

ZTE TECHNOLOGIES

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Expert Views

New 5G Wisdom,
New Digital Future

Success Stories

ZTE UniSite+ Assisting
OSP Building a Green Network

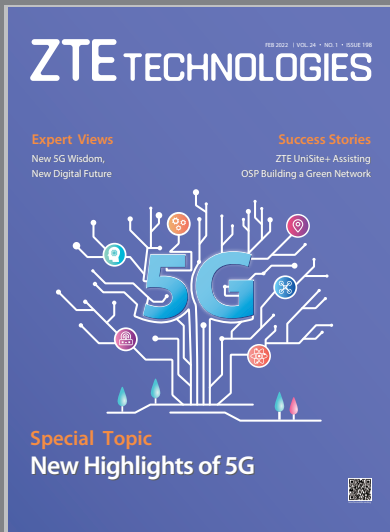


Special Topic

New Highlights of 5G



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DITO Accelerating Network Rollout to Bridge Digital Gap

Source: Disruptive.Asia

DITO Telecommunity, the newest telecommunications provider in the Philippines, is accelerating the rollout of its network. In an interview, DITO Chief Administrative Officer Atty. Adel Tamano, DITO CTO Ret. Maj. Gen. Rodolfo Santiago, and ZTE Vice President Shen Hui talk about how this greenfield telecom project succeeded against the backdrop of COVID-19 restrictions and an erupting volcano in 18 months and what significance it holds for DITO.



Welcome to join us to a fabulous greenfield telecom project in the Philippines. I'd like to start up with Adel. Could you tell me a little bit more about DITO, the Philippines' newest telecom player?



Adel

Adel: Let's first put it in a context. In the Philippines, we have actually two major players for the better part of three decades. The lack of competition really makes service not optimal, and many Filipinos claim for enhanced competition. There was a push to have a third telco. The third telco is DITO. That's the name for our company, a Filipino word for "here".

We became a third telecom through a competitive bid, where we got the status of New Major Player, and we got our Certificate of Public Convenience and Necessity in July 2019. And just very recently, we actually had our franchise extended for another 25 years. So DITO is the third major telecom player coming to the Philippines. The idea is to revolutionize the telecom industry and really bring competition with better services, lower prices, and more inclusion.

Our technology partner is China Telecom. We are banking on their 5G and strong technology. Another Philippine partner is a conglomerate Udenna—that group brings the local knowledge and local network that's needed for a telco to survive the complexity and challenges of the Philippine market. So that's what we are.

Shen Hui, this is really an interesting project. I'd like to know a bit more about the background that you've

been working on in detail.

Shen Hui: I think it's the largest turnkey construction project in Philippines, which is to provide the third wireless network covering the whole country. As the major supplier of the project, ZTE aims to provide the Philippines with high-quality and cost-effective 4G/5G network services. We are responsible for two regions: South Luzon and Visayas, occupying around 35% market share. The project started in October 2019. After more than one year, we have already covered 187 cities, and 41 of them have been put into commercial use.

It must be a quite big challenging project, because I didn't mention earlier some of the challenges, not the least of which was the pandemic. Give us a background of how you overcame some of those big challenges in rolling out the network.



Shen Hui

Shen Hui: ZTE has more than 30 years of experience in communication network construction. And we have a global end-to-end engineering service capability system. To ensure the success of the project, ZTE invests in the project in a strategic manner. We quickly assigned a global experienced engineering team to the Philippines. To solve the resource shortage, we also invited many global strategic partners to the project.

Second, we have different types of support. During the pandemic, we really faced challenges. We have received a lot

support from our customer, DITO. Also, the local government of the Philippines gave us great help. Here I would like to express my special thanks to our local employees for their great efforts during the special times. For this pandemic, we also took very strict control measures to prevent the pandemic and to ensure the employees' health and safety.

The third part is the digital delivery. We have an end-to-end digital network deployment system. We simplify the on-site network construction process by using digital systems and intelligent tools, and implement network construction and project management in a very efficient way.

After 18 months' hard work, ZTE has completed the construction of over 1000 full turnkey sites and more than 4000 km optical cables. The speed of construction is very exceptional in the Philippine telecom history.

What does this project mean to DITO? What did it bring to DITO and to the Philippines in general?

Adel: If you wanna go a little bit on the financial side, at 257 billion pesos it is one of the biggest projects in the history of this country. You have to build in 5 years what the two incumbents built in nearly three decades. So just a scale of it, the massiveness of it. A lot of people said that it was impossible just to get this project off the ground. So that's the first part of it.

I think it's also important to know we have been able to build this network, have our commercial launch, and build our operations. Although we are still starting, we did it during the time of COVID-19. We did it during the time when most of our people were working remotely or from home, so that's added some complexity to it.

The last thing I'd like to say about this project, there's really a nation building element in it. You know we are providing jobs in this difficult time. We're providing jobs, investments, and at the same time we

are addressing a big need. Because one of the things we did discover with COVID-19 was the dependency of people on working from home, studying from home, E-commerce. This also showed the weaknesses within our ICT infrastructure, which is why we're here. We want to bridge those gaps and also to bring competition.

Rodolfo, what is your investment plan for the 4G network? Do you have plan for 5G network in the future?



Rodolfo

Rodolfo: Our aggressive commitment to government requires us not only to implement a 4G network but also 5G because of the commitment of 55 Mbps on the second year all the way to the fifth year. 4G would not be able to deliver that, and we need 5G to deliver that. The eruption of the volcano in South Luzon, which is one of the areas of implementation of ZTE, really affected it. Most of the South Luzon areas were closed. You can't get to where you are working. For COVID-19, you can still get to where you are working. When the volcano erupted, the area is really closed to everyone, and despite that they were able to achieve the milestones that were asked for them.

What do you think of ZTE's contribution to the project and what do you expect of the future cooperation with ZTE?

Rodolfo: We know that they are at the forefront of 5G and fiber optic technology. We expect that we will be working with them until we finish the five-year commitment to government. **ZTE TECHNOLOGIES**



Gu Jun

Chief Engineer of Wireless
AI R&D Planning, ZTE



Tang Xue

Vice President of RAN
Product Line, ZTE

New 5G Wisdom, New Digital Future

With the large-scale deployment of 5G commercial networks, the launch of the “sailing” action plan for 5G applications and the implementation of “carbon neutrality goals” in China, new scenarios, new services and new ecosystems of 5G networks have injected infinite possibilities into the innovation of various industries, and have also put forward new requirements for network transformation and service capability evolution. The traditional network-centric, KPI-targeted and centralized O&M strategies, architecture, technologies and services cannot precisely meet the differentiated needs of network development in different periods, regions and service scenarios. Based on the innovative practice of digitization, intelligence and service-based concept, combined with the latest development of information theory, cybernetics, system theory and AI technologies, ZTE has rolled out the industry’s first flexible resource orchestration solution based on BBU native intelligence, aiming at building high-quality, system efficient, low-carbon and value-oriented intelligent networks.

New Network, New Paradigm

Facing the highly complex network

environment as well as differentiated service requirements and terminal capabilities, the core mission of 5G network is to precisely meet diverse 2C and 2B experience goals including large bandwidth, high reliability, and low latency. From the perspective of network operation, the basic logic of network value creation is undergoing profound changes. The context-aware experience economy is gradually replacing the traditional payload-based bit economy and becoming the new network philosophy that leads the all-round reconstruction of 5G network and service paradigm, and finally realizes the “BEST” network under joint consideration of multi-dimensional value, namely benefit, experience, simplicity and transformation. The shift in the network paradigm involves:

- **From network to user:** The traditional network KPI cannot precisely reflect the experience of each user, because it is a cell-level indicator. However, according to differentiated service needs of users, the context-aware user experience needs to flexibly orchestrate radio resources through the combination of user and network orchestration, so as to achieve accurate and reachable user experience with optimal network efficiency.



- **From physical to virtual:** Application scenario can be extended by segmentation. Traditional application scenarios such as schools, hospitals, and shopping malls represent physical attributes, while virtual scenarios need more fine-tuned information including wireless environment, service characteristics and user behavior from multiple levels like grid level, cell level, site level and regional level. This provides the structured scenario basis for a personalized experience using machine learning and reasoning.
- **From human experience to machine knowledge:** Based on the intelligence of virtual scenarios, the knowledge such as network serving capability and user reachable experience in each scenario can be machine learned and updated iteratively, so as to realize the transition from rough manual experience to fine-grained scenario perception.
- **From commonality to individuality:** Personalized policy-based intelligent reasoning and enhanced learning are implemented anytime and anywhere to precisely meet the dynamic needs in different time and space scenarios.
- **From experience to intention:** The intention-driven network paradigm can be realized through the integrated intention recognition and intelligent mapping between service requirements and network serving capability. This

helps to achieve diverse scenario specific intention, extreme experience, and lowest energy consumption.

- **From technology to business:** The intention-driven network paradigm effectively builds a bridge between business goals, technical goals and intelligent services, and continues to promote the value of network intelligence.

New Architecture, New Computing

Based on the new paradigm of user-centric experience, context-aware policy and flexible resource orchestration, new challenges are posed to the evolution of network intelligent architecture and the ability of network perception, cognition, decision-making and reinforcement learning. The centralized, non-real-time automation and intelligence capabilities carried by outside-BBU intelligence such as network management system and big data system cannot meet the growing requirements of diverse services for computing flexibility, timeliness, accuracy and economy.

The distributed intelligence that is highly integrated with computing power and BBU has unique value in quickly responding to environmental changes, making effective decisions in time, and improving the real-time perception/cognition ability at the edge of the network. Therefore, it is the key driver of user-centric experience. Compared with the edge computing based on independent infrastructure, the ICT transformation and continuous computing enhancement of base stations have laid a foundation for distributed edge intelligence with more flexibility, lower cost and simpler O&M. With its future-oriented intelligent BBU native computing architecture as well as efficient collaboration between communication computing and intelligent computing, ZTE can provide an ideal choice of incremental expansion and smooth evolution for on-demand deployment of edge intelligence in different scenarios and industries.

Heterogeneous intelligence is stemming from the joint of distributed computing based on BBU native intelligence and centralized computing based on outside-BBU intelligence, which makes full use of their advantages and integrates them efficiently. The distributed native intelligence enhances the communication process in near real-time with efficient, accurate, and highly autonomous user-centric computing services, provides agile closed-loop of the last mile computing intelligence, and applies to centralized intelligence for optimal resource allocation on the network layer as needed. The centralized exogenous intelligence centered on networks provides intelligent active O&M capability to ensure network quality at low costs, as well as multi-dimensional resource orchestration driven by efficiency, income and other goals, and provides necessary constraints and protection mechanisms for micro-level intelligent behaviors at the macro level.

New Service, New Value

In June 2021, ZTE officially released its Radio Composer, the industry's first intelligent radio resource orchestration solution, including network orchestration and user orchestration driven by BBU native intelligence. Through hierarchical flexible resource orchestration services, Radio Composer flexibly and precisely meets the diverse core value needs of network development in different periods and different scenarios, and continues to empower the high-quality development of 5G networks by enhancing user experience, accelerating traffic migration, strengthening resource sharing, and reducing power consumption.

- **Enhancing user experience to expand 5G user base:** Through the orchestration, users can be guided in time to the frequency and cell with the best experience and the highest resource efficiency. This increases user satisfaction

and attracts more 5G users.

- **Accelerating traffic migration to improve 5G network value:** While ensuring user experience, user orchestration improves 5G camping ratio and data consumption, and increases 5G network value.
- **Strengthening resource sharing to improve 5G spectrum gain:** Network orchestration employs intelligent traffic prediction, precise traffic steering, adaptive LTE shutdown and flexible interference coordination to optimize 5G experience with least impact on 4G users, thus providing operators with more profitable resource sharing solutions.
- **Reducing power consumption to improve 5G network efficiency:** Through the coordination of user orchestration and network orchestration, users are precisely migrated to the frequency and cell with the highest energy efficiency without affecting legacy user experience, thus maximizing 5G network efficiency.

New Economy, New Future

The rise of experience economy and "dual-carbon" goal has put forward a new proposition for the mobile industry to drive digital transformation and sustainable development with a greener and more efficient paradigm. It has also placed new basic requirements on collaborative evolution of heterogeneous intelligence, flexible orchestration and context-aware policy. ZTE will work with industrial and academic partners to deepen cooperation in the vision of a low-carbon digital society, and drive the development of new networking and computing theory, integrated computing and network architecture and key technologies, industry standards and commercial applications. With the two-wheel drive of technology and value innovations, they will jointly build a new people-oriented digital future. **ZTE TECHNOLOGIES**

Leveraging mmWave for 5G Industrial Applications

Hao Ruijing, Senior System Architect of ZTE RAN Products

5 G is enabling a new era of internet of everything (IoE). As the 5G mid- and low-band spectrum resources are relatively limited, mmWave has come into the spotlight with its benefits of larger bandwidth, higher capacity, and less interference. Especially for the ultra-high bandwidth and ultra-low latency vertical applications, mmWave can provide better guarantee and better user experience. Therefore, 5G mmWave has attracted wide attention in the industry and will be an important direction in the next wave of 5G.

Comprehensive mmWave Technology Development

The continuous 5G mmWave trials have greatly promoted the development of mmWave technology. Meanwhile, higher requirements are put forward for the actual wireless performance of services, which can be addressed from multiple dimensions such as wireless coverage extension, network capacity improvement, and network architecture evolution.

Expanding mmWave Coverage Capability

At high frequencies, 5G mmWave suffers from high propagation loss and poor diffraction and penetration. mmWave signals can be easily blocked by buildings, trees, rain, snow, humans, or vehicles, resulting in high indoor-to-outdoor propagation losses and limited coverage. This is the biggest challenge facing the 5G mmWave communication system. ZTE has introduced multiple coverage enhancement solutions to expand mmWave network coverage.

- **Hybrid analog-digital beamforming scheme:** In the analog domain, single-panel based beamforming of high



Fig. 1. ZTE achieved a single-user downlink peak rate of above 8.3 Gbps in an NR-DC field test in November 2021.

“
As the 5G mid- and low-band spectrum resources are relatively limited, mmWave has come into the spotlight with its benefits of larger bandwidth, higher capacity, and less interference.

Hao Ruijing”



frequency signals is implemented through a low-cost phase shifter. In the digital domain, multi-panel based beamforming is implemented through the baseband processor. By increasing the number of antenna elements in a large array, we can get a higher equivalent isotropically radiated power (EIRP) to overcome the impact of fast attenuation in mmWave.

- **Intelligent beam management:** More refined beams and scene-based beam configuration solution are designed to allow more flexibility in mmWave beams and solve the coverage hole problem while increasing the signal transmission gain of the base station and UE, reducing the interference and improving the data transmission rate of the system.
- **Multi-TRP enhancement:** Multiple transmission/reception points (multi-TRPs) are used to perform coordinated transmission and reception of multiple beams from various angles, thus reducing the adverse effect of blockage and improving the robustness of the radio link. In this way, mmWave application in the uRLLC scenario becomes possible.
- **Reconfigurable intelligent surface:**

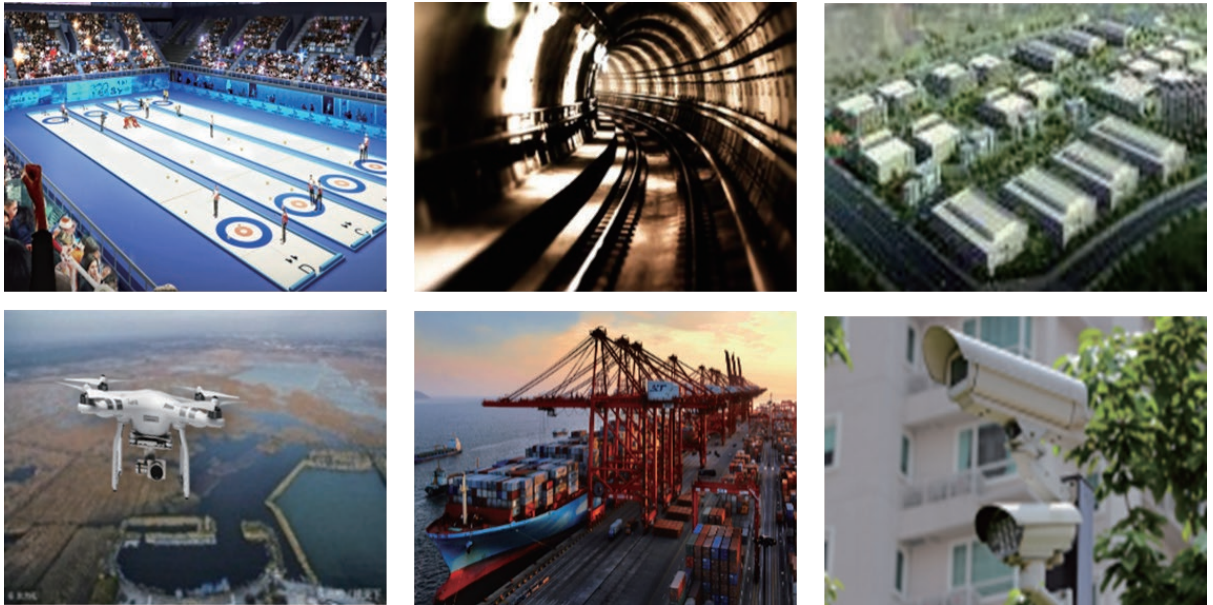
An intelligent and controllable wireless propagation environment can be constructed through ZTE RIS, which uses the reconfigurable intelligent MetaSurface. In this way, the non-line-of-sight transmission problem of mmWave can be solved, further expanding the coverage range and enabling the gradual evolution to 6G.

Improving mmWave Network Capacity

Abundant frequency resources, large bandwidth, large capacity, and ultra fast speeds are the greatest advantages of 5G mmWave system.

mmWave downlink capacity improvements can be achieved through DDDSU frame structure, MU-MIMO and scheduling enhancement, making FWA and AR/VR viable. In 2018, ZTE completed the real-time UHD 4K video transmission in Tokyo, Japan to verify the real-time performance of mmWave networks in complex and dense urban areas, in 2020 the industry's most complete mmWave terminal interconnection test, and in November 2021 the industry's first NR dual connectivity (DC) field test with a single-user downlink peak rate of above 8.3 Gbps (Fig. 1).

Fig. 2. Vertical industry scenarios for mmWave.



mmWave uplink capacity improvements can be achieved through DSUUU frame structure and high transmission power terminal, making mmWave applicable to uplink-data-intensive vertical applications like 4K/8K video live broadcasts and machine vision. ZTE, together with other partners, achieved the world's first DSUUU frame structure-based 5G mmWave 8K video upstreaming demonstration through lab testing in May 2021. In September, ZTE assisted China Unicom in completing the world's first field demonstration of DDDSU frame structure-based end-to-end 8K video service. In October, it completed the industry's first NR-DC field test with a single-user uplink peak rate of 2.2 Gbps.

The dynamic frame structure solution is used to cater to scenarios where there are dynamic differentiated requirements for UL/DL services due to service type change or time period change. Different DL/UL frame structures can be selected and time granularities can be adjusted according to the latency, traffic and PRB utilization requirements of the application scenarios, and the uplink/downlink ratio can be automatically adjusted according to the change of uplink/downlink traffic. Thus, the mmWave radio resources can be dynamically

allocated to match the service requirements, improving the network capacity and spectrum efficiency of mmWave.

Network Architectures Adaptive to Application Scenarios

The 5G mmWave network architecture supports the NSA (EN-DC) network architecture utilizing LTE, and also the three options of SA architecture (NR-DC, NR-CA and FR2 only).

The mmWave SA or NSA architecture depends on the operator's objectives (regional and service requirements), investment plans, and maturity of the industry chain. For ToC and FWA application scenarios, mmWave is mainly used for supplementary coverage and hotspot coverage. The area covered by the mmWave base station must be covered by LTE or low-frequency NR. Therefore, NSA networking is preferred in the early stage of 5G mmWave deployments. In the vertical industry application scenario, mmWave is mainly used for private network deployments, and the SA networking becomes the inevitable choice. A new SA network using FR2 can be built with its control and management independent from

the operator network. Operators can also deploy NR-DC or NR-CA by overlaying the early 5G low-frequency network with mmWave. Only the mmWave base station needs to be deployed without deploying the core network (5GC) for NR-DC or NR-CA, thus saving the operator's CAPEX and OPEX and increasing the network capacity.

ZTE has been actively researching the SA network architectures of NR-DC, NR-CA and FR2 only, while accelerating the verification of the NR-DC technology. ZTE completed the world's first NR-DC (FR1+FR2 DC) laboratory test in August 2021, and the industry's first NR-DC field performance test with industry-leading uplink and downlink performance in October.

Exploring More Application Scenarios

Due to its large bandwidth, 5G mmWave can provide a higher 5G transmission rate, but with limited range. Therefore, it is more applicable to capacity boost in hotspots, FWA use or ToC hotspot coverage. In addition, the large capacity and low latency of mmWave also offer great potential for vertical applications (Fig. 2).

FWA can be complemented by 5G mmWave. Compared with wired FTTH, 5G mmWave has obvious advantages in peak rates and large capacity. Therefore, FWA can provide a lower-cost way to deliver faster broadband speeds over mmWave to homes and business, bringing operators opportunities to expand market share and increase revenues.

Indoor and outdoor ToC hotspot coverage is the major application requirement for 5G mmWave. For airports, railway stations, large shopping malls, and other high-traffic indoor areas, mmWave hotspots can be conveniently deployed. For outdoor hotspot areas such as squares, gymnasiums, and busy streets where there are a large number of users and high traffic demands during peak hours, the large bandwidth available in mmWave can be

utilized for high-speed data transmission services, and also for spatial division multiple access operation to simultaneously serve multiple user.

Large-bandwidth and low-latency vertical applications require the use of 5G mmWave. 5G mmWave can carry big video services such as high-speed access, live video broadcast, machine vision, and VR, and is applicable to a variety of vertical industry scenarios such as stadiums, smart factories, smart subways, and smart ports. In scenarios like stadiums, mmWave has an irreplaceable advantage in big video transmission. Streaming UHD single-channel video requires up to 200 Mbps of bandwidth. FR1 cannot meet the large-capacity scenarios that require multi-channel video streaming. Only by introducing mmWave can the bandwidth and capacity requirement be met. In the smart subway, 5G mmWave serves as the wireless backhaul of the train-to-ground communication system to perfectly carry large-capacity services such as real-time video monitoring and in-train ToC service. In the smart factory, 5G mmWave is suitable for carrying material inspection, quality inspection, 3D mapping, and other machine vision services. In the smart port, 5G mmWave can be used to meet large-capacity requirements of HD video backhaul for quay-side gantry crane, and the sub-6 GHz bands high reliability requirements of services such as PLC remote control.

Conclusion

With the rapid development of 5G and the user's increasing demands, 5G mmWave is being embraced by vertical industries, operators, equipment manufacturers and terminal manufacturers when the present spectrum resources are limited. It is believed that 5G mmWave will be widely used in scenarios like vertical industries and ToC hotspots with the upcoming large-scale deployment of industry applications. **ZTE TECHNOLOGIES**

Innovation Helps to Maximize 5G Value



Bai Gang

ZTE VP, Deputy General
Manager of RAN Products

As 5G applications expand from B2C to B2B markets, more new technologies and solutions will be developed to meet the needs of customers and applications. ZTE has always regarded innovation as an important cornerstone of sustainable development, making continuous breakthroughs in key technologies to help industrial partners and customers obtain more extended functions. By achieving higher capacity, enhanced performance, and substantial improvements in network efficiency, ZTE helps operators maximize the value of their wireless networks.

5G Commercialization in Full Gear

The global 5G commercialization is in full gear. According to the latest GSA report, 200 operators around the world have launched commercial 5G services, and there are 99 operators engaged in 5G standalone (SA) networks. Among them, China is the country with the largest and most advanced 5G commercial deployment. As of December 2021, the total number of 5G base stations in China had hit

1.425 million, accounting for more than 60% of the world's total 5G base stations. The number of 5G terminal connections in China has reached 450 million, 5G SA network has covered all cities in the country, and its dataflow of usage (DOU) is 50% higher than that of 4G.

As the world's leading supplier of wireless products and solutions, ZTE has cooperated with more than 90 operators around the world on 5G. In the third quarter of 2021, the share of global shipments of 5G base stations was 28.6%. ZTE has also been engaged in different 5G vertical industries, with a total of over 500 partners. The global revenue share of its 5G SA core network reaches 29% and there are more than 170 commercial partnerships on 5G Core.

Looking back at history, technology innovations and breakthroughs have always given strong support for the great progress of human society. ZTE introduced software



defined radio (SDR) technology and launched the industry's first SDR base station in 2007. Since then, Telecom has entered into a new era of ultra-broadband, multi-carrier and multi-mode. ZTE proposed the concept of applying 5G to 4G in 2014 and launched the industry's first Massive MIMO based on Pre5G AAU. The Massive MIMO technology was rapidly recognized by the industry, and ZTE won two awards at the Mobile World Congress 2016. Now, the Massive MIMO base station has become the mainstream site of 5G deployment.

In the future, ZTE will continue to innovate, because it believes that only innovation can bring development and create greater value for customers worldwide.

5G Development Provides Greater Value Space

The key mission of 5G is to create new value for the B2B market and

provide opportunities for operators to explore industrial markets and maximize network value.

In terms of 5G infrastructure network, ZTE adopts innovative solutions to offer excellent experience and maximize network value. With the acceleration of 5G construction, the global 5G deployment shows a trend from outdoor to indoor, from single-band to multi-band, and from low/medium frequency to high frequency. ZTE has proposed a series of innovative solutions based on the trend. The SSB 1+X solution enhances the coverage of high buildings for outdoor scenario, and the SuperMIMO solution improves indoor coverage and capacity for indoor scenario. ZTE has also proposed its innovative FAST solution for in-depth aggregation of time and frequency domain resources. Millimeter wave features high bandwidth and can be used as an ultra-large-capacity solution in hot-spot areas. ZTE is also the first in the

industry to support 1D3U, with a single-user uplink rate of up to 960 Mbps.

ZTE launched its Radio Composer, the industry's first intelligent orchestration solution in 2021. Based on BBU's built-in intelligence and heterogeneous computing power, it can provide multi-dimensional network perception to improve user experience and network efficiency. User orchestration takes users as orchestration objects to achieve intelligent user steering and scheduling. Network orchestration uses network resources as orchestration objects to achieve orchestration for spectrum, frame structure and beams. It is a powerful tool for operators to develop 5G networks in the post-5G era.

At present, many countries have set carbon neutral targets. Energy-saving solutions have become the focus of operators. For the radio part, energy saving solutions involve equipment level, site level and network level. ZTE continues to develop products and features that consume less power, and launched the PowerPilot solution in 2019. The solution is based on four concepts: scenario-based

policies, energy-saving policies without impact on capacity or coverage KPIs, multi-band multi-mode synergy, and AI technology. So far, the PowerPilot solution has been commercially deployed for more than 30 operators around the world.

The B2B market usually requires mobile edge computing capability. How can this demand be met quickly and easily? ZTE has launched NodeEngine, the industry's first and unique lightweight B2B solution with an embedded edge computing engine in the base station, which can be configured and activated in one hour only by inserting a board into the base station. NodeEngine has a wide range of appeal to the B2B market, and has been applied in more than 10 industries and more than 60 commercial projects.

Unlike operators, many vertical customers do not have large and dedicated operations teams. ZTE's ToBeEasy operations and management solution is the right one for them. It is an end-to-end lightweight simplified solution with embedded intelligent fault prediction and resolution capabilities, alleviating the nightmare of

Fig. 1. Leading supplier to enable global 5G success.



AI is nothing new in 5G era, but it is expected to become the core functionality of the 5G-Advanced network in the future. AI and wireless technology will combine with each other and develop and evolve together. This is a two-way street, benefiting both technologies.

many enterprises manually troubleshooting network resources. As a result, enterprises can focus more on their own business and services. ToBeEasy also allows enterprises to easily manage and activate their services.

With a strong network and a variety of upgrades or new services, 5G is helping to create a more convenient and enjoyable digital lifestyle. 5G is also changing many industries, many projects have been launched and running, and many projects are being tested. The "Bloom Cup" 5G application competition organized by the Ministry of Industry and Information Technology of China has been held for four times. The exploration and promotion of 5G applications in China has achieved positive results. There are over 10,000 innovative 5G application cases across the country, which play an enabling role in a wide range of industries, such as manufacturing, health care, education and transportation. From consumers to vertical industries, 5G plays an important role in making digital economy an essential part of the society. The 5G network will continue to grow and is expected to deliver more experience.

Orientation to the Future

AI is nothing new in 5G era, but it is expected to become the core functionality of the 5G-Advanced network in the future. AI and wireless technology will combine with each other and develop and evolve together. This is a two-way street, benefiting both technologies.

ZTE RIS is a kind of 6G technology brought forward to the 5G-Advanced era, which uses the re-configurable intelligent surface to improve 5G network performance, just as

ZTE did to Pre5G Massive MIMO, a 5G technology brought forward into the 4G era. Normally, using the reflection of electromagnetic signals from ordinary materials, the wireless channel can be considered passive or fixed. However, with ZTE RIS, the wireless channel can be considered active or reconfigurable. Therefore, it can tremendously improve the performance of the whole wireless system. For example, if the RIS is introduced in a 5G network, potential benefits include a 30% reduction in the number of sites and power consumption through enhanced site coverage, especially through mmWave.

The requirement of 6G is more challenging than the current 5G. For example, throughput requires one Tera bits per second, and the connection density is 100 times that of 5G per square kilometer. The areas of active 6G research include frequency, such as frequency sharing based on block chain, and higher frequency Tera Hertz. Space utilization is another area to work on, such as virtual smooth cell and spatial convergence. In terms of air interface, AI will be closely integrated into MIMO, and wireless channel will become more adaptive and configurable. Sensing network and communications network will further converge.

In the face of future technological evolution, ZTE insists on taking value as the core, problem-solving as the guide, working closely with the industry chain, and constantly innovating, iterating, exploring and practicing, so as to promote the integrated development of the whole industry and maximize the value of the network. **ZTE TECHNOLOGIES**

Radio Composer Unlocks Network Potential and Accelerates 5G Monetization



Zheng Lingxia

Director of Wireless Product Planning, ZTE

Operators have long been looking for ways to improve user experience and enhance utilization of expensive yet limited spectrum. More than ever before, 5G poses big challenges to operators in delivering quality network and optimal user experience as it is more complex than previous generation technologies with more spectrum bands to leverage and more services to support. As a key infrastructure of the digital society, 5G network not only serves individual users, but also supports digital transformation across industries. However, the evolution of radio resource management has been far behind that of radio access technologies due to much simpler service offering by previous technologies. Consequently, the increasingly diversified demands have further deepened the contradiction between “one-fits-all” network policy and differentiated user experience requirements. It is therefore of great importance for operators to deliver user-centric experiences for industry applications and consumers within limited network resources.

Introduction of Radio Composer

Understanding the need for operators to migrate from network-centered policy to user-centered policy to deliver the best

experience in the most resource-efficient way, ZTE has innovatively proposed Radio Composer, the industry’s first AI-driven context-aware, customized experience solution. Starting from the multi-layer of the whole network, Radio Composer enables multi-dimensional perception and machine learning of UE capability, service characteristic, network characteristic and inter-domain information, manages and optimizes radio resources to meet service requirements in a dynamic way by changing the traditional “best effort” mechanisms to “always optimal”, and implements best mapping between service requirement and radio resources. It empowers user-centric policy to achieve a near real-time, customized user experience, and facilitates best user experience and highest network efficiency, so as to expand 5G users, unlock network potential, and promote the development of 5G industry and ecosystem.

Radio Composer takes the lead to use BBU native intelligence as the key driver of wireless network intelligence. With advanced radio resource allocation algorithm, it empowers consumers and industry applications with first-class performance without the necessity of extra hardware, and enables network policy shifting from “one-fits-all” to “context-aware”. The AI training is implemented when CPU working at low load in order to minimize impact on legacy user experience, and

computing capability coordination will be activated among neighbor cells with the growth of 5G users. The BBU native intelligence enables edge computing, which makes service applications as close to access as possible. This facilitates the implementation of low-latency services like gaming and AR/VR, which exploit more application scenarios and opportunities, accelerate the monetization of 5G networks, and increase the revenue of operators.

Radio Composer features flexible radio resource scheduling via network orchestration and user orchestration, in which user orchestration enables a digital-map-like experience navigation with smooth user experience, while network orchestration implements a lego-block-like resource adaption with higher network payload (Fig. 1).

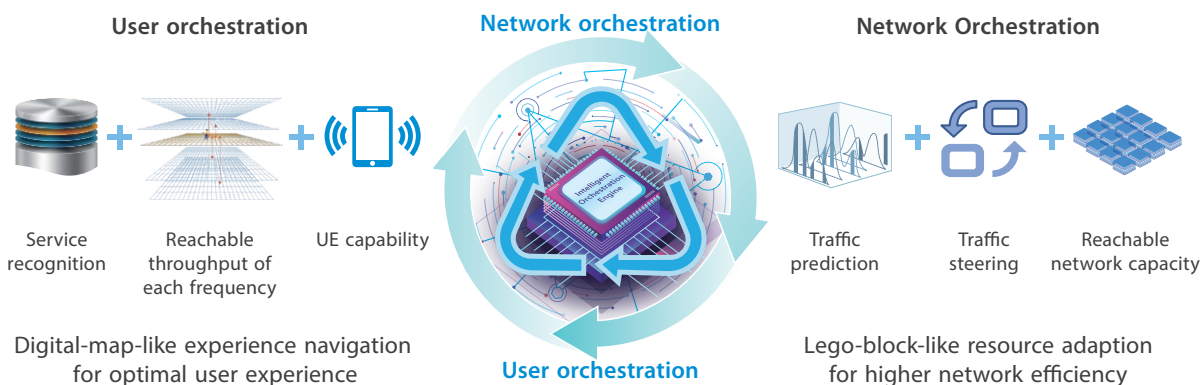
Network Orchestration

Network orchestration targets at future-oriented network design, enables adaptive adjustment of spectrum, frame structure and beam pattern according to intelligent traffic prediction and interference avoidance on a cluster basis, and implements accurate mapping between variable network serving capabilities and traffic pattern prediction. This helps to improve network payload and reduce O&M cost. According to the results of field tests, it increases network payload by an

average of 32% and reduces O&M cost by 46%.

Although the spectrum with dynamic spectrum sharing (DSS) features, such as 2.1 GHz, is a cost-effective way to provide 5G coverage based on legacy FDD equipment, DSS NR performance is severely limited due to the interference between LTE and NR. In particular, the degradation of DSS NR performance caused by the intra-cell and neighbor-cell LTE CRS interference becomes the common concern among global operators. Radio Composer opens a door for DSS to further improve performance and be deployed on large scale. With intelligent traffic prediction on a cluster basis, the LTE traffic of 2.1 GHz can be intelligently steered to the co-coverage 1.8 GHz cell without affecting LTE user experience, thereby making LTE shutdown in the 2.1 GHz DSS cell possible when LTE traffic is fully carried by the co-coverage 1.8 GHz cell. With only NR in the DSS cell, the absence of LTE CRS interference greatly improves DSS NR performance.

With the growth of uplink services in both consumer services and vertical applications such as live webcasts and high-definition videos, higher requirements are put forward for uplink bandwidth. However, the current 5G network features the default frame structure focusing on high-speed downlink, like 3D1U, which limits the serving capability of 5G network on the uplink. Radio Composer can flexibly adjust frame structure according to



◀ Fig. 1. Flexible radio resource scheduling via network orchestration and user orchestration.

uplink and downlink service requirements. It adjusts the frame structure from 3D1U to 1D3U when there is large uplink demand, and from 1D3U to 3D1U when downlink is the major requirement. Compared with manual frame structure adjustment, Radio Composer not only improves network efficiency but also reduces O&M cost.

User Orchestration

User orchestration targets at a smooth user experience through user steering and scheduling. Based on accurate predictions of network service capabilities and precise recognition of service requirements, together with terminal capabilities, it achieves flexible steering and scheduling among multiple frequencies in the network. In the field network, it improves the average throughput of cell-edge users by more than 300%, reduces handover delay by more than 48% and decreases low-speed NR user ratio by 51%.

For video streaming services, users can enjoy 1080p videos in areas with good coverage while degrading to 360p in areas with poor coverage. With Radio Composer, users will be steered to the cell with best experience when the experience is going to slide. Therefore, smooth user experience can be ensured through source cell experience evaluation and target cell experience prediction based on machine learning. The steering can also be implemented in the shortest latency without waiting for measurement feedback. In a summary, Radio Composer improves user experience and saves video buffer delay and first frame playback delay.

In terms of slicing service, vertical applications in some scenarios, such as smart manufacturing, have stringent requirements on delay or reliability. Traditionally, more resources would be allocated in a fixed manner to guarantee the SLA requirement, resulting in a waste

of resources. With Radio Composer, slicing resources can be managed dynamically through machine learning of traffic patterns on a daily or weekly basis.

Therefore, Radio Composer allows two or more slices to be configured in the same network resources instead of one fixed slice, thus improving spectrum efficiency.

For terminals with different location characteristics for vertical applications such as drone inspection and differential protection services, the traditional policy is to use a unified priority to reside on the high-frequency network with 5G capability. With Radio Composer, the drone inspection service can be accurately guided to the low band for wide coverage while the experience is also on-demand; and the differential protection service with fixed-location terminals is preferentially directed to the high-frequency network to better meet the needs of users for differentiated services.

Future-Oriented Evolution

Radio Composer will continue to evolve in response to different stages of network development and differentiated service requirements, and exploits the best way to combine new services and application scenarios to offer best experience and optimal efficiency. Moreover, Radio Composer can be driven by more intentions, such as energy-saving intention for carbon neutrality and the comprehensive integration of multiple intentions, like experience, efficiency and energy efficiency. With the introduction of cross-domain information, the joint orchestration of consumers and industry segments will be further strengthened to implement more flexible coordination of user experience, network efficiency and other intentions within a single network, thus facilitating social digital transformation and 5G business prosperity. **ZTE TECHNOLOGIES**

PowerPilot: Enabling End-to-End Greener 5G Networks

Digital transformation is increasingly becoming a new engine for global economic recovery and growth. This is not only spurring enterprise growth but is giving communication service providers (CSPs) the opportunity to unlock at least \$700 billion in new revenues from industrial 5G and B2B2x opportunities. GSMA forecasts that 5G connections will reach 1.8 billion by 2025, accounting for a fifth of total mobile connections. Thus, 5G mobile network will be the cornerstone in driving digital transformation.

However, climate change is arguably the biggest challenge of our time. The total energy consumption by the mobile industry would be tripled from 2020 to 2030 according to some forecast, and 5G radio access network would be a big part of the increase. So the critical thing to do is to reduce 5G's carbon footprint in every possible way, but not at the cost of user experience promised by 5G. Many of operators have set ambitious targets about carbon neutrality and/or net zero, which is the mobile industry's strong commitment to the world. Meanwhile, it is not just about the network itself because the other industries can also benefit from a greener network either with direct reduction of carbon emission, or using 5G as an underlying technology to make their own businesses more efficient, more productive

and therefore greener.

According to the GSMA Intelligence 2021 report, 73% of the energy of the participating operators is consumed in the radio access network (RAN). The network core (13%), owned data centers (9%) and other operations (5%) account for the rest. Thus, reducing the power consumption of the main equipment at wireless sites has become the top priority of all.

On the basis of network-level intelligent energy saving policy management and site energy-saving scheduling control, PowerPilot with AI-powered base station implements network scene adaption, one site one policy, and multi-network collaboration energy saving management, which maximizes network energy saving benefits while ensuring stable network performance.

The solution focuses not only on analysis of wireless single-domain data but also collaborative analysis of cross-domain data, covering platform with AI and site with AI (Fig. 1). The battery life of terminals will also be improved during the implementation of network energy saving strategies.

AI-Powered Platform: Precise Network Energy-Saving Management

The energy saving platform, based on ZTE VMAX system, automatically obtains



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network data including engineering parameters, MR measurement data, historical performance KPI data, and neighbor cell relationships from the RAN domain through scenario-based open APIs.

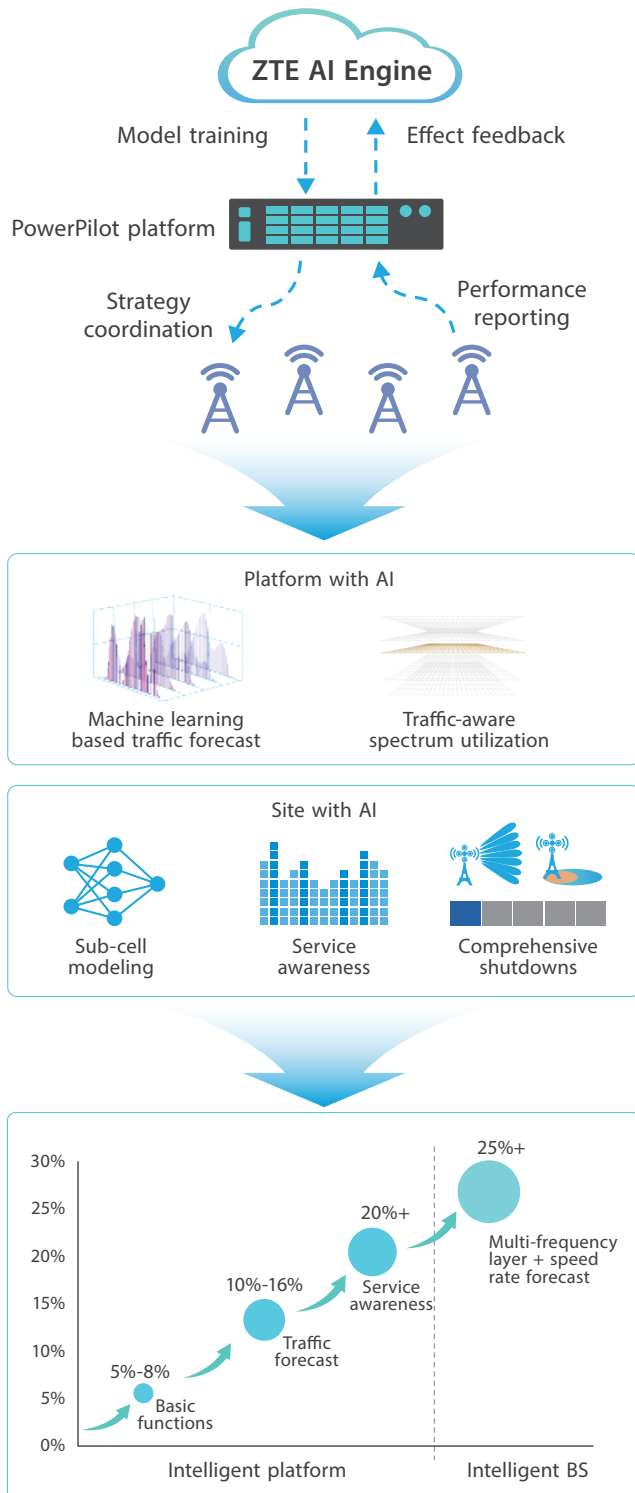


Fig. 1. Powered by AI, the network can be more energy efficient.

- Based on big data analysis, the platform automatically identifies network energy saving scenarios, predicts network traffic trends, such as traffic busy/idle hours and areas, traffic/energy consumption trends, identifies co-coverage cells and automatically generates energy saving policies.
- The system automatically delivers energy saving policies and implements network-level intelligent energy saving policy management and site energy-saving coordinated scheduling.
- Real-time monitoring of impact on network KPIs and energy saving benefits is achieved, allowing visualized management of energy saving benefits of mobile networks.

Large-scale deployments of it have shown an increase in power-saving activation rate by more than 80%.

AI-driven network energy saving solution is not a particularly new concept. Equipment vendors have started to offer AI-driven energy-saving solutions as an extension to existing network management platforms to enable more precise energy savings based on traffic and other site related conditions, improving efficiency and reducing the manpower required.

AI-Powered Site: Multidimensional Service-Aware Energy Saving

AI-driven service awareness has been taken into consideration since 2020, which exploits the differences in the energy efficiency of different types of services to deliver certain services to the most energy-efficient network, helping achieve the most efficient energy usage.

However, the multidimensional complexity of 5G is posing tremendous

challenges to the transition from network-centered to user-centered. Different network resources, such as bands, modes, carriers, frame structures, and beams can be combined flexibly; and it's very complex to predict and select the resource combination capability in the violently changing radio environment. Meanwhile, due to industrial evolution and diverse application scenarios, terminal capabilities vary greatly in terms of support for system, mode, feature and 2B/2C services, which is an important constraint for scenario-based and personalized services. Thus, only service type based user steering is not enough.

With the improvement of computing power of base station, more intelligent strategies can be introduced to base station and equipment. Cross-domain information that may affect energy consumption can all be obtained automatically by base station to make the user steering more precise.

Network service capability knowledge library introduced by ZTE Radio Composer solution will be applied and combined with service pilot to balance between network energy saving and user experience. Built on sub-cells of various scenario-based capabilities, the library predicts different cells' network service capabilities at different frequency layers through learning the history data, and combining with real-time information (e.g. service type, rate request and user type).

5G Terminal Energy Savings

A report from GSMA Intelligence highlights that one mobile connection required an average of 14.8 kWh of energy during the 12 months of operation. As of the end of September 2021, the number of 5G terminals had reached 445 million in China, which means over 6.5 billion kWh

will be consumed yearly. At the same time, the subscribers are constantly complaining about the heating problem and battery life of 5G terminals.

For better 5G experience and lower personal carbon footprint, PowerPilot supports more technologies to assist mobile phones working in an energy-saving state for a longer period of time, and the battery life can be extended by 20%.

Bandwidth part (BWP) combined with uplink smart pre-scheduling and inactive state of radio resource control (RRC Inactive) reduces the amount of signaling required during state transitions, making it possible to significantly lower both latency and battery consumption. The access latency was shortened by up to three times in a trial with China Unicom. This shortened time lag will have a big impact on user experience in applications such as cloud gaming where multi-player interactions require 20–30 ms end-to-end latency, enable the battery savings of up to 30% and improve the battery life by over 20%.

PowerPilot was awarded "Outstanding Catalyst—Impact for Society" at TMForum 2020 and "Innovative Breakthrough in Mobile Technology Award" at GTI 2021. Till now, the solution has been deployed in 30 networks over 800,000 sites. In typical network configurations, the power consumption of 5G base stations can be reduced by 20%–25%, and the emission of about two million kg carbon dioxide can be avoided for every 1000 base stations in one year. The average shutdown duration is 9.88 hours, which is a 60% improvement compared with that when the feature is manually enabled.

We all have a role to play if we are going to meet the challenges of the global climate crisis, and we do believe we can make some contribution to the mobile net zero target. **ZTE TECHNOLOGIES**

SSB 1+X Advanced: Improving 5G Offload Ratio and User Experience



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As the urbanization process develops rapidly in China, major cities are planning to upgrade their core urban areas and CBDs. The high-rise building economy has brought strong impetus to the local economy. Guangzhou Tianhe CBD has more than 120 business buildings in an area of 12 square kilometers, with a GDP of over 300 billion yuan, where the densest skyscrapers above 300 meters in China are located. Changsha, a fast-growing city in central China, has planned and is building nearly 20 CBD regional centers (Fig. 1), of which more than 100 business buildings with more than 20 floors are gathered in the core CBD area of Wuyi Square alone. The occupancy rate of enterprises in these buildings is up to 90%, which belongs to a high-tax area.

However, the sample data of office buildings in China shows that it is difficult to deliver high-quality wireless coverage services in high-rise buildings. Before 2022, the proportion of 5G indoor distributed coverage is less than 25%. The priority of 5G indoor distributed coverage is still very low during the current construction period, and the pain point of vertical three-dimensional coverage requirements is highlighted. The vertical coverage of

high-rise buildings becomes a bottleneck, indoor signals are poor in deep coverage, and 5G traffic backflow to 4G is serious.

5G NR SSB broadcast channel evolves to support multi-beam configuration and management. Most operators pay more attention to horizontal coverage at the early stage of 5G. Therefore, multiple horizontal SSB beams (7 or 8 beams) are widely used. The multiple horizontal narrow SSB beams with more concentrated radiation energy ensure horizontal coverage and align with the coverage of beamforming service channels, but the vertical coverage in high-rise buildings is still extremely insufficient. Although SSB multi-layer multi-beam stacking solution can cover both horizontal and vertical coverage, there are over 10,000 options for the antenna weight database of SSB beams. Therefore, the algorithm efficiency is very low in selecting appropriate cell antenna weights. Operators do not want to see complex scenarios with too random and too many uncontrollable multi-layer multi-beam combinations. They are eager to reduce the complexity and cost of network planning and operations.

ZTE launched an innovative SSB 1+X solution for lean beam design in 2019.

The solution supports wide/narrow beam combination, horizontal/vertical beam decoupling, and flexible beam layers adapting to complex and diverse coverage scenarios. Three major operators in China all adopted horizontal multi-beam networking for their 5G networks (China Mobile used 8 horizontal beams, and China Unicom and China Telecom employed 7 horizontal beams) in 2018–2019. Compared with the traditional single-beam networking, the 7/8-beam networking did provide enhanced cell edge coverage, and slight coverage improvement in driving test. Considering unstable performance and advantages of 5G horizontal multi-beam networking, there were many concerns and great pressure at that time to launch the SSB 1+X solution that combined horizontal and vertical coverage. For example, will there be serious interference between multiple horizontal beams and SSB 1+X adjacent networking? Can the coverage capability of “1” enhanced horizontal wide beam align with the horizontal multiple narrow beams?

The planning and optimization tools for the SSB 1+X solution are not yet mature, how can the solution be promoted on a large scale? Should multiple horizontal beams be replaced by SSB 1+X as soon as possible or should they coexist for a long time?

The answer lies in the implementation of ZTE’s SSB 1+X Advanced solution.

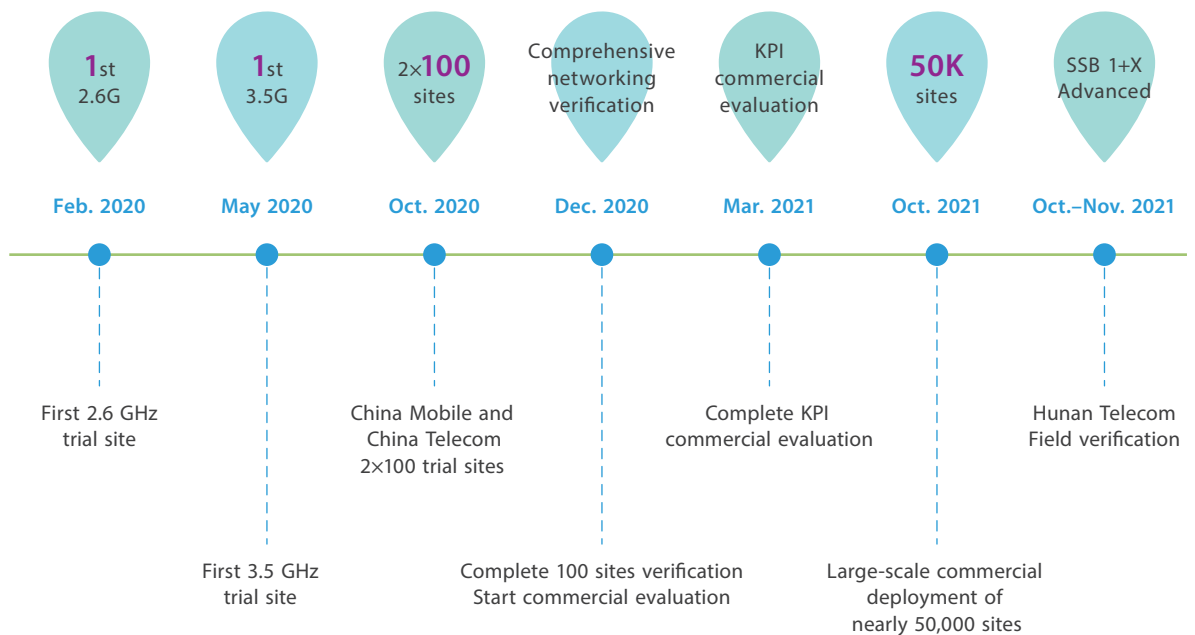
Several important milestones have taken place in more than one year, such as the first SSB 1+X trials of Guangzhou@2.6GHz and Zhuzhou@3.5GHz, the comprehensive networking verification of 2×100 sites in Guangzhou and Changde, large-scale commercial evaluation based on real online user KPIs, and iterative innovation of SSB 1+X Advanced in Changsha, Hunan province (Fig. 2). The evolution of network value has undergone vertical coverage enhancement, three-dimensional coverage coordination, and both improvement of 5G offload ratio and user experience. The SSB 1+X Advanced solution has helped operators establish their 5G brands, build 3-Gigabit communities, and promote quality network growth. After field verification and many revisions in many cities, the solution is maturing and has been put into large-scale commercial use.

In large-scale commercial deployments, SSB 1+X provides enhanced 3D vertical coverage, resulting in a significant increase in 5G users/traffic/offload ratio. However, because operators pay close attention to 5G offload ratio, SSB 1+X cells will



◀ Fig. 1. A CBD regional center in Changsha.

Fig. 2. Important milestones of deploying SSB 1+X Advanced.



absorb edge users to the greatest extent both outdoors and indoors. Operators need to solve the problem of how to improve the 5G offload ratio while enhancing edge user experience. ZTE's 5G SSB 1+X Advanced solution can address the problem, in which AAPC intelligent optimization tool accelerates the pace of whole network to be self-intelligent and uses the 4G/5G switching strategy based on quality and the innovative algorithm for self-adaptive performance enhancement to continually improve 3D coverage, thus achieving the improvement of both 5G offload ratio and edge user experience. The 5G SSB 1+X Advanced solution was deployed in Changsha city from September to early November 2021. The number of 5G users increased by 15.67%, 5G traffic increased by 33.96%, 5G offload ratio increased by 3.86%, and 5G user average uplink throughput increased by over 20%. The deployment ratio of vertical X-beam cells in the CBD area of Wuyi Square in Changsha is up to 45%,

making it one of the cities in China with a high proportion of X-beam cells deployed in the SSB 1+X solution.

The smooth evolution from horizontal multibeams to SSB 1+X had been implemented in nearly 100 cities in 30 provinces/municipalities by the end of October 2021. The total application of SSB 1+X is close to 50,000 sites, of which about 10,000 sites (20%) have X vertical beams. SSB 1+X has good adaptability in four aspects such as NSA/SA structure, multiple application scenarios, multiple bands and anchors, and 64TR/32TR AAU hardware equipment.

ZTE will continue to work with operators to expand the replication and application of SSB 1+X Advanced. They will further explore AAPC intelligent optimization tools and intelligent orchestration to improve network value and user experience, accelerate the evolution to self-intelligence networks, and maintain technology leadership, network leadership and market leadership. **ZTE TECHNOLOGIES**

AI Empowers Smart and High-Efficiency O&M of Wireless Network

The rapid development of intelligent network and intelligent O&M has been driven externally by the global digital transformation and internally by operators' long-term goals of reducing costs, increasing efficiency, and increasing quality and income. The rapid development of AI technology also accelerates the intelligent network upgrade. Developing "5G+AI" information infrastructure to empower all industries is becoming a top priority for operators. They have established the goal of "intelligent digital transformation and high-quality development" and accelerated the intelligent digital transformation and upgrade of network O&M in a bid to build highly automated and intelligent cloud-networks.

After decades of development, different generations of mobile communications networks coexist. The large-scale deployment of 5G has further introduced many new functions and services, making network O&M more complex, and some scenarios have exceeded the upper limit of manpower capability. Meanwhile, operators invest a large amount of manpower and money in O&M every year. It is imperative to introduce big data and AI to achieve intelligent and automated O&M, and gradually move towards a highly autonomous network.

Overall Solution

ZTE has been continuously developing and exploring network intelligence. It launched the intelligent network solutions uSmartNet several years ago, and is committed to helping operators

achieve ubiquitous network intelligence through continuous practice. Based on the uSmartInsight AI platform, the uSmartNet uses hierarchical closed-loop principle to construct intelligent network systems at network element level, single domain level and cross domain level (Fig. 1). AI is introduced into different layers of the network so as to build a self-evolution network. The NE intelligence with an embedded real-time AI engine perceives network data, responds to requirements in real time and dynamically adjusts resources. The single-domain intelligence (management layer intelligence) implements intelligent closed-loop processing of single-domain services through multi-dimensional data analysis for all scenarios. The cross-domain intelligence (operation layer intelligence) focuses on the end-to-end service closed-loop and external application interconnection. ZTE's uSmartInsight platform is the intelligent brain that guarantees consistent AI specifications, including data specifications, AI model specifications, knowledge specifications, and reasoning process specifications, to ensure the reasonable flow and sharing of AI models and knowledge.

ZTE divides the network intelligence evolution process into five intelligence levels, taking into account of manual involvement in different dimensions including requirement mapping, perception, analysis, decision-making and execution. Based on the unified architecture of uSmartNet, ZTE's wireless network intelligence solution uSmart-RNIA



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helps improve the automation and intelligence of network planning, construction, maintenance, optimization and operation, improve the O&M efficiency and save O&M costs. In these scenarios, it reduces manual operations, performs high-complexity multi-dimensional analysis, proactively prevents faults, and finds optimum solutions through digital and intelligent empowerment, making a solid step in intelligent O&M.

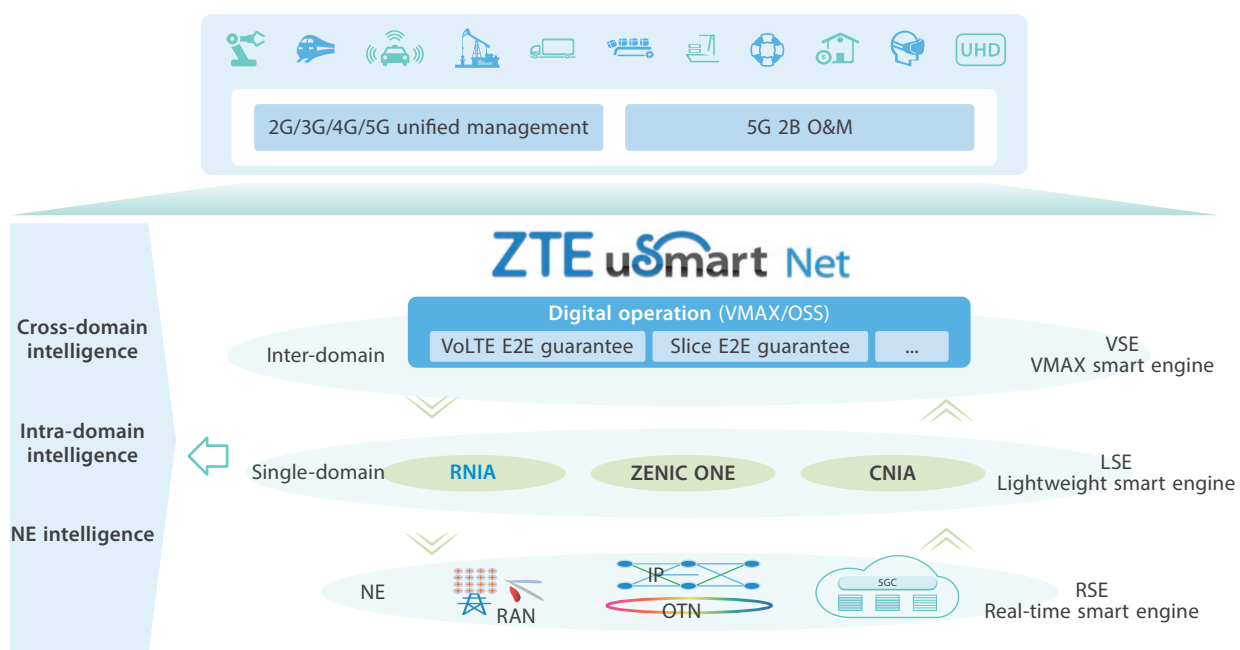
Function Highlights

Network development starts with planning, including initial network planning and capacity expansion planning. For the 5G network, we can provide intelligent insights to identify the value areas from the dimensions of traffic, user/terminal, key service and scenario while making forecasts on future traffic/user development, identifying explicit weak coverage and exploring hidden problems of high backflow, resulting in accurate planning oriented to the value areas. Planning of a local network can be completed in one week, with efficiency improved by 70% and site quantity saved by 30%, and this solution has already been applied to more than 40 projects in China.

In the early stage of large-scale 5G network construction, automatic site commissioning and automatic drive test are very important for rapid 5G commercialization. The automatic site commissioning through mobile phones has been realized in many projects, and over 2,000 sites have been commissioned in five months in a project in Fujian Province, saving more than 3.2 million yuan. With the help of cloud server + terminal app, ZTE can achieve automatic single-site acceptance. This solution only needs one person, one car and one terminal, and allows automatic navigation and automatic acceptance report output, improving efficiency by 65% and reducing manpower by 68%.

For the troubleshooting of faults that occupy a large amount of manpower on a daily basis, AI-based learning is introduced to automatically learn fault characteristics and related parameters, counters, and signaling. According to the characteristics of fault scenarios, intelligent drilling analysis is performed to quickly determine the root cause of the fault and enable interconnection with the work order system for closed-loop verification. At present, the fault locating accuracy rate is over 80%, and the time for determining the root cause is reduced from day level to minute level.

Fig. 1. ZTE uSmartNet architecture.



One of the outstanding advantages of AI is that it can predict the future trends based on the learning of a large amount of historical data, making predictive O&M possible. For example, the health of optical modules and optical links can be checked actively to identify the hardware aging and failure trends, and early warning will be given to guide proactive inspections and O&M. This is especially applicable to high security scenarios and VIP sites.

Massive MIMO for 5G uses large-scale array antennas and multi-beam broadcasting. One cell has tens of thousands of possible antenna parameters. In case of multi-cell coordination, the optimization workload increases exponentially. Manual optimization of 2,000 cells requires 160 man-days. In fact, the parameter model can only be fixed according to the expert experience. ZTE's automatic antenna pattern control (AAPC) uses the optimized search algorithm to greatly compress the optimization time. Meanwhile, the antenna parameters can be optimized according to different optimization objectives and scenarios to realize the closed-loop process. The optimization work of 2,000 cells only require three man-days, which improves the efficiency by 10 times, significantly improves the coverage, and increases the user throughput by 10%. The scheme has already been applied to more than 60 projects in China.

As the network scale and users continue to grow, the workload of network optimization will also increase, and it is necessary to focus on the optimization of the worst TOP N cells according to the Pareto principle. The system will automatically identify the cells with poor KPIs without manual intervention, achieving high efficiency and accuracy. For the identified poor quality cells, the system automatically analyzes the anomalous counter, determines the root cause determined in order and provides corrective suggestions. The analysis period is shortened from 10 hours to about 1 hour.

While poor KPI cells analysis can be considered as macro-layer network optimization analysis, network fluctuation detection learns and predicts the KPIs of subnet cells with a granularity of

15 minutes. It compares predicted KPIs with the KPIs collected in real time, and automatically finds the counter that has the greatest impact on the KPI fluctuation to determine the root cause.

An important factor that affects network quality is interference, especially the unpredictability of external interference. It takes a long time to find and locate the interference manually. A interference type feature library can be established based on expert experience and machine learning. After a task is set, the system automatically collects data of the entire network, identifies interference cells, analyzes interference types, and locates interference sources. Taking the interference analysis of 1,000 sites as an example. Compared with the traditional interference analysis that needs 15 hours, the interference analysis function only needs 5 hours and 3 minutes, improving the efficiency by two thirds.

Future Prospects

There are still many intelligent application scenarios waiting to be explored, and the road to wireless network intelligence cannot be achieved overnight. ZTE has been conducting pilots, expanding the application scenario and scale, and exploring new algorithms and applications. ZTE will continuously improve its intelligent capabilities based on the existing network, and build an intelligent orchestration network integrating baseband, network and service, and in the longer term, an AI-native, intent-driven autonomous network. Technologies like intent-driven operations, edge AI, ICDT integration, baseband intelligence and digital twin simulation can be introduced to realize a high level of intelligence in 5G-Advanced networks to connect the physical and digital world. In the future, by introducing the intelligent plane and data plane, we will construct a AI-native and trustworthy intelligent network architecture to achieve a highly intelligent information network, laying a solid foundation for the digital economy. **ZTE TECHNOLOGIES**

NodeEngine 2.0: Building a Simplified, Open and Intelligent Private Network



Sun Yangjun

RAN Product Solution
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5G communication technologies are becoming an important engine for promoting digital transformation of the industry. With the widespread deployment of 5G networks, 5G new products, new services and new business models in the 2B field continue to emerge. The core demand for 5G networks is to meet the needs of industry users for diverse, personalized and economical private network construction. Based on this concept, ZTE has developed its NodeEngine, a unique site-level computing power engine solution. Through the ultra-lean deployment strategy, the solution minimizes the construction of private networks, allowing a large number of small and medium-sized enterprises to build their private networks quickly and economically, and enjoy the benefits brought by 5G. The solution can also support diverse terminals, services and QoS requirements, which provide abundant network functions while realizing intelligent guarantee of service requirements. Moreover, NodeEngine features service capability exposure function, built-in computing power and flexible adaptation to scalable service requirements, laying the

foundation for the emerging 5G industry applications and IT/CT/OT convergence.

With the deepening of digital transformation in the 5G industry, customer needs for cloud-network convergence are becoming stronger and stronger. Therefore, leveraging the experience in deploying NodeEngine 1.0 with local traffic offload as the core, ZTE has proposed an innovative “1+N+∞” architecture in NodeEngine 2.0, in which “1” represents a single board (only 1 board is needed to build a plug-and-play local private network), “N” means N-dimensional services that NodeEngine can provide (covering various fields such as low latency videos, high-precision positioning, self-service portal, and SLA guarantee, and providing enhanced service capabilities based on NodeEngine 1.0), and “∞” refers to unlimited expansion of network capabilities through the capability exposure function. As a result, NodeEngine can be built into a new information infrastructure that integrates network connectivity, computing power and capability exposure, making it possible to support an unlimited variety of application scenarios.

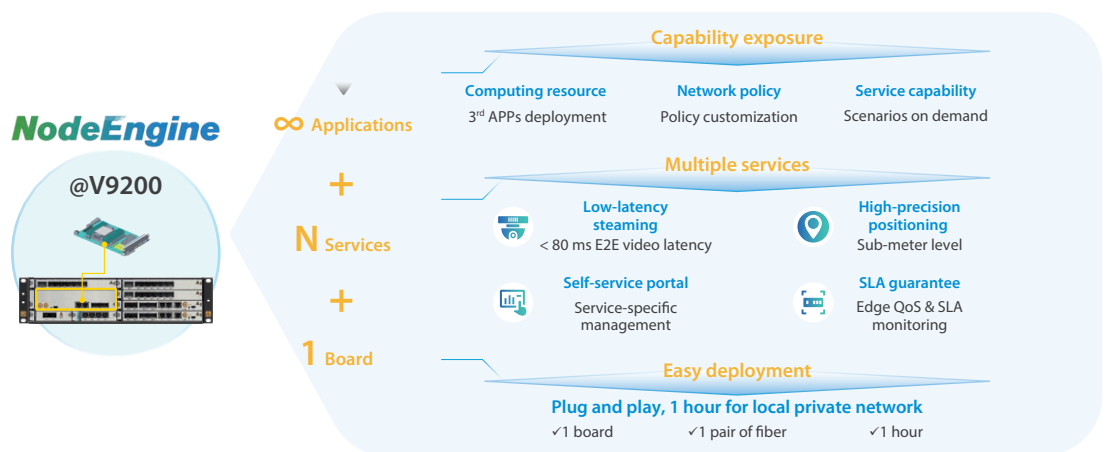


Fig. 1. Innovative “1+N+∞” architecture.

Thanks to the leading design of “1+N+∞” architecture, NodeEngine 2.0 realizes ultra-lean network deployment, intelligent network connection and wireless capability exposure in addition to basic capabilities such as no data out of the campus, multi-type terminal access, accurate network capability, self-service and cost-efficiency, so that customer needs can be fully met. The ultra-lean network deployment includes ultra-lean engineering, ultra-lean configuration, and ultra-lean networking.

Ultra-lean engineering can be summarized as “five one”, that is, just adding “one single board” on BBU, then implementing connection with existing hardware through “one optical fiber”, and finally adding the configuration of “one pair of IP addresses”, so that an “one hop access” campus private network can be built within “one hour”.

Ultra-lean configuration involves default subscription of blank SIM cards and flexible service allocation. The blank SIM card can be subscribed by default, i.e. be configured through the local self-service portal to establish a mapping relationship with the specific service and provide featured local private network services for the corresponding terminal. The flexible service allocation ensures that the SIM card and CPE can be matched at will, thus greatly improving the flexibility in service deployment.

Ultra-lean networking contains the isolation site autonomy solution that enables 4G/5G convergence and service continuity when the connection to the core network is interrupted and the 5G nomadic base station solution that allows for plug-and-play private services. This considerably reduces the complexity in building a mobile private network.

Intelligent connection guarantee is implemented through intelligent identification, intelligent scheduling, and intelligent orchestration. Intelligent identification can analyze the SLA requirements input by users, and continuously perceive network services. Through AI deep learning algorithm, AI engine and service awareness engine can obtain service types and features, and comprehensively analyze them

to get the required network guarantee policy. Then, according to the results of service identification, the system intelligently selects the best scheduling policy and performs closed-loop scheduling optimization in accordance with the results of flow KPI measurement. For the services that do not meet the guarantee goals, intelligent orchestration can also be introduced to implement QoS flow optimization through service peak shifting and service splitting, so as to guarantee fine-grained service SLA and help customers create a “wireless industry brain” that knows more about service features and application scenarios.

In addition, NodeEngine 2.0 supports three capability exposure modes: computing resource exposure, service capability exposure, and network policy exposure. Computing resource exposure means that computation resources and operation environments are opened to support the deployment of third-party industrial APPs. Service capability exposure means that NodeEngine 2.0 native service capability can be opened to the outside according to the needs of users, thus expanding application scenarios on demand. Network policy exposure means that NodeEngine 2.0 can open the policies such as traffic offload, bandwidth management and SLA guarantee to the outside, thus making possible the customized service-level policy orchestration. With these capability exposure functions, NodeEngine 2.0 is no longer a closed system but can fully interact with the cloud side and finally achieve the integration of cloud, network and industry.

The launch of NodeEngine 2.0 has won full recognition from operators and industry customers. So far, NodeEngine 2.0 has been applied in more than 70 projects, covering over 10 industries such as smart mines, smart manufacturing, smart entertainment, smart livelihood and smart medical care. It has helped customers quickly and well build their private networks in various scenarios and achieve good deployment results. The widespread deployment of NodeEngine 2.0 will accelerate the pace of digital transformation of the whole industry, providing better services for various industries. **ZTE TECHNOLOGIES**

Hierarchical DAS Collaboration Solution for Flexible 5G Indoor Coverage



Wang Jing

Senior Engineer of RAN
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As 5G services develop rapidly, operators pay more attention to deep indoor coverage deployment. On the one hand, 5G indoor data services account for 90% of total data services, which raises higher capacity requirements for indoor networks. On the other hand, the network analysis of some tier one cities in China shows that insufficient indoor coverage is the main factor for high backflow ratio of 5G traffic, and more than 85% of complaints about poor 5G signals or slow 5G speeds occur in indoor scenarios. It is therefore important to extend indoor 5G coverage.

The traditional passive distributed antenna system (DAS) has low capacity when directly upgrading to 5G, while the high-performance digital active DAS represented by QCell is expensive. Balancing cost and performance in a variety of indoor scenarios is a major issue to be addressed. ZTE has proposed its hierarchical DAS collaboration solution that can achieve the best balance between cost and performance through the collaboration within the same DAS and between different DASs, giving operators the flexibility of deploying their 5G indoor coverage.

eDAS Reuses Existing DAS and Improves Performance to Meet

Low-Cost Needs in Low-Value Scenarios

Passive DAS has a huge established market with mature technologies and low costs, and is easily shared by multiple operators with multiple frequencies and modes. However, it has the disadvantages of low capacity, poor user experience, and difficulty of offering higher-order MIMO by adding more feeder channels to existing DAS. In the 5G era, how to reuse the existing DAS system to achieve faster and more cost-effective indoor 5G coverage is still a major concern of operators.

ZTE's eDAS uses the following key technologies to make up for the disadvantages of passive DAS:

- For a typical 2T2R DAS system, two 2T2R RRUs with antennas and feeder channels for two adjacent cells can be collaborated to achieve a virtual 4T4R network in overlapping areas without the need to deploy any new antennas and feeder channels, thus reducing interference between cells and enhancing network performance.
- The innovative 5G algorithm is used to reduce the negative impact on MIMO performance caused by unbalanced signal transmit power between different DAS channels.

eDAS can reuse the traditional DAS system architecture, which greatly saves costs and avoids the often painful site location acquisition. Only by deploying the software version, single-channel DAS dual-stream and dual-channel DAS four-stream can be easily achieved, which considerably improves the performance of traditional DAS network. eDAS is also compatible with 5G terminals and has no restrictions on the terminals.

Collaboration of Passive DAS and QCell Achieves Smooth Capacity Expansion and Quality User Experience in Middle-Value Scenarios

The existing passive DAS can be upgraded to support 5G, but it still faces the capacity challenge brought by rapid growth of 5G services. 90% of existing DASs only support 1T1R with a single feeder channel, and even if they are upgraded to 2T2R, the capacity increase is still limited. The distribution of indoor traffic is unbalanced. 80% of the traffic occurs in 20% of the indoor areas, and the traffic will increase with the growth of customer services. However, capacity expansion for passive DAS is difficult because it has to replan, combine more additional RRUs and re-adjust feeder connection, resulting in higher costs and longer cycles.

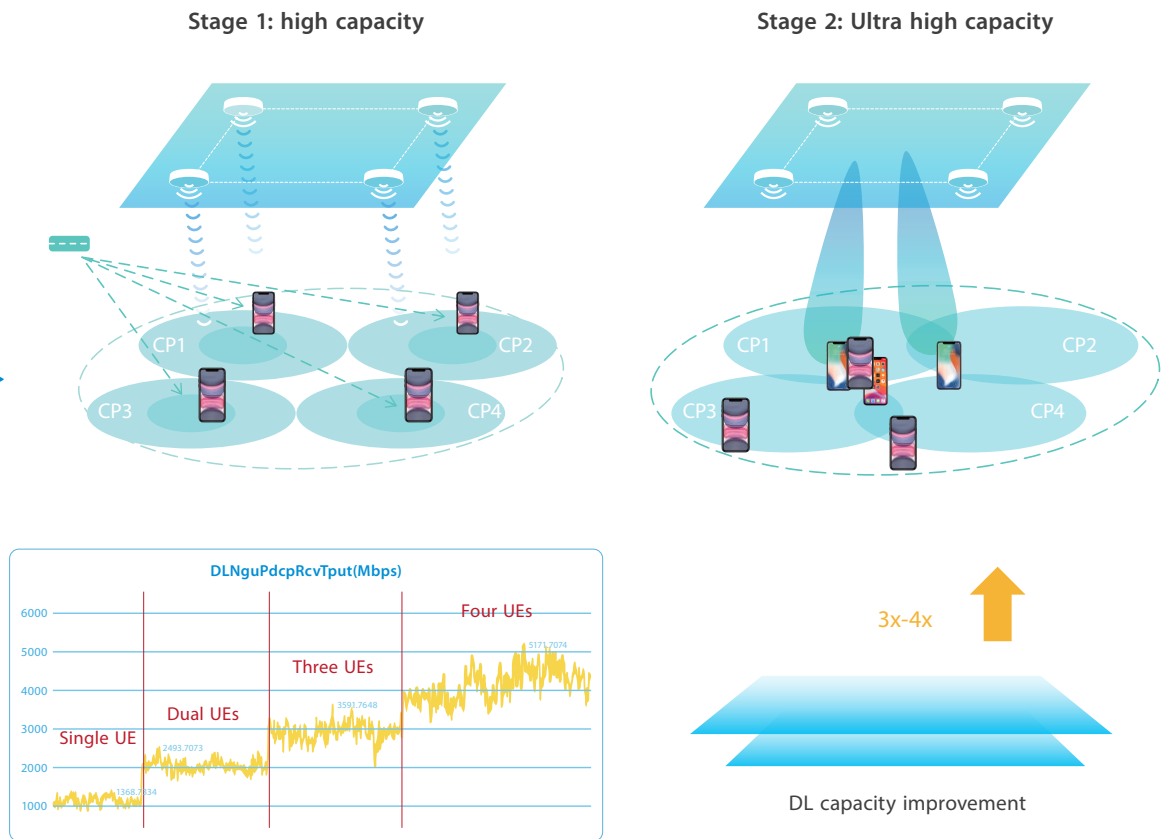
To solve the challenge of passive DAS expansion, ZTE has proposed the collaboration solution that leverages the coverage advantage of passive DAS and the capacity advantage of QCell. For example, in a shopping mall or office building where passive DAS systems have been deployed, QCell can be deployed directly in areas where capacity enhancement is needed such as shops or VIP conference rooms. To ensure

that QCell works normally and is not interfered by co-channel DAS signals, it is usually necessary to adjust the DAS system in the corresponding area and disable DAS signals in this area, which brings not only difficulties in engineering and network optimization but also poor experience to users. ZTE's collaboration solution solves the problem of different signal transmit power and transmission channels between different DAS systems, turns interference into gain, simplifies the overlay deployment of QCell, and effectively improves the capacity and user experience in hot spot areas. In addition, it can reduce handover and interference to improve user experience at the junction of passive DAS and QCell, such as the areas between elevators and halls or between subway tunnels and platforms.

SuperMIMO Boosts Capacity in High-Value Hot Scenarios

Digital active DAS such as QCell has the advantages of simple deployment, scalability and manageability, and can better meet the needs of future service development, so it has become a preferred choice for high-value scenarios. With the growth of 5G services in high-value scenarios, QCell can split few cells to meet the capacity requirement. However, as the number of split cells increases, inter-cell co-channel interference increases dramatically. When the interference reaches the threshold, system capacity is saturated, cell splitting cannot improve capacity, and user experience becomes worse. ZTE has developed the SuperMIMO solution for Qcell, which collaborates multiple distributed antennas of QCell as one massive MIMO antenna to serve a single UE or multiple UEs in a cell. In this way, user signals are enhanced while solving the problem of co-channel

Fig.1. SuperMIMO improves cell capacity in high-value scenarios.



interference. This improves user experience and cell capacity, and addresses the contradiction between interference and capacity.

To accurately match the high capacity and ultra-dense capacity requirements in network development, SuperMIMO is planned into two technical stages (Fig. 1). For high indoor traffic scenarios, the super cell technology is used to reduce multi-cell interference and handover, and the system automatically performs space division pairing for multiple UEs to enhance cell capacity. For the UEs in the overlapping area of edge signals, the number of MIMO layers can be increased by collaboration of adjacent multi-antenna transceiver solution. For the scenarios with extremely high traffic, ultra-dense user distribution and poor spatial isolation, it is necessary to achieve accurate beamforming gain and MU pairing to improve cell capacity

through the collaboration of QCell's distributed massive antennas.

Currently, eDAS has been commercialized on a large scale in more than 10 provinces in China such as Guangdong, Beijing and Shandong. It makes full use of the existing DAS, improves performance by 35% in the downlink and 25% in the uplink, and reduces the cost by 80% compared with the newly built DAS. SuperMIMO has also been widely used in metro, airport, hospital and shopping mall in more than 10 cities in China such as Guangzhou and Shenzhen, and has increased cell capacity by three to four times. With efficient collaboration and flexible deployment, the hierarchical DAS collaboration solution can help operators significantly improve indoor network performance, reduce network construction costs and build quality 5G indoor coverage networks. [ZTE TECHNOLOGIES](#)



Orange

ZTE UniSite+ Assisting OSP Building a Green Network

Orange Spain (OSP) is the Spanish branch of the Orange Group, the world's leading network operator and digital service provider. OSP is the second-largest operator with integrated offerings of fixed, mobile and TV services in Spain, and also the largest subsidiary of the French Group abroad.

OSP has widely distributed wireless spectrum resources and a total of seven frequency bands from 700 MHz to 3.5 GHz, resulting in a complex networking structure. Before the 5G era, the wireless equipment deployed in OSP's network was mainly single-band products. And there was also a certain amount of RSU equipment reused from the 2G/3G era. The wireless network equipment had low integration level and high power consumption, and did not have the 5G evolution capability. With the maturity of 5G

technologies and accelerated 5G commercial use, it is imperative to modernize and transform the existing wireless network in order to further strengthen OSP's overall market competitiveness and optimize the TCO of the entire network. In Q3 2019, after making the overall evaluation of ZTE UniSite+ solution and the excellent performance of 5G SA pilot in Valencia, Spain, OSP decided to award ZTE the project of FDD modernization and 5G deployment in several cities of Spain.

A High-Standard Network with Optimized Site Energy Efficiency

After being awarded the project, ZTE together with OSP formulated the implementation plan of its 5G-oriented solution UniSite+, which leverages 2G/3G/4G/5G multi-mode BBU V9200 and ultra broadband RF units (UBRs) covering all of the available spectrum



Liu Lei

RAN Product & Solution Manager, ZTE

to enable site simplification. This solution successfully passed OSP's software and hardware validation tests with great results, providing a solid foundation for future field commercial deployment. On January 28, 2020, the first modernized site was officially commissioned in OSP's existing network.

ZTE UniSite+ solution greatly reduces the complexity of OSP's site architecture. At the BBU side, only one 2U-height multi-band/multi-mode BBU V9200 is implemented per site to swap multiple BBUs deployed before, greatly reducing the occupied space in cabinets. At the radio unit side, by introducing tri-band 2T4R UBR R9222 M728090, FDD low bands 700 MHz, 800 MHz and 900 MHz can share a single RRU; and by introducing dual-band 4T4R UBR R8894E M1821, FDD 1.8 GHz and 2.1 GHz can share a single RRU. Meanwhile, the deployment of 2.6 GHz 4T4R R8854H S2600 with an embedded combiner in hotspot areas could further reduce the usage of external combiners and simplifies the site solution. When pre- and post-swap frequency bands are consistent, the total number of RRUs deployed in a single site could be reduced by up to 50%, further reducing the tower rental fees.

After the UniSite+ solution is implemented in OSP's network, the overall energy efficiency of the site is greatly improved. Take the typical LB + HB site in the ZTE area as example. There are a total of four frequency bands including 800 MHz, 900 MHz, 1800 MHz and 2100 MHz (700 MHz not yet on air due to auction issue). If the 1.8 GHz/2.1 GHz RRU maintains the pre-swap 2T2R configuration and pre- and post-swap RRU output power is aligned, the overall power consumption

per site can be 18% lower than that before modernization based on the evaluation of average site power consumption. If the 1.8 GHz/2.1 GHz RRU uses 4T4R configuration—the standard capability of UBR R8894E M1821, the overall power consumption per site can still be 3%–5% lower than that before modernization with the FDD performance improved from 2T2R to 4T4R and the total output power doubled.

After site modernization, all of OSP's frequency bands could support smooth evolution to 5G. At present, OSP has already re-farmed existing 2.1 GHz to evolve its network from legacy 3G/4G to 3G/4G/5G dynamic spectrum sharing solution ZTE's SuperDSS. This solution ensures that 5G FDD NR can be activated while 3G/4G technologies are still kept in the same FDD band, achieving fast 5G coverage without deploying additional hardware. Network modernization with UniSite+ fully releases the potential of existing FDD spectrum and improves the spectrum utilization efficiency.

For N78 or the 3.5 GHz TDD band, considering the N78 spectrum re-allocation in Spain by the end of 2021 and the need to protect N78 m-MIMO equipment investment, in the year 2020, ZTE commercially launched the industry's first IBW 400 MHz/OBW 200 MHz 64T64R Massive MIMO product A9631W S36 in OSP's network. This product with an operating bandwidth from 3400 MHz to 3800 MHz fully meets the requirements of N78 spectrum reshuffling without the need for any hardware change. Until now, OSP has already commercially deployed 64T64R A9631W S36 in all six northern cities of the ZTE area, providing users

with high-quality 5G experience.

Energy-Saving Features to Further Improve Energy Efficiency

Besides the energy-saving benefits obtained by modernizing legacy equipment, the UniSite+ solution can also bring additional energy-saving benefits by enabling energy-saving features. From 2020 to 2021, organized by Orange Group Skill Center, ZTE has verified several features like UMTS carrier shutdown, LTE carrier/symbol/channel shutdown, 5G AAU enhanced symbol shutdown and deep sleep in OSP's network. The field tests prove that by activating these energy-saving features, the power consumption of UMTS can be reduced by about 6%, that of LTE by about 8%–22%, and that of 5G AAU can be greatly optimized based on live traffic load. All of the above-mentioned energy-saving features have obtained the certification from Orange Group Skill Center. OSP and other Orange branches can select the necessary energy-saving features and commercially deploy them in their existing networks on demand.

To further build the low-carbon network, ZTE's innovative energy saving solution—PowerPilot can be introduced. Based on the energy-saving gains obtained in site modernization and energy-saving features, PowerPilot can further release the energy-saving potential of the base station. With AI-based in-depth learning, the strategy for enabling and disabling the energy-saving features can be automatically formulated through historical traffic analysis, and wireless users can be navigated to the most proper technology or band according to their traffic demand. Inter-cell energy-saving

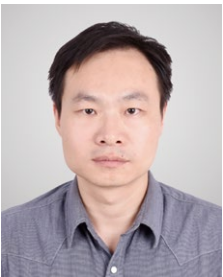


policy coordination can also be realized via AI, improving the energy-saving gains efficiently. OSP's technical team has stated that, after the commercial deployment of the basic energy-saving features, the feasibility study and analysis of PowerPilot will be the next step for building a green network. ZTE will cooperate with OSP to further improve energy efficiency and reduce carbon emissions, building a greener network.

ZTE is committed to providing operators with more options, simplifying network operation and maintenance, helping operators improve user experience and brand competitiveness, and maximizing spectrum value and operational benefits of existing equipment. Looking to the future, ZTE will continue to explore the application of new wireless technologies and features in commercial networks, and help OSP further improve network quality, reduce network energy consumption and achieve high-quality development. **ZTE TECHNOLOGIES**



Digital Transformation of SANY Heavy Industry



Zhou Chong

Director of RAN Product Planning, ZTE

Facing the digital transformation of engineering machinery and manufacturing industry, SANY Heavy Industry (SANY) has no choice but to forge ahead. If the digital transformation fails, it may die, and if the transformation is successful, it will grow stronger. This classic statement was put forward by Chairman Liang Wengen when he released the digital transformation strategy of SANY Group in 2018. It reflects the plight of the traditional manufacturing industry and SANY's firm determination to embrace the digital upgrade.

So far three years have passed since the statement. How is SANY doing on the road of digital transformation?

Remarkable Achievements in Digital Transformation

SANY is an absolute giant in the global engineering machinery manufacturers,

with services covering more than 150 countries and regions around the world. Its concrete machinery products rank first in the world, and its large-tonnage cranes, caterpillar cranes and port cranes rank first in China.

The production of engineering machinery is a typical discrete manufacturing mode, with the features of being offline-oriented, process-assisted, and assembly-focused. It is faced with many challenges, such as diverse manufacturing devices, difficult equipment interconnection, insufficient data integration, discrete production lines and heavy dependence on manual operations, which seriously restrict the improvement of production efficiency. Therefore, the development of engineering machinery towards digitalization, networking, and intelligence has become the main direction of the new round of technological and industrial revolution. Upgrading to smart manufacturing is an urgent need

for the engineering machinery industry.

In this context, SANY is committed to promoting digital transformation with a strong determination. Through the intelligence empowerment based on digitization, networking, sharing and data security, SANY works to achieve full wireless connection, less-manned operation, and fast on-demand production, adding the value of the industry in an orderly manner.

Based on its high speed, large connection, low latency and highly reliable network capabilities, 5G is accelerating the integration with digital technologies such as artificial intelligence (AI), big data, and edge computing, and has become the key engine for empowering digital transformation of traditional manufacturing industries. Building 5G private networks is the core of digital upgrade and transformation of the factories.

SANY decided to invest nearly 10 billion yuan in 2019 to digitize dozens of its factories. By the first half of 2021, SANY had built 11 factories that met the production requirements, increasing production capacity by 70%, shortening the manufacturing cycle by 50%, and increasing the automation rate to 90%. It has made remarkable achievements on the road of digital transformation.

NodeEngine Empowering SANY 5G Smart Factory

SANY, China Telecom and ZTE jointly built a 5G digital factory in Changshu industrial park in 2021. This factory has implemented internal equipment interconnection, fast-networking and accurate data collection, thus improving the production efficiency of subordinate enterprises in the industrial park.

SANY's 5G private network in Changshu

factory is based on the "Adjacent Mode" of China Telecom and adopts NodeEngine, ZTE's lightweight site-level edge computing solution. The 5G private network only needs to insert one board into the existing base station, and can be deployed in one hour, which is very simple and efficient.

The main function of NodeEngine is to offload data locally on the base station side and transmit the local data to the internal server directly in one hop, which meets the requirements of low latency, large bandwidth and high security for industry applications in 5G networks. NodeEngine also supports extended functions such as local equipment interconnection, wireless positioning and QoS guarantee. The computing resources, network policies and service capabilities of the NodeEngine platform can be opened to the third party, which provides greater potential for the expansion of industry applications.

Based on the NodeEngine solution, SANY Changshu factory has enabled various functions such as 5G+data collection, 5G+video surveillance, 5G+machine vision and 5G+smart warehousing, and used them in the production process of product machining, painting and assembly.

5G+data collection can transmit massive data generated during the production process to the local data center in real-time. After analysis and diagnosis, it formulates maintenance, management and control strategies that can reduce equipment waiting time and failure time by optimizing production process and enabling predictive maintenance.

5G+video surveillance enables SANY Changshu factory to intelligently identify and dispatch personnel, materials and equipment, improve management and production efficiency, and automatically raise alarms in the event of an accident to



Replicating Success Stories

Through continuous exploration and innovation, SANY has overcome many difficulties on the road of digital transformation in recent years, and finally ushered in the success of many projects including Changshu 5G smart factory.

At the first China Manufacturing Leaders Summit with the theme of "China Basics" held in Dongguan, SANY won the Benchmark Factory

Award of the 2021 Digital Transformation Award for its industry-leading smart manufacturing capabilities. It is the only award-winning company in the heavy industry.

SANY will promote its successful experience of 5G+smart manufacturing on a large scale, accelerate the construction of 5G smart factories in many other SANY factories across the country, and open its capabilities to empower the outsourcing manufacturers in the industry chain and grow together.

"Smart manufacturing is the foundation of SANY's development and a new industrial civilization that will profoundly change the whole world", said Liang Wengen, chairman of SANY, who led SANY's digital transformation and achieved such success.

SANY is now accelerating towards the "3+3+3" digital transformation strategic goal of achieving sales of 300 billion yuan, 3000 workers, and 30,000 engineers by 2025, leading the transformation and upgrading of China's manufacturing industry, safeguarding the real economy, and helping to build a manufacturing power. **ZTE TECHNOLOGIES**

ensure the safety of personnel and production.

5G+machine vision helps SANY Changshu factory implement such functions as intelligent material feeding, multi-system collaborative operation, unmanned dangerous production, automatic assembly and intelligent quality inspection. The labor cost has been reduced by 64%, and the product defect rate has also been reduced by 14%.

The 5G+smart warehousing improves the connection quality of automated guided vehicles (AGV), and can ensure a latency of less than 10 ms. It achieves high-speed and stable operation of AGV transportation operation and scheduling control, increases the warehousing management efficiency by 50%, and reduces the overall costs by 20% to 30%.

It is estimated that after the digital upgrade of SANY Changshu factory, the downtime of equipment failure has reduced by 50%, the equipment utilization has increased from 35% to 75%, and the production capacity has doubled without the purchase of new equipment.

Zero-Footprint and High-Capability 5G Edge Infrastructure for Industries

Source: Telecom Review Asia

Telecom Review Asia Pacific interviews Dr. Han Gang, Deputy General Manager of RAN Market, ZTE. Dr. Han is focused on developing RAN solutions and strategies. He is also responsible for ZTE's RAN industry partnership programs and ZTE's international markets.

What are the requirements and challenges for 5G in terms of digitally transforming vertical industries?

5G has been opening up new opportunities for various industries to achieve digital transformation. However, not many enterprises, particularly small and medium-sized businesses (SMEs), which account for more than 90% of all businesses in China benefit from it, due to certain challenges.

Firstly, SMEs tend to be concerned with economic feasibility and deployment convenience when engaging in newer technology. One of their key requirements is keeping data within the enterprise's premise to ensure data security and optimal performance. Solutions such as miniaturized 5GC or edge UPF for private networks require dedicated equipment room or space, new power supply, additional transmission link, and other auxiliaries, which are expensive and slow to deploy, thus holding many enterprises back in embracing 5G.

Secondly, SMEs are usually small-scaled businesses scattered across different industries. They have distinct application requirements that demand more flexible solutions, making widespread deployment across SMEs a challenge.

Thirdly, most industrial businesses are based on indoor scenarios. Centralized 5G services within limited indoor space may pose an uplink capacity challenge for networks. For example, remote control and HD monitoring are typical automatic scenarios in the

mining industry, where requirements for video upload of a single camera are usually 2–20 Mbps (1080P–4K) and cell uplink capacity can reach 300 Mbps–1 Gbps for concurrent uploading of multiple cameras.

Finally, huge differences exist between 5GtoB and traditional 5GtoC fields in terms of latency, reliability, rate, and self-service capability. 5GtoC networks adopt the best-effort service strategy for end-users, with more attention paid to network-level KPIs. Basically, for vertical industry applications, each terminal has definite requirements for delay, reliability, and bandwidth, and requires user-level performance guarantee.

How does your solution address these challenges?

Given that most vertical industry applications are based indoors and SMEs require private 5G network solutions with lightweight deployment, fast service commissioning and adaptive SLA guaranteed, ZTE proposes 5G edge solution. This solution offers the smallest footprint without the need for standalone edge servers, but only a dedicated card inside the existing baseband unit.

Thanks to the latest progress in chipset and radio technology, it also offers three times the capacity compared with traditional solutions. This provides flexible deployment together with strong 5G capability for vertical industries to create value for operators and other users.

Essentially, ZTE's 5G edge solution offers features that address the challenges in vertical 5G deployments. For instance, it leverages on QCell and NodeEngine solutions



Dr. Han Gang, Deputy General Manager of RAN Market, ZTE

“ZTE’s 5G edge solution offers the smallest footprint without the need for standalone edge servers, but only a dedicated card inside the existing baseband unit.”

to make private network deployment as simple as possible, to facilitate quicker and lower cost transformation of SMEs.

ZTE QCell is a distributed indoor small cell solution consisting of a BBU, hub unit, and Pico RRU, a three-layer architecture that offers easy deployment by Ethernet or optical cable widely used in commercial indoor networks in 4G. On the other hand, direct-link QCell features a two-layer architecture without the need for an intermediate hub, configured with compact BBU to fit the requirements of SMEs while keeping Capex low. Essentially, both QCell solutions share all components such as Pico RRU and BBU cards to minimize an operator’s overall investment.

Commissioning of private networks also becomes simplified with NodeEngine, the industry’s unique built-in base station computing engine. It features private network capability requiring just one board inserted into an existing BBU cabinet, to eliminate engineering surveys or reconstruction, and inter-operability between the NodeEngine and core network to significantly reduce time and effort invested into supporting IoT. With one board, one fiber, and two IP addresses, NodeEngine can be turned on within one hour.

Traditionally, SIM card subscription is a prerequisite for networks, which generally involves long procedures such as service type confirmation and QoS mapping to bind SIM cards, CPEs, and industrial devices. However, fast service deployment is now possible with the NodeEngine solution as it provides a more flexible way to support dedicated local private network services for corresponding terminals with all SIM card default subscriptions through intelligent service identification and scheduling policy matching.

Furthermore, 5G small cells offer advantages such as flexible customization, cost efficiency, and lower energy consumption to meet various industry requirements. In fact, ZTE’s QCell has been ranked first, earning a perfect score in the Global Data’s Enterprise SmallCell Rating Report.

ZTE’s QCell has been customized for various industries. One example is the mining industry where safety is a key requirement. Owing to the flexibility of the QCell architecture, ZTE has customized QCell for the mining industry, with features such as the industry’s first 700-MHz QCell, low transmission power, redesigned heat-dissipation fin for better heat-dissipation in an explosion-proof box, and high voltage resistance.

In addition, as AI computing and applications usage accelerate, NodeEngine realizes closed-loop guarantee of service quality through the complete process of intelligent identification, intelligent scheduling, intelligence orchestration, and real-time SLA monitoring.

Another example is indoor location services. Rich indoor location services such as navigation, asset management, automated guided vehicles (AGVs) have different location precision requirements. Different technologies such as 5G, Bluetooth, or UWB have different location precision capabilities and costs. To combine the advantages of all technologies to reduce deployment and O&M costs, a cascading port has been customized on QCell to provide connection and PoE for third-party Bluetooth or UWB equipment. Also integrated is NodeEngine’s location computing capability to provide unified and efficient location-based service

(LBS) for upper-layer service applications, as well as open API interfaces for third-party apps.

To address the challenge of increased uplink capacity to satisfy industry application requirements, one solution is using ultra broad bandwidth radio to support more frequency resources. A 300 MHz QCell can support up to 3 carriers NR with 100 MHz each and has been deployed in Olympic venues in Hangzhou city to provide enhanced live broadcasting services for the 19th Asian Games Hangzhou 2022.

Another solution is using the 1D3U frame structure with more uplink time slots. This is suitable for the mining industry. Since underground private networks and operators' public networks are isolated and tend to not have interference problems caused by different frame structures, QCell, with 100 Mbps NR carrier, and 1D3U can provide about 700 Mbps uplink peak rate.

ZTE QCell SuperMIMO function is also an innovative way to improve the capacity of both uplink and downlink by coordinating multiple QCells. Combining the technologies of Super Cell, MU-MIMO, and Joint Beamforming effectively addresses the contradiction between "interference" and "capacity" and increases user perception. Field applications have shown that with SuperMIMO, indoor cell capacity and user experience can be improved by 3 to 4 times.

In addition, as AI computing and applications usage accelerate, NodeEngine realizes closed-loop guarantee of service quality through the complete process of intelligent identification, intelligent scheduling, intelligence orchestration, and real-time SLA monitoring.

Citing an industrial park as an example, NodeEngine can receive the SLA requirements of the services through a self-service portal defined by an enterprise. As traffic is offloaded locally, service characteristics based on the local data from local applications can be easily identified. SLA requirements from the portal and learned service characteristics, such as packet size and packet cycle of service flow, can be transformed into the scheduling strategy of a QCell network to schedule wireless resources accordingly. At the same time, end-to-end delay of service is monitored and feedback to the policy engine for closed-loop SLA guarantee. The results will be presented on the portal in real-time for ease of operation.

Is this solution applicable to different markets on a global scale?

This solution has been widely applied in more than 10 vertical industry scenarios and 50 projects in China. It is also successfully applied by AIS, the largest mobile operator in Thailand.

To date, there are over 20 projects in smart manufacturing. For instance, ZTE intelligent manufacturing base uses 5G to power 5G smart manufacturing for Xinfengming Group and 5G+ intelligent manufacturing for SANY's smart factory. For the latter, 5G enabled machine vision helps the factory implement functions including intelligent material cutting, multi-system collaborative operation, unmanned dangerous production, automatic assembly, and intelligent quality inspection. This reduces labor cost by 64% and product defect rate by 14%. 5G intelligent storage improves the connection quality of unmanned AGV trolleys and ensures a latency of no more than 10 ms. It achieves high-speed and stable operation of AGV operation and scheduling control, increases storage management efficiency by 50%, and reduces overall costs by 20%–30%. These successful applications allow SANY to reap the many benefits of digital transformation.

In the area of smart mining, 5G edge solution powers high reliability, high bandwidth, and low latency capabilities in underground explosion-proof 5G equipment and overground remote control via low-latency HD videos. This minimizes the number of tunneling workers and significantly enhances security levels and operational productivity. This solution is deployed in many mines across Anhui, Shanxi, and Shangxi provinces in China.

In terms of digital city management, indoor location can be applied in various scenarios. High-precision 5G indoor positioning with QCell and NodeEngine in Grandview Mall, Guangzhou, provides accurate shopping location navigation services for 5G users. Combining 5G network capabilities such as location information, 5G messaging, and 5G cloud edge network technology, ZTE will continue to deliver the benefits of 5G+ digital business solutions to positively impact industries and economies. **ZTE TECHNOLOGIES**

To enable connectivity and trust everywhere