, aiming at improving existing 4G network performance as well as the rate and delay of hot services. The related acceleration technology can also be applicable to future 5G networks. The MEC platform can greatly improve the delay and rate performance of specific services and significantly improve the performance degradation caused by poor servers.

In the field test performed by Wind Tre, the average download rate was increased by more than 40%, the ratio of samples below the rate of 20 Mbps was decreased from 19.91% to 7.8%, and the ratio of samples above the rate of 80 Mbps was increased from 7.47% to 16.62%. After the TCPO function was enabled, the average delay of hotspot websites was reduced by about 20%. Wind Tre spoke highly of the test results.

Introducing NB-IoT to Improve Revenue

NB-IoT has obvious advantages in cost and coverage over other IoT technologies, and is considered as the mainstream IoT technology in recent years. According to the Ovum report, the average number of IoT connections per user is 2 to 6 by 2020, and each IoT connection is expected to bring an increase of 5 euros per year to operators. The Pre5G solution adopted by Wind Tre can be upgraded smoothly to support NB-IoT, which greatly reduces construction costs and deployment time. In 2018, Wind Tre decided to deploy a commercial NB-IoT network. In just a few months, ZTE assisted Wind Tre in launching NB-IoT services at more than 8,000 sites across the network.

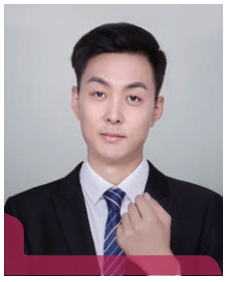
Within two years, Wind Tre and ZTE quickly consolidated the two networks. An Italian media reported that after the network consolidation, 4G rate was increased by 250% and the coverage was also significantly improved, especially the indoor coverage.

Wind Tre overtook competitors in just three years, and has now grown into a leading mobile operator in Italy. ZTE's leading technical strength has been highly praised by Wind Tre. "Our relationship with ZTE is simply fantastic," said Wind Tre CEO Jeffrey Hedberg. Benoit Hanssen, chief technology officer of Wind Tre, and Carlo Melis, director of the project, also jointly sent a letter of praise expressing their recognition of ZTE. ZTE TECHNOLOGIES

H3A: The First Operator to Commercialize 5G in Austria

Liu Zheng

FDD Product Marketing Director, ZTE



Zheng Chen

FDD Solution Manager, ZTE

Hutchison Drei Austria (H3A) owns the largest LTE network in Austria, covering 98% of the country and accounting for 30% of the mobile market. H3A is the second largest operator in Austria in terms of subscriber base. In the network evaluation over the years, H3A has successively won the best mobile network in the German-speaking area.

To become the first 5G operator in Austria, H3A started the NSA project at the end of 2018, aiming to commercialize 5G in 2019. At the Austrian 5G auction in February 2019, H3A finally obtained 100 M spectrum of the 3.5 GHz band. As the sole supplier of H3A, ZTE provides a series of unique Uni-RAN solutions to help H3A achieve the vision of the first commercial 5G in Austria.

Unified Telecom Cloud Platform Reduces Operation Costs

H3A had traditional ICT devices and some network elements, as well as VMWARE and different versions of Open Stack-based virtualized platform. The network O&M was difficult and the cost was high. H3A has adopted ZTE's unified telecom cloud platform based on the NFVI solution to reduce O&M costs and deploy new services in a more efficient and flexible manner. The platform also supports future-proof new service evolution.

UniSite Solution Guarantees Fast and Efficient 5G Deployment

As H3A becomes the second largest mobile operator in Austria, its subscriber base and network load are gradually increasing. H3A's network carries more than 65% of total mobile data traffic in Austria. The average mobile traffic per SIM card ranks second in the world. H3A needs to not only increase the capacity of existing 4G sites but also add new 5G devices, which is a great challenge for the current site solution.

H3A employs ZTE's unique UniSite solution to tackle its problem of site deployment. The large-capacity 5G BBU V9200, UBR, and Qcell are used for deployment. While increasing site capacity in both hotspot and blind areas, the UniSite solution also reserves antenna space for 5G commercial use.

The UBR released by ZTE is the first in the industry to support both 4G and 5G. It also supports smooth upgrade to 5G NR only through software change. Moreover, its power resources can be flexibly configured between 4G and 5G. This can help H3A achieve fast and efficient 5G deployment while protecting its existing investment.

Real Commercial 5G

H3A announced in June 2019 that it had launched a commercial 5G network in Austria, with a total of 20 5G sites implementing continuous 5G coverage in Linz area. This also marks that H3A has become the first operator in Austria to commercialize 5G networks.

H3A CEO Jan Trionow said: "Other vendors are just '5G ready' or have upgraded individual transmission masts across Austria. Today we are launching the first true contiguous 5G network that is worthy of the name. While the others only talk about the future, in Linz it is already a reality today. The race for the 5G leadership in Austria is officially open."

"The next step of H3A is to deploy the 5G network to cover all cities and other areas in Austria. Early 5G deployment like Linz is crucial to assessing 5G networks and technical performance to ensure first-class services and the fastest rate after deploying 5G across Austria," said Jan Trionow.

To advance the development of Austrian 5G networks, Jan Trionow also said: "We would like to invite companies, institutions and municipalities from all over Austria to cooperate and study with us."

As a pioneer in 5G, ZTE not only helped H3A achieve its first contiguous 5G network in Austria, but also launched a new flagship mobile phone—ZTE Axon 10Pro in Austria, which is the first 5G smartphone in the Austrian market.

Expanding the IoT Market

Due to its stability, high performance and extremely low latency, 5G has great business prospects in a variety of industries. H3A has chosen ZTE as its exclusive provider of an end-to-end solution that includes chips, modules, wireless access equipment, core network and application platform. The solution provides H3A with NB-IoT services throughout the network.

At the 5G service launch held in June 2019, H3A joined hands with ZTE to showcase innovative services such as VR video, automatic driving, and robot surgery. This fully proved the prospect of 5G in new fields of artificial intelligence, cloud services and HD digital services in the future.

Since the cooperation with ZTE in 2010, H3A has maintained a rapid growth, ranking first among Hutchison's six branches in Europe. H3A ranked the first in network performance in both the 2015 P3 test and the 2016 chip test. In the industry satisfaction survey conducted by a third-party organization in Austria in 2019, H3A won two firsts in customer satisfaction, i.e., the first among network service providers and the first of wireless mobile networks. Recently, H3A again won the first place in the 2019 network quality assessment in the German-speaking area organized by TUTELA, Canada. With the help of sincere cooperation with ZTE, H3A will gain more social recognition and higher customer satisfaction in the 5G era. ZTE TECHNOLOGIES

To enable connectivity and trust everywhere