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# ZTE TECHNOLOGIES

## CEO's Voice

WindTre: Accelerating Digital Transformation with 5G in Italy

## Expert Views

ZTE: To Be a Road Builder of Digital Economy

## Special Topic

# 5G ToB New Capabilities

Cover Figure | *Jeffrey Hedberg, CEO of WindTre*

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# WindTre:
## Accelerating Digital Transformation with 5G in Italy

Reporter: Alessio De Sio

***Jeffrey Hedberg, CEO of WindTre, talks about the necessity of accelerating digital transformation with Fiber/5G/FWA roll-out as well as developing digital skills in the post-COVID era. As an industry veteran, he also shares with us his management philosophy and work experience.***

### What is your assessment of the post-COVID situation regarding telecommunications in Italy? Will our Country be able to relaunch itself with a clear sense of direction?

The COVID emergency has clearly reinforced the necessity for our country to enable and empower an infrastructure capable of connecting its people, schools, hospitals, businesses and other institutions. While the volumes generated by fixed and mobile data and voice services have grown by around 50% during COVID, we are also witnessing the requirement for policies aimed at accelerating the digital transformation and developing digital skills and capabilities across the country.

Specific to telecom companies, we have effectively responded to this surge in demand for high-quality voice and data services, thanks to the teams within our Company. The ability to deliver for our customers and for our people has been made possible by investing Euro 6 billion over 5 years in the modernization of our network, our systems and other key customer touchpoints.

### Which aspect of network infrastructures needs to be further developed?

At this moment, the real game changer and driver of economic development remains a cross fertilization of Fiber, 5G, and FWA as these technologies are interdependent in providing a competitive and sustainable connectivity advantage across Italy. Specifically to 5G, where WindTre covers over 91% of the population due to our dynamic spectrum sharing capabilities, we are providing advanced services to the B2B verticals—health, security, energy, education or smart campus solutions. The 5G standard is also much more spectrum efficient, essential for supporting the increasing demand for connectivity from businesses, institutions, families and individuals. 5G represents an important opportunity for growth not only for telecommunications companies, but for the entire economy.

### About 5G, how much are new skills needed?

While investment in spectrum, network and systems will always be important for successfully enabling digital transformation and innovation, developing the required skill sets (eg. coders, application developers) and capabilities (eg. attracting funding, leading change) will be the most decisive source of competitive and sustainable advantage. This is an area in which Italy must have a clear and ambitious plan as according to latest DESI reports, there is room for improvement. Nevertheless, I am confident that by aligning the resources of government, educational institutions and industry, Italy can quickly close the gap given the abundance of creativity and talent of this Country's human capital.

### How much will digital transformation support industrial competitiveness?

While, as noted above, Italy has clear areas to focus on to improve its competitiveness, there are several important advantages, such as the manufacturing sector, which is the second largest in Europe and one of the largest in the world. To strengthen the economy and continue to be competitive globally in manufacturing and other sectors, we will require a strong set of public/private partnerships between institutions, industry and education with efficient decision-making processes; and all underpinned by clear and measurable KPIs. By continuing to collectively invest in infrastructure and skills, we will enable the opportunities that digital transformation provides while empowering Italy to take

advantage of these benefits.

## In terms of expertise, how much could ZTE contribute to the creation of WindTre's new Top Quality Network?

In addition to providing world class technology, service and support, the ZTE team has been very effective in listening to and learning from its customers. They have demonstrated a continuous ability to respond to rapid external and internal changes and have been a true partner over the years. Thanks to this teamwork, ZTE has made a significant contribution to the construction of the new WINDTRE network infrastructure. A network that has been defined Top Quality by the major independent institutes, and which today reaches over 91% of the Italian population with 5G service.

## Simplified rules, a digital future. What else would you like to ask of the new Draghi government?

After months (perhaps years) of discussion on the most appropriate vehicle for accelerating the roll-out of broadband across Italy, now is the time to act and I am very encouraged by the clear and practical approach championed by the new government. Moreover, the policy response to the requirement and surge in demand for connectivity is also underpinned by the opportunity to leverage the European Recovery Fund. Policy makers, institutions and industry must leverage this unique opportunity for the country to accelerate the roll-out of Fiber/5G/FWA, develop the required digital skill sets and simplify the processes for enabling these opportunities. In addition to this simplification, there are others, starting with a review of the limits on electromagnetic fields, which should be


harmonised with European levels so that there is a level playing field.

## As a leader, you are recognised and appreciated for your humanity and empathy. But are people born to be leaders, or do they become them?

I have always followed the simple Golden Rule from Confucian times—"Do unto others as you would have them do unto you." Lead with courage and purpose and always be yourself; whether you are a born leader or a made leader, who cares?

## What advice can you give to a young person just starting out in the world of work?

I have had the opportunity to live and work across the US, Europe, Africa and Asia and similarly I have listened, I have learned and I have engaged and discovered that if you can attract, inspire and mobilize the right people and the right partnerships you will be successful. Never be afraid to embrace change and to always learn, learn, learn…particularly in these times of rapid transformation.

Be visible in the field not just in the Board Rooms, be clear and transparent (in good times and in bad), and work and measure always as a team. Finally…

"I am a great believer in luck and I find the harder I work the more I have of it. " (Thomas Jefferson) ZTE TECHNOLOGIES

# ZTE: To Be a Road Builder of Digital Economy

Zhang Wanchun, Senior Vice President of ZTE Corporation

The COVID-19 pandemic has changed the way people live and work, and accelerated the pace of digital and intelligent transformation of enterprises. 5G has become the core engine of industrial digital transformation. It is commonly agreed in the industry that standalone (SA) is the target architecture of 5G. With the maturity of industry chain and successful commercial use in leading markets, SA will be deployed on a large scale in 2021 to maximize 5G value and its industry application potential. ZTE is devoted to becoming a road builder of the digital economy. Starting from typical industry scenarios and real pain points, ZTE aims to explore the mechanism of deep integration of 5G and the industry, to create 5G industry application products and solutions with innovation, ingenuity and perseverance, and to empower digital and intelligent transformation for thousands of industries.

The pain points faced by different industries are diverse and differentiated, such as

- **Harsh working environment, high risk and heavy workload:** Some industries including mines, ports and metallurgy face problems such as harsh working environment, high risk and heavy workload, which makes it difficult for enterprises to recruit workers. Therefore, they urgently need the transformation to less-manned and unmanned operation.
- **Low production efficiency and high manpower costs:** Some manufacturing enterprises are faced with problems such as low automation, low production efficiency, large fluctuations in the skill level of employees, and high manpower costs. Therefore, the transformation to automation and intelligence is imminent.
- **Limited capabilities of traditional telecom technologies:** Incumbent telecom technologies fail to meet the industry-specific needs, such as the mobility requirements of AGVs and drones, the millisecond-level delay and nearly 100% reliability

**In response to the problems faced by enterprises for 5G networks, ZTE focuses on four aspects that involve ultimate 5G network, precise cloud network, special solutions, and open cooperation.**

**Zhang Wanchun**

requirements of automatic driving and industrial control, the millisecond-level delay and high precision timing requirements of smart power distribution network, and the above 100 Mbps uplink bandwidth requirements of industrial machine vision and train-to-ground communication.

- **Lack of facility mobility and inflexible deployment:** Industries such as live video streaming and emergency communications face the challenges of facility mobility and flexible deployment. Therefore, services need to be provisioned quickly anytime, anywhere.
- **Unable to smoothly evolve existing telecom equipment:** The existing private network equipment has entered the later stage of its life cycle, and the industry chain is about to break, facing the difficulties of smooth evolution of PMR, DMR, P25, TETRA, GSM-R and so on.

What kind of 5G network can meet the differentiated and fragmented requirements of different industries, different scenarios, and different applications? The 5G network needs to have the following characteristics:

- **On-demand network coverage:** Where there is information, there is a network. The network needs to provide the performance required by the business, and it moves with the information.
- **Deterministic network performance:** Network performance needs to be highly deterministic and highly reliable. Enterprises can schedule, configure, predict, monitor, manage, and evaluate network performance by themselves.
- **Intelligence and agility:** Computing resources can be flexibly moved, configured and adjusted. Network components are modular and can be called and combined freely.

In response to the problems faced by the industry and the requirements of enterprises for 5G networks, ZTE focuses

on four aspects that involve ultimate 5G network, precise cloud network, special solutions, and open cooperation.

## Lead by Innovation to Create Ultimate 5G Network

ZTE has never stopped its innovation in developing an ultimate 5G network including the simplest network architecture, the highest spectrum efficiency, the best performance, the lowest energy consumption, and the most intelligent OAM. It has rolled out the UniSite+ solution that supports the simplest 2G/3G/4G/5G site deployment and coexistence, the SuperDSS solution that supports 2G/3G/4G/5G dynamic spectrum sharing, the Massive MIMO and SSB 1+X solution that further improves vertical coverage in complex scenarios by 30%, and the eDAS solution that realizes uplink/downlink multi-stream MIMO transmission to improve indoor 5G experience at low costs through the reuse of the old DAS system and software upgrade. ZTE has also developed the PowerPilot solution that saves about 15% energy consumption by introducing Big Data and AI technologies. Its AI-based AIVO solution improves OAM efficiency at each stage of network planning, construction, and maintenance.

## Reshape Capabilities to Build Agile and Precise Cloud Network

To meet the differentiated and fragmented requirements of vertical industries, ZTE has proposed the precise cloud-network integrated solution that decouples key technical features from scenario features, extracts them into components with common capabilities, and forms a building-block component library. Various application scenarios can be supported through a flexible and efficient combination of components. Through the trials of components in the application scenarios, the component library can be iterated and optimized continuously.

Distributed precise cloud features on-demand creation, lightweight, flexible deployment, and fast iteration. At the IaaS layer, the computing power is evenly distributed on the end, edge, and cloud. At the access edge, a NodeEngine solution can be deployed to provide edge computing only by adding a functional board to 5G BBU. At the convergence edge, more powerful computing can be achieved by deploying the cloud-network integrated cabinet embedded with general servers. At the city edge, a standalone network cabinet or cloud cabinet can be deployed to provide more powerful computing. At the PaaS layer, the cloud decouples network architecture horizontally into finer-granularity components and vertically into the technical service layer and the general service layer. The resources are optimized cyclically between the technical service layer and the underlying layer, while the general service layer can iterate with application scenario innovation. Regarding the software, the TECS Cloud Foundation (TCF) is compatible downwards with various IaaSs and provides upwards service-oriented

interfaces that shield upper-layer applications from cross-platform details.

The deterministic precise network synergies with the cloud and achieves precise network capabilities customization and deterministic SLA guarantee by accurately distinguishing industry characteristics and business types and accurately allocating network resources. ZTE has encapsulated key network technologies as network atomic capabilities such as large bandwidth, low latency, high reliability, end-to-end slicing, high-precision positioning and local offloading, which can be flexibly and quickly adjusted and combined to deliver customized 5G private services for different scenarios. In terms of end-to-end network performance guarantee, the radio access network, bearer network, and core network coordinate with each other based on the network resource orchestration and SLA strategy. Global resource scheduling can be achieved through slicing, URLLC, TSN, FlexE, and radio resource scheduling algorithms, so as to provide a precise 5G network for industry customers. In terms of full service process guarantee, the most appropriate resources and functions can be allocated and scheduled for 5G applications in vertical industries through precise planning, precise slicing, precise identification, precise scheduling, precise measurement and precise OAM. This provides precise service guarantee and lays a solid foundation for 5G applications in thousands of industries.

## Implement Integration to Offer Adaptive Products and Scenario-Based Solutions

ZTE has actively advocated to

find demands, carry out R&D, and innovate on the front line. It has worked with enterprise customers to focus on the pain points, mechanisms, and processes of 5G integration with vertical industries, and embed the most appropriate 5G products and solutions into the value chains of vertical industries. ZTE has also insisted by itself on using industry innovation first. For example, it has used 5G+ industrial internet technology in the Nanjing Binjiang manufacturing base to practice manufacturing 5G with 5G. During the COVID-19 pandemic, it has enabled 30,000 R&D personnel to quickly resume their work on the cloud and conduct R&D collaboration on the cloud.

ZTE has carried out widespread application practice in 15 industries including media, industry, power, mining, transportation, ports, medical care, cultural tourism and agriculture, and has developed a large number of industry-specific products, solutions and features. It has customized the 5G ATG solution for the civil aviation industry, explosion-proof base stations and core network for the mining industry, the site-level edge computing platform NodeEngine for campus applications, the 1D3U frame structure to meet industry's ultra-large uplink bandwidth needs, the small-granularity hard slicing functions such as PRB for high security applications, and the high-precision timing functions for differential protection of power distribution networks. ZTE has won 23 awards and 4 first prizes in the third "Blooming Cup" 5G Application Collection Competition sponsored by the Ministry of Industry and Information Technology of China.

## Open and Cooperate to Build a Symbiotic Ecosystem

ZTE has actively cooperated with industry alliances, integrators, leading enterprises, telecom operators, and upstream and downstream industry partners to share experience and achievements in different technical fields and industries in terms of requirement identification, standard coordination, innovative products, end-to-end solutions, and capability exposure, and to jointly promote the prosperity and development of 5G industry applications. The low-tech threshold enabling platform ZTE has specially developed for industry customers and ecological partners can output an industry component library formed by common core technological capabilities such as big video, big data, IoT, industrial control, and remote office to the partners to accelerate application innovation and ecological creation.

ZTE has developed more than 500 cooperative partners in 15 industries including industrial engineering, transportation and energy. They have jointly explored 86 innovative 5G application scenarios and successfully carried out more than 60 demonstration projects worldwide. Facing the opportunities and challenges of 5G industry applications, ZTE will as always, be down-to-earth, continue to innovate, build agility, and be a road builder of the digital economy to empower industrial digital transformation and upgrade. ZTE TECHNOLOGIES

# Standing at the Forefront of Digital Transformation

## ZTE Precise Cloud-Network Solution

**Tu Jiashun**
Principal Scientist of NFV/SDN, ZTE

The basic proposal of precise cloud-network is to focus on scenario-based, value-driven, and precise services of converged digital infrastructure. The core idea is to identify the pain points and key problems in 2B scenarios, and help telecom operators build brand-new cloud-network platforms to facilitate the digital transformation of industry customers through rapid iteration.

With the development of mobile internet, big data, artificial intelligence, cloud computing, IoT, edge computing, and other new technologies, human society is entering the fourth industrial revolution characterized by digitalization, 5G, automation and intelligence. The characteristics of 5G make it destined to go beyond the scope of connectivity, integrate with the cloud computing, AI, and big data technologies behind it, and become the cornerstone of the fourth industrial revolution. With the commercial launch of 5G and the acceleration of network construction, digital transformation implemented by the integration of 5G in vertical industries will become the key to future society. According to KPMG, the potential value of the 5G technology in the global vertical industry is estimated to be US$4.3 trillion.

The digital transformation of vertical industries differ greatly in network requirements covering network coverage, latency, bandwidth, reliability and security. The private networks currently used by vertical industries are limited and cannot meet their diversified requirements. At the same time, different industries have very different requirements for the cloud. The existing public cloud cannot meet the digital transformation requirements of industry customers. Based on this, ZTE proposes a package of cloud-network integration solutions named "precise cloud-network solution" to help telecom operators meet the huge market opportunities in the digital transformation of the industry.

The precise cloud-network uses "distributed precise cloud" and "deterministic precise network" to realize cloud on-demand and network scaling with the cloud, and provides comprehensive support with "end-to-end coordination", "simplified maintenance" and "endogenous security".

### 5G Deterministic Precise Network

5G deterministic precise network refers to

the use of 5G end-to-end networks to provide deterministic, accurate, and SLA guaranteed mobile network capabilities to meet the needs of vertically differentiated services. Before 5G, the 2G/3G/4G network was a best-effort network, and the main target services were best-effort IT applications, lacking a precise SLA guarantee mechanism, and unable to undertake the requirements of interconnection of everything. In 5G deterministic precise network, deterministic SLA guarantees are achieved by wireless, transport, and core networks, and end-to-end orchestration (Fig. 1).

**Precise Wireless Network**

The 5G wireless network guarantees precise network SLA through slice-level wireless physical resource blocks (PRBs). The wireless access network (RAN) can customize the physical private network (exclusive), hybrid private network (priority) or virtual private network (shared) for vertical industries. It integrates various advanced technologies such as multiple resource scheduling, QoS guarantee, delay&jitter control and access control to guarantee the bandwidth and service availability, meeting the different requirements of vertical industries precisely.

**Precise Transport Network**

Based on the existing SPN technical architecture, the TSN+ by adding new hierarchical TDM multiplexing small particles and hard isolation in the L1 implements the precise transport network. On this basis, the FlexE technology perfectly isolates the forwarding plane to ensure the high security of users, and the telemetry and in-band OAM technologies are introduced to provide real-time perception of network traffic and quality.

**Precise Core Network**

As the network brain for network perception, user perception, and business perception, the core network adopts a micro-service architecture, supports 2G/3G/4G/5G access, and supports 5G NSA/SA architecture, and uses software acceleration and hardware acceleration technologies to improve its performance. AI and machine learning (ML) are introduced to enhance the

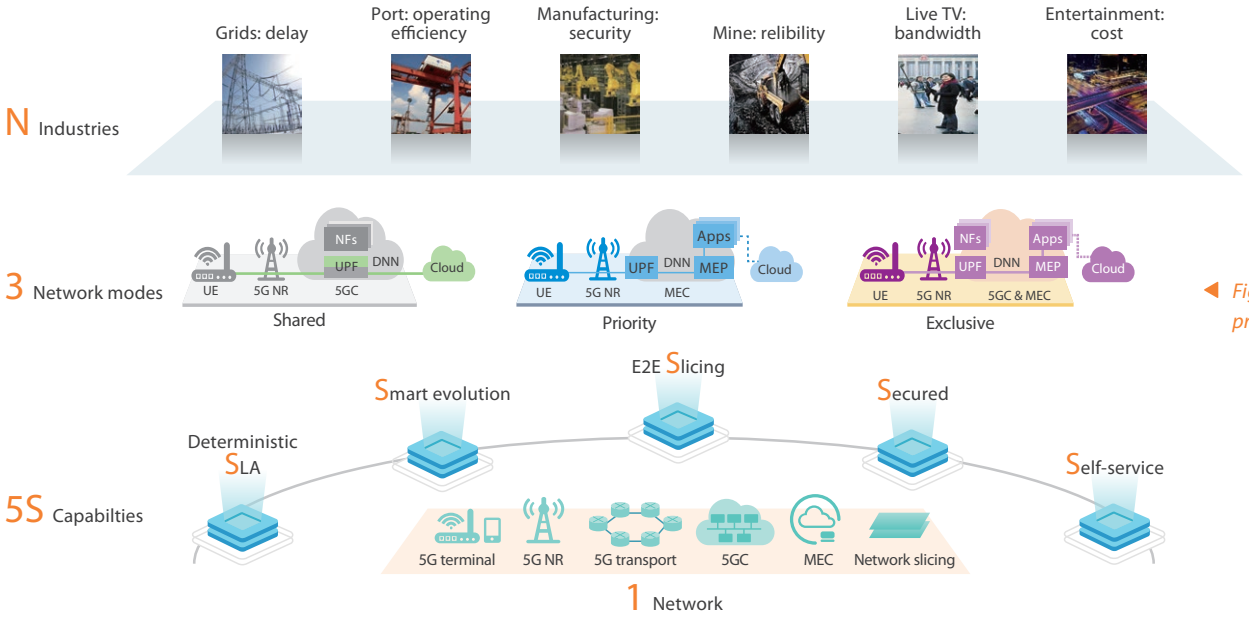


*Fig. 1. 5G deterministic precise network.*

intelligence of operation and maintenance, so as to realize a precise core network.

**Precise End-to-End Orchestration**

The end-to-end orchestrator uses the big data engine to predict KPIs such as user behaviors and traffic within the specific slices, and network resources are dynamically scaled-in/out to ensure end-to-end network KPIs. At the same time, the root cause analysis (RCA) based on the AI engine can locate and handle the network faults automatically, so as to ensure that when some nodes in the network are faulty, the active/standby switchover is automatically triggered, and KPIs are guaranteed through remote disaster recovery and alternative routing.

In a specific industry application, deterministic precise networks do not always require the highest KPIs of all scenarios, but optimal costs while meeting the right requirements for industry application. For example, industrial control slices such as power grids require extremely high reliability and low latency; live HD video broadcast slices have high bandwidth requirements but general reliability requirements; and financial slices have the highest requirements for isolation and security. Precise networks provide three networking modes of "shared", "priority" and "exclusive" for all industry application scenarios, providing deterministic service quality, independent intelligent evolution capabilities, end-to-end network slicing, all-round security assurance, and full-process self-service.

## Distributed Precise Cloud

Compared with the existing central public cloud, the distributed precise cloud has two distinct features. The first feature is distribution. By using operators' central office and sites all over the country and the 5G edge computing (MEC) capability, the precise cloud can be deployed in geographical areas near industrial customers. This achieves low latency processing and avoids the security and bandwidth usage problems caused by long-distance data transmission to central public cloud. ZTE proposes the site-level computing power engine solution named NodeEngine, which can implement site-level cloud deployment, so as to perform real-time edge cloud processing for local services in the place nearest to the enterprise campus. The NodeEngine solution ensures low-latency, reliable transmission of enterprise data without leaving the campus, avoiding the risk of leaking enterprise information, and helps the enterprise localize the digital application with the minimum cost and time.

The second feature of precise cloud is to locate industry needs precisely. The platform based on the dual virtualization technologies of virtual machines and containers is fully compatible with applications on mainstream cloud platforms. IaaS and PaaS can be customized and tailored according to different industry applications. At the IaaS level, the precise cloud can use different hardware acceleration cards (FPGA, GPU, ASIC, etc.) to achieve customized acceleration for different industry applications. Take e-game clouds for an example. GPU resource pools used for 3D rendering of e-games can be implemented in the edge cloud, so that even on ordinary mobile phones, you can experience high frame rates and extremely low delay control. At the PaaS level, the precise cloud integrates the capabilities of multiple general platforms such as AI engine, real-time database and big data engine. Based on the image recognition capabilities of the AI engine, it can be applied in general occasions such as face recognition for access control, and can also be customized into the automatic defect detection in manufacturing. Based on the ZTE GoldenDB distributed database engine, ZTE brings computing and expansion capabilities to the financial industry that traditional stand-alone databases cannot provide. ZTE GoldenDB

provides database services featuring high availability, high reliability and flexible resource scheduling, and supports financial industry in business innovation and comprehensive digital transformation.

## End-to-End Service Chain Coordination for Cloud-Network Convergence

Compared with the uncertainty brought by the traditional "best-effort network + best-effort cloud," the "5G deterministic precise network + distributed precise cloud" can guarantee end-to-end deterministic service experience. The precise cloud-network solution provides three capabilities: end-to-end service coordination, minimal maintenance, and endogenous security. End-to-end service coordination including cloud-network synergy, cloud-edge synergy, and edge-edge synergy realizes dynamic scheduling of overall resources on demand, elastic scaling, and delivers a senseless experience to customers. Minimal maintenance can be operated with one-click, so that the enterprise has full customization and management rights of their own. Endogenous security means constructing an active defense and customized security network. Through the introduction of a zero-trust architecture, the ultimate enterprise security guarantee is created in the three dimensions of network, data and users, and end-to-end security solutions are customized according to the characteristics of different industry customers.

## ZTE: To Be an Ultimate Cloud Company

ZTE aims to build itself into an ultimate cloud company. ZTE has started digital transformation of R&D a few years ago, and now it is currently using the concept of precise cloud network to upgrade and transform the entire R&D, sales, logistics, manufacturing and after-sales system. Through such components as the private cloud, public cloud, AI engine, big data engine, and orchestration center, we can build an agile customer oriented service chain to improve end-to-end working efficiency. We also use big data to provide insight into business opportunities, and accelerate online services to respond to customers in a timely manner. Nowadays, an all-in one digital application named iCenter enables mobile office, paperless office, office-free office and client-side office.

At the Nanjing Binjiang manufacturing base that was put into operation in early 2020, ZTE built a flexible 5G manufacturing line independently, which adopts the digital twin technology. A large number of robots/AGVs based on precise 5G network connection are used, which realize the fully automated manufacturing and packaging of 5G base stations. The AI-based visual inspection system on the precise edge cloud can automatically identify various product defects such as false welding, lap welding, and inadequate assembly, and truly realize the 24/7 "lights-off factory" of "manufacturing 5G with 5G".

ZTE has carried out comprehensive digital transformation exploration in many industries such as education, media, industrial manufacturing, mining, agriculture, health care, logistics and entertainment, enhancing the vertical industry's own value. Since 2019, ZTE has assisted 500 leading companies across 15 industries in 5G+ digital transformation.

The precise cloud-network is to help operators meet the huge market opportunities in digital transformation of vertical industries, give full play to the advantages of operators' networks, and build a new cloud-network integration platform. In the wave of digital economy, ZTE has positioned itself as a road builder of the digital economy, providing products and technologies for the industry, and working with industry partners to create a bright future of digital transformation. ZTE TECHNOLOGIES

# New Technologies Boost Comprehensive Development of 5G Vertical Applications

**Bai Gang**

Vice General Manager of ZTE 5G RAN Products

**Wang Jingfei**

Director of ZTE 5G ToB Business

In the current era of moving from industrial economy to digital economy, 5G has become a new driving force for integrated innovation and new information consumption, and a new engine for industrial upgrade and sustainable economic growth. In response to ever-changing needs of the industry, ZTE has built a leading 5G precision network to stimulate the power of private networks in various industries. In innovating 5G+ industry applications, ZTE precisely triggers the industry engine and provides atomic capabilities for 5G private networks. The wireless atomic capabilities of ZTE 5G precision network include large bandwidth, low latency, high reliability, slicing, precise positioning, and local offloading.

## Large Bandwidth

Large bandwidth in the uplink is required in all industry scenarios that were first put into commercial use. Typical scenarios are high-definition monitoring, remote control and machine vision, which require an uplink bandwidth of up to hundreds of Mbps or even Gbps. ZTE has proposed the 5G time-frequency dual-aggregation solution based on its mature carrier aggregation technology that uses the frame structure adopted in TDD bands and combines the uplink channel switching technology introduced by the R16 standard. The solution improves frequency utilization in both the time and frequency domains and maximizes uplink throughput. This can effectively enhance the performance of 5G network and meet the demand of large uplink bandwidth in the industry at this stage. Take the TDD network as an example. After introducing the 5G time-frequency dual-aggregation solution based on the mature commercial 2.6 GHz frequency band, its downlink throughput of a single user

can be increased by 30% to over 2 Gbps, and its uplink throughput by more than 2.3 times to 1 Gbps+.

## Low Latency

Low latency is required in control application scenarios. This requirement has been considered at the beginning of 5G design. 5G hopes that the one-way user-plane communication between user terminals and base stations can have the limit delay of 1 ms, so the mini-slot concept is introduced to 5G new radio (NR). The mini-slot supports the length of two symbols, four symbols, and seven symbols. A shorter time slot can reduce the feedback delay, so that key data can be transmitted within a shorter time. Moreover, the key data service such as URLLC can preempt the resources allocated to ordinary data service such as eMBB to ensure its low delay transmission. Remote control in industrial applications, such as port and shore bridge control, is a typical low-latency service. With the introduction of low-latency technology into a 5G network, the real low-latency remote control of shore bridges can be implemented, which greatly saves hours of commuting time for control personnel. ZTE has adopted the pre-scheduling technology in Tianjin Port to achieve a 5G NR control plane latency of less than 10 ms, and will continue to reduce the latency in the future.

## High Reliability

Controllable and guaranteed reliability is an important symbol that distinguishes 5G from other unreliable communication systems. Reliability can be achieved by

conservative scheduling at the cost of sacrificing partial spectrum efficiency. This can achieve a success rate of 99.999% for one-shot transmission, reducing re-transmission and latency. Within the allowable range of latency, 5G can also use the re-transmission mechanism to further improve the success rate of transmission. URLLC has more conservative adaptive coding modulation results and lower modulation order than eMBB. A lower modulation order can reduce the constellation points on the constellation diagram. This enhances fault tolerance of modulation and demodulation, thus improving the reliability of wireless transmission. For example, in a power-grid network where there are different performance requirements for multi-service areas and individual service areas, ZTE has proposed an innovative dynamic scheduling mechanism based on the service requirements to provide flexible and high reliability guarantee for applications.

## Precise Positioning

The precision of 5G positioning has reached and exceeded that of satellite positioning, and the positioning precision of 5G R16 has reached the meter level. Based on the RF fingerprint positioning algorithm, ZTE can provide an indoor positioning precision of less than 5 meters. Benefiting from the fact that the 5G spectrum bandwidth is above 100 MHz, the positioning precision based on the time difference of arrival (TDOA) can be improved to 1 to 3 meters. ZTE has also proposed its integrated 5G positioning solution that integrates Bluetooth AOA and UWB and provides the centimeter-level high-precision positioning capability. A traditional blue-tooth label is embedded in the external antenna of 5G NR, and its power supply and status detection are carried out through the feeder. This greatly improves monitoring and management capabilities and reduces maintenance costs. Moreover, 5G and SLAM integrated algorithms can provide a more accurate centimeter-level positioning solution. The 5G network provides bandwidth guarantee for SLAM positioning, and MEC enables edge computing capability. 5G NR can also provide coarse-granularity auxiliary positioning that reduces the probability of SLAM location loss and allows an intelligent robot to operate more stably in the indoor environment. In practical applications, different integrated positioning technologies are selected for enterprises according to the environment factors and service requirements.

## Slicing

To support differentiated services, multiple virtual networks can be sliced from 5G to guarantee SLA for different services in the same network. Through the “slice+5QI”, different user levels are marked. For different user services, different scheduling priorities can be flexibly set to guarantee different service capabilities. In order to ensure high-reliability low-latency services, a 5G NR enables the pre-scheduling mode of these services to guarantee low latency and reduces the target BLER to guarantee high reliability. ZTE is the first to develop physical resource block (PRB) hard slicing in the industry. The PRB hard slicing solution ensures the reliability of slice services by reserving PRB resources for specific slices. For example, fixed PRB resources

such as 10 MHz bandwidth can be reserved for class I slices in power production control safety areas. These resources are exclusively occupied by the slice I. Various sub-services in the slice I are then scheduled within the slice based on the 5QI priority. This ensures system security and service priority of the power control slice. ZTE has also deeply optimized the scheduling algorithm of PRB hard slices to achieve the optimization of overall resource scheduling. In addition to setting fixed PRB resource slices for ultra-high priority slices, an integrated mechanism of priority PRB scheduling and shared scheduling is also introduced.

## Local Offloading

To ensure secure information about enterprise production, ZTE has rolled out traffic offload function(TOF) solution on its self-developed NodeEngine platform that can offload local services at the place nearest to the enterprise campus and thus realize direct RAN accessing of service data. This not only ensures reliable low-latency transmission of enterprise data without leaving the campus, but also prevents leakage of information about enterprise production and communication. Existing 4G terminal and new 5G traffic in the campus can also be offloaded to the local data control center. The solution only needs to insert a computing board on the base station of the campus. It is a plug-and-play mode that can help enterprises deploy digital applications locally at the lowest cost and in the shortest time, thus speeding up the pace of campus transformation.

The wireless atomic capabilities of 5G precision network combined with ZTE's NodeEngine solution can help operators and their enterprise customers accelerate digital transformation in the campuses. This provides not only TOF for operators and their customers but also value-added services for other campus applications, so that the incubation of applications in different vertical industries can be promoted in the campus. For example, Edge QoS can optimize QoS management and control of services, while eBridge allows local terminals to interwork with each other and provides network-based indoor positioning.

ZTE has collaborated with industry partners to inject wireless atomic capabilities into 5G applications and explore the path to industrial transformation. In the industrial field, 5G helps companies such as Sany Heavy Industry and Xin Fengming improve efficiency and quality, and accelerates the transition to flexible and intelligent manufacturing. With 5G river water management and monitoring implemented in Jiangxi province of China, hills there turn green and water turns clear. In cooperation with Dongsoft, Thailand AIS, and New Dongfang, 5G enables quality medical and educational resources to be accessible at any time. The holographic new media interview with Xinhua News Agency and the 5G live TV at the the 2nd National Youth Games of China have also witnessed immersive 5G experience.

With the deterministic precision network, ZTE has achieved network-cloud synergy. It can provide enterprise customers with streamlined, deterministic, and continuous precision services by empowering atomic capabilities in 5G private networks, so as to fully support digital, network-based, and intelligent transformation of the economic society. ZTE TECHNOLOGIES

# 5G+ Smart Grid Solution: Pioneering Innovation for Intelligent Industry

**Shu Yu**

Chief Engineer of ZTE RAN Power Grid

**Cao Changjiang**

Director of ZTE RAN Power Grid Solution

Power grid is a basic energy industry and essential for people's livelihood. Power grid intelligence, known as Smart Gird, is a pillar of China's national energy strategy, and power communication network is at the core of Smart Grid.

## 5G Brings New Dawn

In recent years, China has developed rapidly in the power grid domain. Many technologies and businesses such as ultra-high voltage grid, new energy, distributed energy, charging piles, smart sensors and meters have developed vigorously. This also puts higher requirements for power grid communication and control network.

Private power grid communication network built by the power grid operator is the traditional solution, and has the major problems of high network costs and insufficient coverage. For example, the direct access rate of optical fiber at the power distribution network site is less than 20%, and the self-built wireless private networks (such as WLAN, 230 MHz and 1800 MHz wireless private networks) are only deployed in a small number of areas with limited bandwidth and coverage.

The operator's public network is an important means to carry services of the power grid communication network. In particular, a public wireless access network is widely used to compensate for the insufficient coverage of the power grid network. But the operator's wireless network designed primarily for personal communications, is a closed system, and it does not take into account the service requirements of customers in vertical industries such as the power grid. For example, the traditional public network can hardly meet the vastly different network performance requirements of diverse power grid services or afford flexible solutions to implement end-to-end service partitioning and strict isolation management. How to provide a secure, flexible, customizable, and multi-service solution for public grid network is a difficult problem.

5G brings a new dawn for the public grid network. It has three major scenarios (eMBB, uRLLC, and mMTC), and provides a network slicing architecture that allows a physical network to be sliced into multiple virtual private networks to serve different customers or services. Thus, it is possible for a public network to serve a large number of public/private customers simultaneously. Strengthening the research on 5G, accelerating the

commercial use of 5G and building innovative vertical solutions have become the focus of 5G industry. 5G smart grid has also become a leading industrial application of 5G with its large-scale industry, high technical requirements, and typical services.

## ZTE 5G+ Smart Grid Solution

As a pioneer in the 5G industry, ZTE has been making continuous efforts in bringing innovation to 5G products and solutions in recent years. Addressing the problems related to the power grid private network, ZTE has successfully launched its 5G+ smart grid solution based on 5G public network together with operators and power grid partners. Based on the normal 5G soft slice virtual network, ZTE's 5G+ smart grid solution introduces physical resource block (PRB), intelligent scheduling, intelligent adaptive modulation and coding (AMC), key link redundancy and reliability enhancement, local traffic offloading and EdgeQoS functions to ensure enhanced security, low latency and high reliability of the power grid services carried by the public network. At the same time, intelligent scheduling control and traffic offloading are used to maximize the efficiency of the 5G network system. ZTE's smart grid virtual communication network (Fig. 1) carries power services based on the operator's 5G public network, and provides key function settings for power services.

### End-to-End Slicing for Power Services of Different Partitions

Network slice is a major architecture innovation of the 5G network. By using the network virtualization technology and service-based architecture (SBA), it can implement end-to-end system orchestration and resource scheduling of the 5G network, and segment a physical network into multiple virtual end-to-end networks. The devices, access, transmission, and core networks

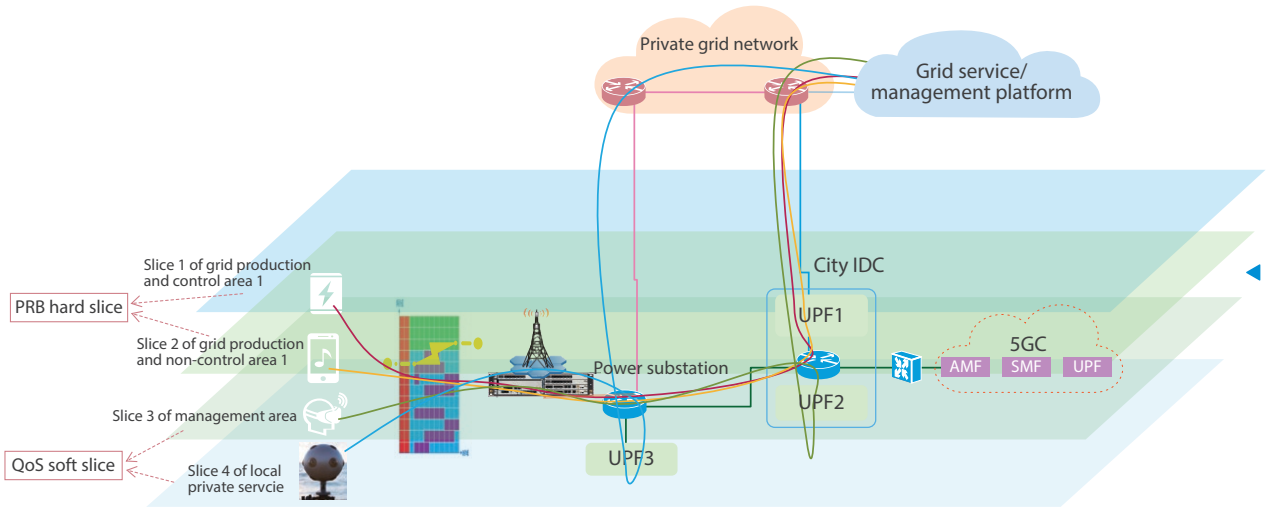


*Fig. 1. ZTE 5G+ smart grid communication network architecture.*

in each virtual network are logically independent.

The 5G network slicing allows the smart grid to customize slices for services of different partitions with dedicated sets of parameters. Different slice domains are isolated to achieve the security requirements of a power grid customer, so that one network can carry services of multiple partitions, share the overall resources, and reduce construction costs.

**PRB Hard Slicing for Power Production Services Requiring High Security**

In the 5G system, air interface resources are relatively scarce. The conventional 5G public network slices usually use soft slice management to manage and schedule the system resources. All slices and services share the whole radio block (RB) resources, and when resource conflicts occur, the RB resources are scheduled according to the 5QI priorities of slices and services.

Soft slicing at the air interface can meet the basic requirements of most conventional power grid information management domain services, but power production and control services need more strict network performance. For example, the power grid real-time monitoring and control services need absolute resource availability and superior priority guarantee to ensure a latency of 10 ms and a reliability of higher than 99.99%.

How to further modify the 5G resource scheduling mechanism for critical power grid services based on the conventional 5G network slices is a practical requirement. ZTE innovatively proposes the PRB hard slicing solution, which guarantees the reliability of the slicing service by reserving certain PRB resources for a specific slice. PRB resource reservation used for power production services ensures that these services have the highest resource priority and strict isolation. For other non-production services, the common soft slice-based PRB sharing mode can be used so that all network slices can share the resources to maximize system resource utilization.

**Intelligent Scheduling Algorithm for Optimal Multi-service QoS**

The power grid system is a multi-service system, and each service has different requirements for transmission bandwidth, latency, jitter and reliability. It is necessary to further optimize the system QoS to ensure the network can transport multiple grid services well at the same time.

For this, ZTE has introduced precise network control technologies. Based on the conventional 5QI service scheduling, the network introduces a hierarchical service scheduling mechanism based on service QoS requirements, and uses intelligent AI algorithms to achieve dynamic parameter optimization for different services and wireless environments. For example, for electrical differential protection with extremely high requirements (20 ms latency and 99.999% reliability), it provides a special policy of air interface scheduling on the physical layer and

MAC layer. For services with 50 ms latency @100 Mbps in the production area and shared management area, the network E2E latency control and service priority-based scheduling are strengthened. For services purely requiring 99.999% high reliability, it uses duplicated PDCP sessions, lower modulation and coding scheme (MCS) value, and pre-scheduling technologies to strengthen the system concurrent scheduling ability.

Through the above-mentioned dynamic scheduling solution, services with significantly different technical features coexist in the same network or even in the same slice environment, solving the problems of public network in transporting power services.

**ZTE NodeEngine Enabling Flexible Deployment of Customized Local Services**

To meet the requirements of building some potential independent core network elements and handling some local services for a grid operator, ZTE provides a customized core network system and its innovative NodeEngine solution. By embedding computer and storage resources in gNodeB, the NodeEngine makes gNodeB an edge computer node that facilitates local traffic offloading in power grid network and shortens the service delivery path from 5G public network to the grid private network. At the same time, the NodeEngine provides powerful support for value-added local service processing and developing the grid's self-owned edge cloud services.

## ZTE 5G+ Smart Power Grid Practice

In order to promote the implementation and verification of the 5G+ smart power grid solution, ZTE, China Mobile and China Southern Power Grid jointly built the industry's largest integrated test filed for the 5G smart grid in the Nansha region of Guangzhou. The test network has a scale of more than 100 base stations. All the typical power grid services will be tested and commercially deployed on a large scale.

The test network has already been constructed, and the virtual power grid slices have been successfully deployed on China Mobile's real commercial 5G public network. The test team has finished the basic 5G+ smart power grid network function and performance test, and is carrying out a large-scale commercial deployment of real power grid services that run concurrently. 44 categories of key power grid services have been successfully deployed, including microsecond-level high-precision timing, millisecond-level differential protection, synchronous phasor measurement unit (PMU), 5G+ power distribution automation, and 5G+ amphibious robot inspection. According to the project plan, tests on all 54 categories of power grid services will be completed in 2021, and a complete 5G smart grid application solution and a clear slice business model will be formed based on the trial, providing a successful reference for the subsequent large-scale commercial application of 5G in the power grid industry. ZTE TECHNOLOGIES

# ZTE Precise RAN Solution Creating Value for Vertical Industry

**Wang Xiaoming**

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At present, a new round of technological revolution and industrial transformation are emerging around the world. New-generation digital technologies represented by 5G, big data, cloud computing, and AI are changing rapidly, and the digital and intelligent transformation of traditional industries is an inevitable trend. As the core engine of new infrastructure construction, 5G has huge potential in supporting this transformation of social economy.

Vertical industries vary widely, and so are their requirements for communication networks. There exist huge differences between ToB and the traditional ToC fields in terms of latency, reliability, rate and self-service capability. The general ToC network basically adopts the best-effort service strategy for end users, and more attention is paid to network-level KPIs. In vertical industry applications, each terminal has rigid requirements for latency, reliability and bandwidth, and requires user-level performance guarantee. The performance guarantee results of each business should also be presented to the end users. To cope with the challenges from vertical industries, ZTE has proposed its Precise RAN solution. Its core idea is to properly apply the radio network functions, allocate radio resources reasonably, and to match service requirements accurately. While ensuring high service quality, it also maintains a high efficiency of radio resource utilization. In this way, ZTE Precise RAN solution enables 5G private network to have the necessary commercial competitiveness.

ZTE Precise RAN solution includes precise planning, precise slicing, precise identification, precise scheduling, precise measurement, and precise O&M, as illustrate in Fig. 1.

## Precise Planning

The first step in private network construction is to determine the network architecture. The isolation, deployment costs, deployment time, and O&M modes should be fully considered in the selection of the architecture. According to resource sharing scheme, industry private networks can be divided into three modes: wide-area virtual private network, regional virtual private network, and physical private network. Generally, the wide-area virtual private network is applicable to wide area service scenarios, such as smart grid, smart city, smart

scenic spots, new media, and internet of vehicles (IoV). The regional private network is applicable to local parks, such as industrial manufacturing, transportation, logistics, port terminals, high-end scenic spots, and urban security. The physical private network is applicable to closed local areas, such as mines, oil fields, nuclear power stations, and high-precision manufacturing parks.

As to the wireless network planning, vertical industry differs from traditional ToC scenarios in three aspects:

- **Performance from area to spots:** The traditional eMBB network planning focuses on overall network performance, while the industry-specific precision planning focuses on the performance of a single terminal at a specified location.
- **Requirements model from one dimension to three dimensions:** The traditional eMBB network planning is based on the assumed service bandwidth, while the industry-specific precision planning is based on the definite three-dimensional service requirements including bandwidth, latency and reliability.
- **Scenario from assumption to clarification:** Radio coverage of traditional ToC network is classified by statistics of building height and density, while the radio environment of the industry application is clear and complex, and feature analysis is based on specific scenarios.

## Precise Slicing

Network slicing logically divides operator networks, isolates resources from services, and thus virtualizes a physical network into multiple logical sliced networks. Different levels of service data can be transmitted on different network slices to meet differentiated requirements for data rates, security, and reliability. The slices can be precisely matched with services through the accurate estimation, allocation and management of

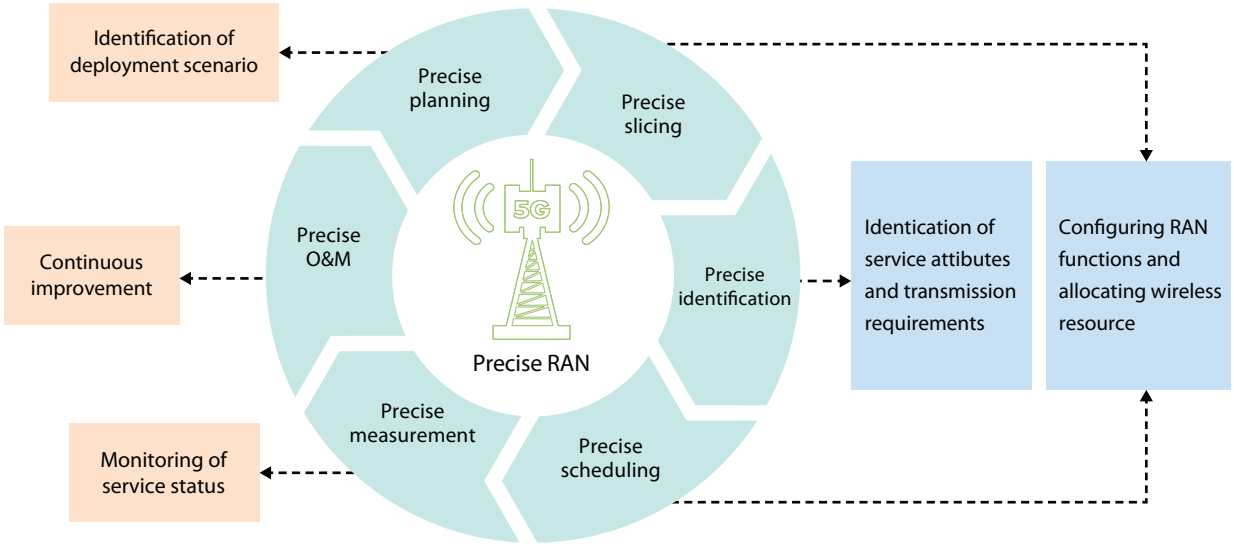



*Fig. 1. Six capability modules of ZTE Precise RAN solution.*

slicing resources based on the number of users, DRB and PRB.

## Precise Identification

In industrial application scenarios, there are many different service types with different requirements. Based on ZTE's innovative NodeEngine solution, 5G RAN can identify each service flow and accurately understand service attributes, and thus match applicable wireless resource scheduling functions and set appropriate parameters to meet expected results.

## Precise Scheduling

Due to security and efficiency of production operations, some service in industrial application are highly sensitive to latency and reliability of data transmission. Therefore, wireless network needs to enhance its scheduling capability after precise identification, such as with dynamic conservative scheduling, with pre-scheduling enhancement, with latency-based scheduling, and flexible orchestration based on wireless environment and execution results, to guarantee low latency and high reliability in data transmission.

## Precise Measurement

Industry customers pay more attention to service experience. Precise measurement refines the granularity of performance statistics to each service flow, provide a more elaborate presentation of bandwidth and latency, and implements a closed loop control from service identification, scheduling to measurement, so that industry customers can better monitor service status.

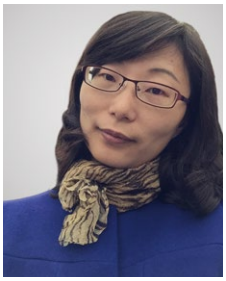
## Precise O&M

Precision O&M is enhanced to meet various ToB requirements. With the introduction of self-service portal, precise O&M provides a visual, configurable, manageable network presentation to both operators and industrial customers, greatly improving the efficiency of ToB network O&M.

With the joint efforts of partners, ZTE Precise RAN solution has been applied in many fields such as power, factories, ports, mining, and rail transit. In the power industry, ZTE has collaborated with the Southern Power Grid and China Mobile to set up the world's largest and most comprehensive 5G+ smart grid application demonstration zone in the Nansha region of Guangzhou. In the intelligent industry, ZTE and China Telecom have collaborated to build a 5G virtual private network in the Binjiang 5G manufacturing base of ZTE Nanjing, to practice the concept of "Manufacturing 5G by 5G." In the port industry, ZTE has worked with China Unicom and Tianjin Port to achieve unmanned trucks and remote shore bridge control. More application cases will be explored in the future.

The development of 5G has entered a key stage of integration and innovation, and the trend of multi-party collaboration among telecom infrastructure providers, equipment manufacturer, and vertical industries is taking shape. As the road builder of digital economy, ZTE will continue to work hard to create value for vertical industries with its 5G Precise RAN solution. ZTE TECHNOLOGIES

# NodeEngine: Building the Simplest Precise 5G Private Network for Vertical Industry



**Yan Liping**

RAN Product Solution Manager, ZTE

In the era of industrial 4.0, data is a new element of production that interacts with traditional manufacturing, business process and organizational structure. The massive data collected by sensors is transmitted through a 5G network, converged in the private cloud of enterprises, and then fed back to the physical world through data mining analysis and AI service, helping enterprises greatly improve efficiency, reduce product costs, increase the efficiency of resource allocation, and achieve digital transformation. As the nerve center that supports enterprise digitalization, the 5G network completes data upload and download and associates the industry brain like AI and big data with perception and execution organs like industrial sensors. It plays a key role in building a private campus network for digital transformation.

## NodeEngine Provides Simplest 5G Private Network Solution

At present, enterprise businesses are divided into two categories: production in the campus and data interaction outside the campus. Among them, the security and privacy of production data is crucial to the competitiveness of enterprises. Ensuring core production data does not leave the enterprise campus has therefore become the most basic requirement of 5G network in enterprise digitalization.

One purpose of enterprise digital transformation is to uniformly access a variety of fragmented and relatively independent terminals, enable cross-layer protocol interconnection, and optimize production resource allocation to achieve better market competitiveness. Therefore, enterprises focus on maximizing the reuse of existing equipment, reducing construction costs of their private campus networks, shortening the deployment period, and lowering O&M costs.

5G private network solutions fall into two kinds: one is based on dedicated frequency bands, and the other is to share radio network resource with the public network. The main features of the second kind are analyzed below, as shown in Table 1.

Based on the above analysis, deploying the computing power down to the sites with local traffic offloading can help enterprises maximize their network resource utilization and save O&M costs. ZTE has launched NodeEngine—the industry's first gNB-centered solution for private campus networks (Fig. 1). Only by inserting

one computing board into the gNB in the campus can NodeEngine build a 5G private network with local traffic offloading function within one hour.

The NodeEngine solution has the following advantages:

- **Shortest and most reliable local transmission path over a 5G network:** Once the data generated from a terminal is uploaded to the gNB through 5G new radio, it will be forwarded directly to the private server through NodeEngine. This can effectively reduce the latency and protect data from attack with the least number of forwarding nodes. The average end-to-end transmission latency is no more than 10 ms.
- **Simplest deployment and convenient O&M:** The NodeEngine solution can be co-deployed with existing 5G sites. No engineering survey or interoperability with core network elements are needed. NodeEngine can be operated and managed uniformly with 5G gNB, helping operators quickly build a private network for enterprise customers.
- **Optimal hardware costs:** When there are multiple sites in the campus, only by inserting one computing board into one site can the NodeEngine solution serve all sites. The simplest private network is thus built at controllable costs.

The NodeEngine solution also provides flexible offloading strategies, including IP 5-tuple/DNS, specific PLMN-ID and slice ID, to meet the needs of enterprises in different scenarios such as traditional campuses, large campuses or specific services in the public network.

## NodeEngine Builds Precise 5G Private Campus Network

With the development and large-scale deployment of 5G and the maturity of 5G industry chain, vertical applications of 5G private campus network are gradually extending from early mobile office and surveillance video transmission to latency-sensitive applications such as motion control and robot/AGV collaborative control. These applications require different bandwidth, latency and reliability. For example, industrial control applications require an E2E transmission latency of less than 10 ms, while remote control applications expect t hat videos on site can be uploaded in 150 ms with a bandwidth of 4M (1080p). There are also a large number of real-time communications between terminals, which requires production network to operate continuously and stably. In addition to local

*Table 1. 5G private network solution based on the public network.*

| Items | gNB-based local offloading | Based on edge UPF | Based on mini 5GC | Based on network slices |
|---|---|---|---|---|
| Data transmitted in campus | √ | √ | √ | √ |
| Network elements related | RAN | RAN & UPF | RAN & 5GC elements | Slicing network |
| Deployment period | Hours | Weeks | Weeks | Weeks |
| O&M costs | Low | Medium | High | Medium |
| Transmission latency | Lowest | Lower | Lower | Lower |

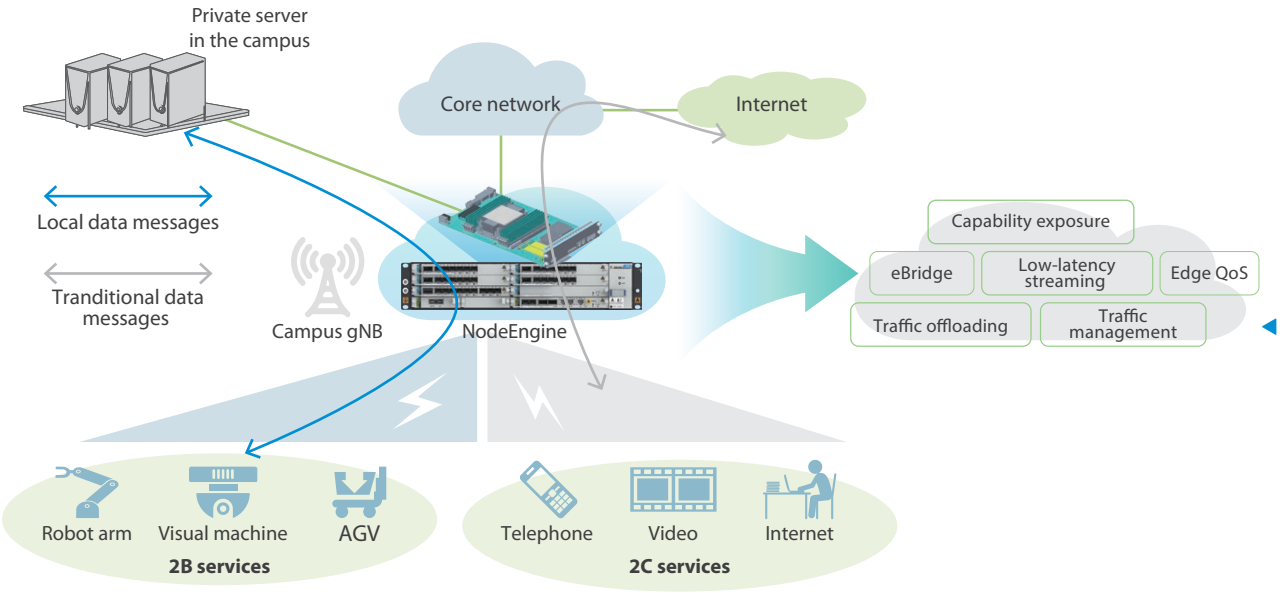



*Fig. 1. ZTE's NodeEngine solution.*

- Built-in BBU board, plug and play, no change to existing network, rapid deployment of private campus network
- Simple and fast deployment of private campus network within one hour

transmission of application data, ZTE's NodeEngine solution also provides more attractive services to serve private campus applications with the best performance.

- **eBridge service:** NodeEngine acts as a bridge between terminals and the campus network, and supports their interoperability in the campus without changing the original configuration and working mechanism of terminals. It is a perfect replacement of the wired or Wi-Fi intranet.
- **Low-latency steaming service:** NodeEngine shortens the end-to-end video upload latency by 80%. When combined with ZTE's self-developed video gateway that uses highly efficient video coding/decoding and distribution technology and acts as CPE on the terminal side, NodeEngine reduces the latency to 100 ms and thus accelerates mobile video applications.
- **Edge QoS service:** NodeEngine provides SLA guarantee for different campus applications. It detects the characteristics of applications in the private campus network, calculates and analyzes them through AI learning. Then it gives a reasonable resource allocation policy to meet performance requirements of the applications in terms of bandwidth, latency and reliability.
- **Self-service portal:** NodeEngine allows enterprises to manage their private networks on their own. Based on unified network operation and maintenance, operators provide self-service portals for enterprises in domain-authorized management mode. Enterprises can realize self-access, self-maintenance, self-alarm and self-traffic-management of their private campus networks.

ZTE has been committed to building an intelligent on-demand private network for operators and their enterprise customers. Through local traffic offloading and diverse value-added services provided by its NodeEngine solution, ZTE can accelerate the incubation of 5G applications in the campus and thus promote digital campus transformation. ZTE TECHNOLOGIES

# Technologies for Ultra-Reliable Low-Latency Communication

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**Li Changxiao**

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With a decline in wireless network users and traffic dividends, operators cannot simply improve the service experience of existing users when making network evolution plans. The demands for using wireless networks in industrial applications for improved productivity and service capability are also increasing. The 5G network can meet different network service requirements in eMBB, mMTC and URLLC scenarios.

URLLC is ideal for applications with stringent latency and reliability requirements. Typical services can be found in vertical domains such as factory, electric power and transportation. Even in a single vertical industry, different applications have different network requirements. Therefore, when upgrading a network for URLLC, operators need to comprehensively use key technologies such as NodeEngine and network slicing to develop diversified network deployment solutions for different industries and applications.

The latency and reliability indicators for URLLC defined by ITU are as follows:

- **Latency:** The minimum requirement for one-way user plane latency is 1 ms.
- **Reliability:** In the urban macro station scenario, the success probability of transmitting a layer 2 PDU packet of 32 bytes within 1 ms in channel quality of coverage edge is 99.999%.

## Low Latency Technology

To reduce the radio interface latency between mobile phones and base stations, key technologies such as a flexible frame structure, mini-slots, and channel multiplexing, can be introduced.

- **Flexible frame structure:** 5G new radio (NR) supports LTE subcarrier spacing of 15 kHz and subcarrier spacing of 30 kHz, 60 kHz, 120 kHz and 240 kHz. The wider the subcarrier spacing, the lower the latency. Meanwhile, 5G NR supports frame structure adjustments. Compared with LTE where there are fixed two slots per subframe, NR allows for 1, 2 or 4 slots per subframe and flexible uplink-downlink ratio configurations, thus greatly

reducing the latency.

- **Smaller scheduling period—mini-slot:** A timeslot is the minimum scheduling unit. A slot in LTE consists of 14 symbols whereas a mini-slot in 5G NR can contain 2, 4 or 7 symbols (Fig. 1). A shorter slot can reduce the feedback delay.
- **Multiplexing of URLLC and eMBB:** The data in the low latency scenario is characterized by strong burst but small data volume. Therefore, NR introduces a preemption-based mechanism where the BTS assigns physical resources of eMBB to URLLC service and informs the eMBB UE of the preemption result to ensure low latency for the URLLC service.
- **Grant-free configuration:** The gNodeB configures a UE to have pre-allocated periodic resources. The UE requests the resources on PUSCH from the BS in advance and is configured by the corresponding parameters. When there are uplink resources, the UE directly uses these resources for transmission without sending a scheduling request and waiting for the feedback from the BS, thus meeting the low latency requirement of URLLC.
- **Enhanced HARQ feedback:** In R15, a UE transmits only one PUCCH carrying HARQ-ACK information in a slot. When the UE needs to transmit HARQ-ACK information again on the PUCCH in the same slot to reduce the latency, it is not allowed. In R16, multiple PUCCHs within a slot are enabled for HARQ-ACK transmission. To support this design, a R16 UE is required to support at least two HARQ-ACK codebooks.
- **Edge computing:** The 5G network allows the UPF to be placed closer to the user side and to be co-located with the edge computing server. When the UPF identifies that the destination address of a service flow is local, it offloads services to the local edge computing server for processing, reducing the redundant transmission paths for services and the latency.
- **Integration of time-sensitive networking (TSN) with 5G:** Time-sensitive transmission is implemented to ensure clock synchronization. High-precision reference time is transmitted via the PBCH or sent through the RRC layer to ensure accurate synchronization between the master clock and the terminal clock and implement time-sensitive transmission. Because TSN is an Ethernet-based technology, Ethernet frames need to be encapsulated with headers, which reduces transmission efficiency. Therefore, Ethernet frame headers need to be compressed to improve data transmission efficiency and reduce latency.

## Ultra-Reliable Technology

Ultra-reliable radio technology involves:

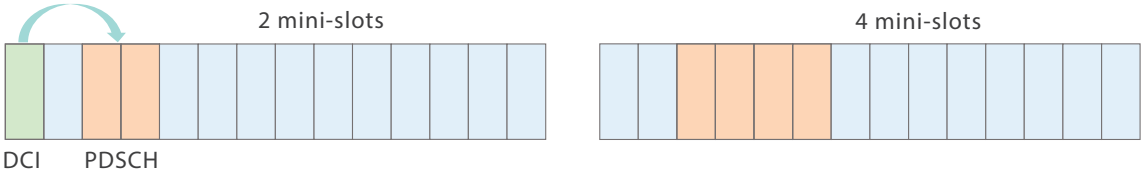



*Fig. 1. The diagram of mini-slots.*

- **Optimizing the MCS/CQI table:** The MCS/CQI in LTE cannot meet the system reliability and transmission rate requirements of NR. Therefore, two lower bit rates are added to CQI table values for NR. Correspondingly, two MCS low-frequency options are added to the base station, and a lower bit rate can be selected between the UE and the base station to ensure reliability.
- **Retransmission of data packets:** The HARQ retransmission mechanism at MAC and RLC layers in LTE achieves reliability at the cost of delay. The NR system duplicates data at the PDCP layer and transmit the same data via different PDCP channels to improve reliability.
- **PDCCH with a high aggregation level:** CCE is the basic unit of PDCCH. An LTE PDCCH contains a maximum of eight CCEs, and a NR PDCCH contains a maximum of 16 CCEs. More resources can reduce the transmission coding rate to improve the reliability.
- **Redundant transmission scheme:** Redundant PDU sessions based on UE are transmitted via two redundant N3 tunnels. First, the NG-RAN duplicates the uplink data packets, and sends them to the UPF through two redundant links (N3 interface). Each N3 tunnel corresponds to a PDU session, and two independent N3 tunnels are established to transmit data. The BTS, SMF and UPF will

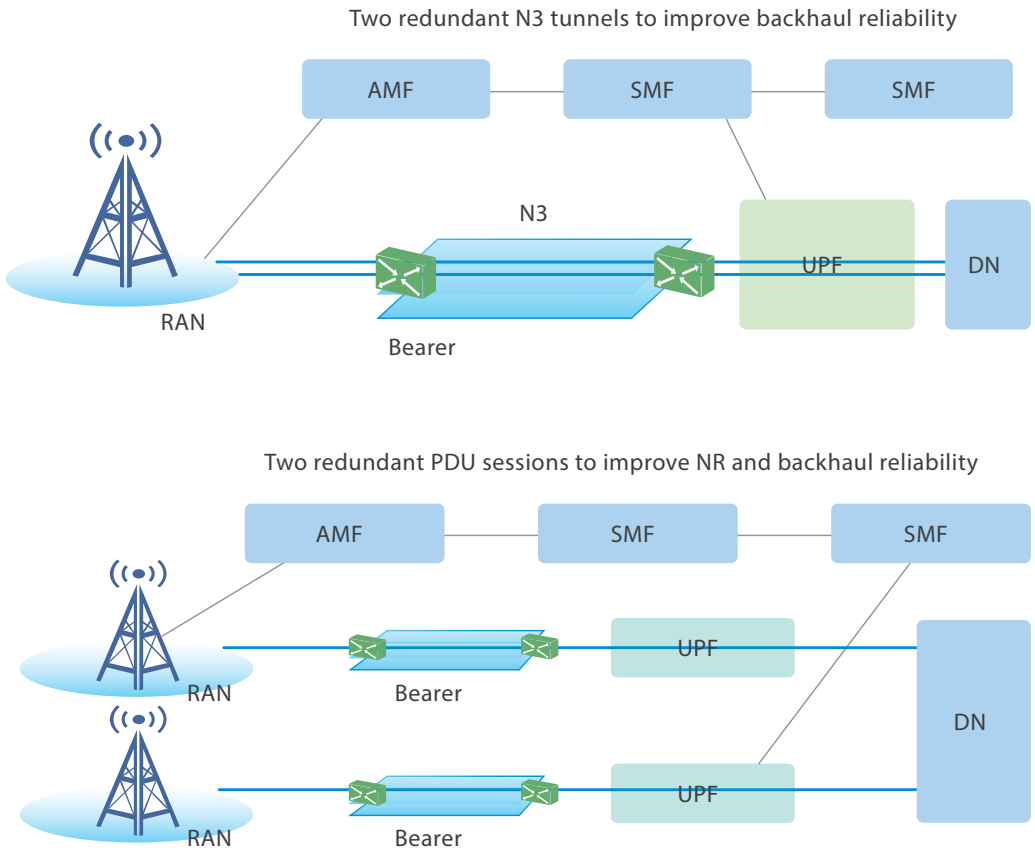



*Fig. 2. Redundant transmission scheme.*

provide different routes for the two links (Fig. 2).

- **Retransmission at the mini-slot layer:** R15 uses a retransmission mechanism based on timeslot scheduling. R16 further supports mini-slot level retransmission with the maximum number of retransmission reaching 16.

## URLLC Deployment Solution

The URLLC service can be deployed in FDD, TDD and millimeter wave bands. 5G network positioning and URLLC deployment in different frequency bands are discussed below.

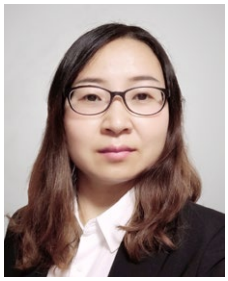
A 5G FDD network can upgrade the key URLLC technologies in an all-round manner to make breakthroughs in industry applications. 5G FDD networks have natural advantages in networking. For example, the 2.1 GHz FDD band, a band refarmed for 5G, is mainly used to improve the coverage of the whole 5G network and supplement the network capacity. The natural advantages of the FDD mode will be more favorable for carrying services requiring ultra-low latency and ultra-high reliability. Therefore, this band can accommodate URLLC applications with extreme performance indicators, and will be the main band for an overall upgrade of the URLLC features in certain areas.

For a 5G TDD network, the technical features of URLLC can be selectively upgraded to enhance 5G network reliability and optimize network service latency. TDD bands at 2.6 GHz and 3.5 GHz are used in the initial phase of 5G deployment. They are the main bands for continuous coverage in urban areas and target ordinary consumers and some industrial users. Limited by a fixed frame structure, a TDD network has greater difficulty in improving the latency than an FDD network, and allows for more downlink capacity. Therefore, URLLC technology upgrades at the wireless side will be aimed at improving the brand competitiveness and the service experience of an operator's 5G network, and will be based on the service requirements in a coverage area.

Millimeter-wave (mmWave) bands are a new band resource for future development. Although the mmWave bands adopt TDD, they support wider subcarrier spacing, and a mmWave network with coverage discontinuity supports a flexible frame structure. Therefore, the mmWave network can better meet low latency requirements in URLLC than the current 5G TDD system.

5G will break through the limitation of the existing mobile communications industry, and enables in-depth integration of wireless communications and vertical industries. Operators need to dig deeper into industry requirements, tap into their advantages in network construction and O&M management, provide end-to-end solutions that truly match the requirements of industry users, and create new value for 5G networks. At the same time, the cooperation between upstream and downstream partners in the industry are required in exploring new URLLC services. ZTE TECHNOLOGIES

# Hybrid 5G Indoor Positioning Enables Internet of Everything



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5G network uses its high bandwidth, low latency, high reliability, and wide connection features to provide basic network support for vertical industry applications, promote intelligent upgrade in various industries, and move towards the internet of everything (IoE). With more and more man-to-man, man-to-thing, and thing-to-thing interactions, the demand for location information has become increasingly prominent. Traditional GPS positioning signals cannot cover the indoor areas where most vertical industry applications occur, so indoor positioning technologies are needed to make up for indoor coverage.

## Challenges

The available indoor positioning technologies include Bluetooth, ultra wide band (UWB), simultaneous localization and mapping (SLAM) and RFID, but have not yet formed a unified positioning solution. There are many challenges in the deployment and maintenance of indoor location services. First, the deployment and maintenance costs are relatively high. The indoor structure of a large building is complex, and the cost of deploying a positioning network alone is high. Moreover, in indoor scenarios, changes may occur, such as floor decoration, equipment repair, and store replacement, which affect the accuracy of location services and increase maintenance costs. Second, indoor deployment is difficult and there are high requirements for security. Indoor deployment involves many management departments, which are difficult to coordinate and need to meet the owner management and physical security requirements. Because the location information is related to enterprise production, it is necessary to ensure its security. Third, positioning technologies are independent of each other and have their own advantages and disadvantages. They fail to play a synergistic role in improving efficiency. Finally, positioning standards related to network construction, performance test, vector drawing, and environmental feature library have not yet been uniformly recognized by the industry. These factors restrict the development of indoor positioning applications.

## Architecture

The hybrid 5G indoor positioning solution integrates Bluetooth, UWB and SLAM with the 5G network to provide location services that meet different positioning precision needs in different

scenarios. This greatly reduces the deployment and maintenance costs and gives full play to various technical advantages, which can coordinate with each other to provide flexible positioning capabilities. The solution architecture includes the terminal layer, network layer, platform layer, and service layer (Fig. 1). The requirements of terminal power consumption, volume and universality are considered at the terminal layer. At present, mobile phones are configured with basic positioning chips such as cellular networks and Bluetooth by default, and UWB is also developing towards standard configuration on terminals, so the integration of terminal communication and positioning has a certain foundation. At the network layer, pan-wireless positioning technologies overlaid on the 5G infrastructure integrate 5G and the location network in physical deployment, while the location computation service deployed on the enterprise edge cloud integrates the positioning services. Map and location services are provided at the platform and the services are shared and opened, which speeds up the convergence of location algorithms, reduces overheads, and provides basic services for applications. The service layer is oriented to industry location applications. The location services and map services provided by the platform layer can meet diverse needs of industry applications.

## Solutions

The hybrid 5G indoor positioning solution leverages the 5G network and multiple positioning technologies to meet the needs of various scenarios. In actual application, the appropriate hybrid positioning technology can be selected according to the local condition and the environmental factors and service needs of the enterprise.

- **5G NR positioning solution:** 5G NR meets both the positioning and communication requirements, supports multiple positioning algorithms such as UTDOA and ECID, and provides the meter-level positioning capability. With

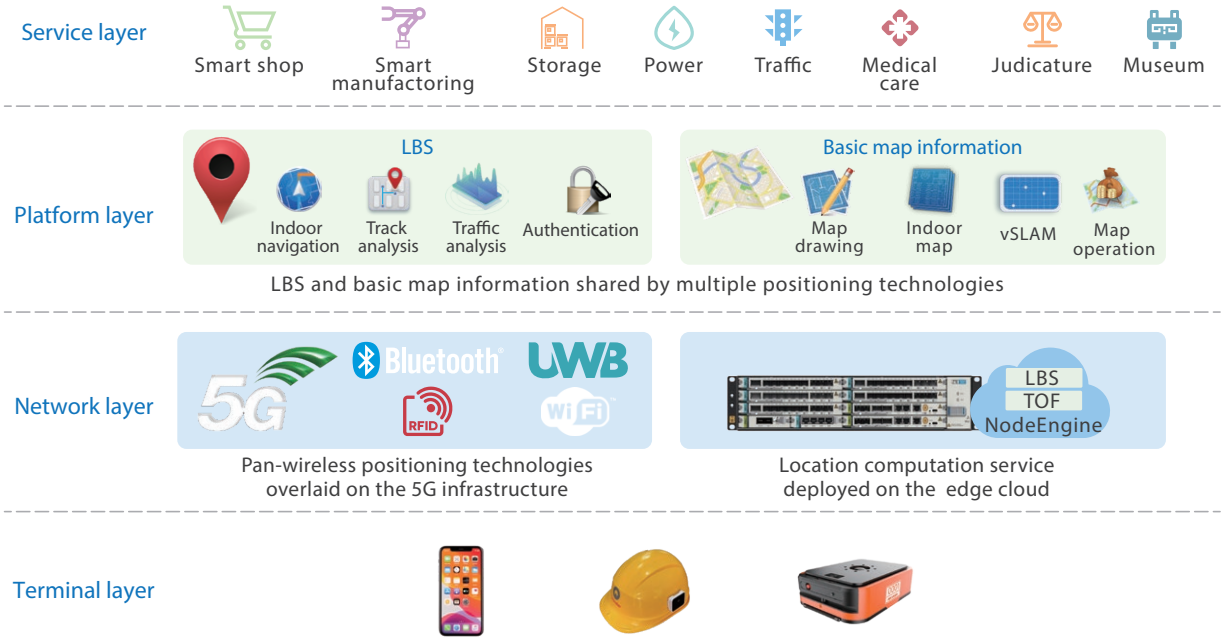


*Fig. 1. Architecture of the hybrid 5G indoor positioning solution.*

the evolution and development of 3GPP protocols, the accuracy of 5G NR positioning will be further improved.

- **5G+Bluetooth AOA/UWB hybrid high-precision positioning solution:** Both the positioning and communication base stations are deployed simultaneously. The location computation service is deployed on the edge cloud node for unified maintenance and deployment, providing the centimeter-level high-precision positioning capability.
- **5G+Bluetooth label hybrid positioning solution:** The Bluetooth label is embedded in the 5G NR to provide monitoring and management capability for Bluetooth devices and reduce later maintenance costs. The positioning precision depends on the density of labels deployed, which can generally reach 3 to 5 meters.
- **5G+SLAM hybrid positioning solution:** SLAM provides the centimeter-level high-precision positioning capability. Combined with the edge MEC, the 5G network provides wireless network guarantee and edge computing power for the SLAM positioning. The 5G network also provides coarse-granularity auxiliary positioning for SLAM, which reduces the probability of location loss and makes the intelligent robot based on the SLAM positioning run more stably in the indoor environment.

## Applications

Location-based service applications have been in the initial development. For example, the automobile assembly industry and the power and energy industry use positioning to meet their production needs; airports and shopping mall applications use positioning to meet customer navigation, entertainment and intelligent management needs. With the development of intelligent interconnection of things, the collaboration between people and people, people and things, things and things is getting closer, and location-based service will serve as a basic capability to support more application innovations.

ZTE has cooperated with industry-leading partners in positioning technologies, maps, and applications to explore the positioning needs in different industries and promote the implementation of location-based services. In the vehicle manufacturing field, a positioning system can be deployed in the factory assembly workshop to provide full traceability of each vehicle in the workshop as well as high transparency and visualization of the operation process. While standardizing the operation process, the positioning system can significantly improve the operation efficiency, realize real-time positioning of assembly vehicles and automatic data push, and relieve the pressure on production capacity. After the introduction of a 5G network, the hybrid positioning solution can not only meet the positioning needs, but also provide a 5G network with large bandwidth, low latency, and wide connections, creating a more promising application prospect.

With the development of AI and wireless technologies, the whole society has entered the era of internet of everything (IoE). Based on the 5G network, the indoor positioning solution combined with leading technologies such as edge computing and big data will enable the digital and intelligent development of various industries, give rise to emerging indoor services, and empower thousands of industries. ZTE TECHNOLOGIES

# 5G ATG Ushers in a New Era of 5G Air High-Speed Internet

**Han Ying**

5G RAN Industry Marketing Director, ZTE

## Demand Analysis in ATG Scenarios

Today is an era of high-speed information development, where mobile network technology has developed from traditional 2G/3G to high-speed 4G/5G internet. Mobile applications are extremely rich, and users are more dependent on mobile networks and terminal devices. However, network coverage in aviation scenarios is still in a stage of relatively slow development, which does not match the urgent needs of ground-to-air internet applications. At a standing meeting of the State Council chaired by Chinese Premier Li Keqiang in April 2018, the promotion of on-board internet access services was officially included in the work of increasing speeds and reducing fees. In the same year, the Civil Aviation Administration and the China Airlines Association issued implementation suggestions on internet access, clearly promoting air access to internet services and basically achieving full coverage of internet access for trunk airline passengers by 2022. The development of air internet market urgently needs a network access solution with low cost, large bandwidth and high performance.

Using mature ground mobile communication technologies such as 4G and 5G, the air to ground (ATG) system can develop high-speed movement and wide coverage features customized for aviation. Special base stations that can cover the sky are established on the ground. With these base stations, a dedicated ATG network with three-dimensional coverage can be built to effectively solve the problem of three-dimensional coverage at high altitude and realize high-speed data transmission between the ground and the air. Following the development of mobile communication technologies, the terrestrial base station solution enables high-bandwidth, high-traffic, and low-cost network that has great advantages in network deployment, upgrade and maintenance. The ATG service can provide airline passengers with on-board entertainment, on-board office and customized services. It has a wide range of industry application prospects, such as aviation medical rescue, flight operation, air weather, flight safety requirements, intelligent and digital aviation administration, and remote terrestrial industry control.

## ATG Solution

The ATG system has an architecture similar to that of the terrestrial base station network. Terrestrial base station signals are introduced into the aircraft cabin through airborne antennas. After being received by

a customer premise equipment (CPE), the signals inside the aircraft cabin are converted into WiFi signals to provide data services for aircraft cabin users. The ATG system architecture is shown in Fig. 1.

Due to the particularity of the ATG scenario, such as aircraft flight altitude, high flight speed and cabin safety requirements, professional technologies are needed to guarantee user experience in the air. Key technologies of the ATG system include ultra-high-speed Doppler frequency shift compensation, super-large cell coverage radius, differential QoS guarantee, and customized high-performance antenna.

**Ultra-High Speed Doppler Frequency Shift Compensation**

The flight speed of an aircraft is usually 800 km/h and the highest speed is 1200 km/h. Ultra-high-speed flight may cause serious Doppler frequency shift and affect system performance. ZTE adopts its unique ultra-high-speed frequency offset compensation technology to reduce the impact of frequency offset on access performance. The airborne CPE pre-compensates at the uplink side for the frequency offset value estimated by the downlink channel. For gNB receiving signals, the clock frequency offset between CPE and gNB is twice as large as that between gNBs. The airborne CPE estimates and pre-compensates for the frequency offset, so that gNB receives uplink data without frequency offset. gNB also uses a similar frequency offset estimation method for frequency compensation. The use of ultra-high-speed frequency offset compensation technology can greatly reduce the impact on access performance and ensure the system performance of the air network.

**Super-Large Cell Coverage Radius**

Due to the high flight speed of the aircraft, using an ordinary cell coverage radius will cause frequent handover and thus affect the performance and user experience of the ATG system. Therefore, the ATG system requires a super-large cell radius. In addition to avoiding handover, there are also requirements for airline

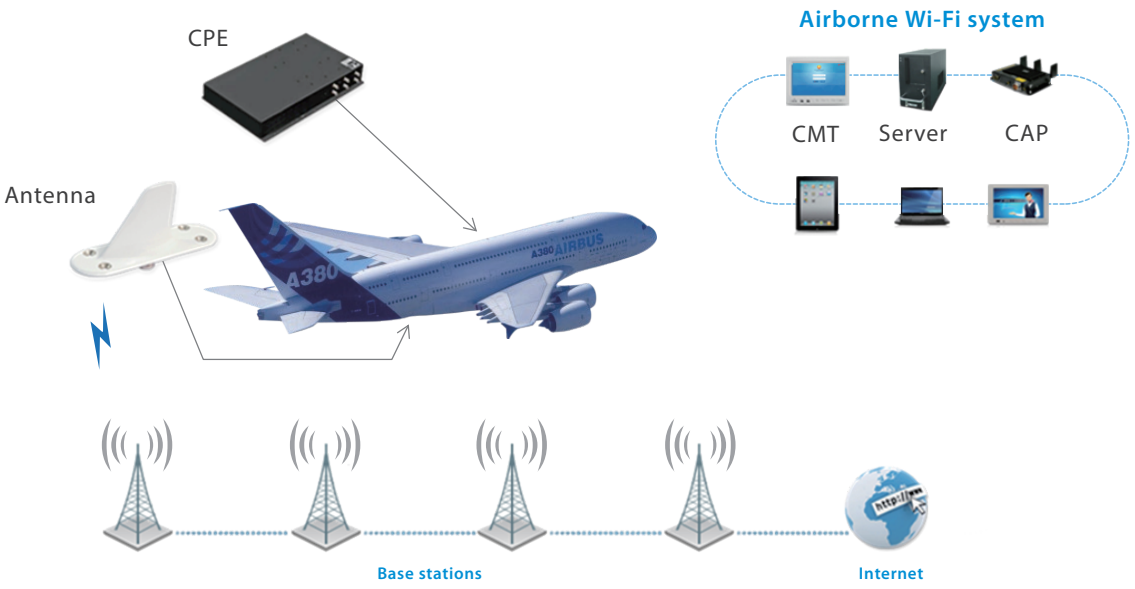


*Fig. 1. The ATG system architecture.*



coverage in the east coast of China and low-cost network construction in northwest areas with low traffic. ZTE's ATG system has a maximum cell radius of 300 km, which can meet the above air coverage requirements. The system uses ZTE's proprietary frame structure design, PRACH transmission timing adjustment, uplink/downlink HARQ, and interference suppression to ensure network access performance at a maximum cell radius of 300 km.

**Differentiated QoS Guarantee**

As aviation scenarios have special requirements for service guarantee and monitoring, it is necessary to provide differentiated QoS protection for users. The ATG system supports different 5QI service priorities, such as signaling, flight data, version data, and service data. The mapping relationship between the 5QI and different data can be configured. As there is a Wi-Fi system in the cabin, the priority relation of 5QI can also be configured with the airborne server.

**Customized High-Performance Antenna**

Due to the special channel environment at high altitude, isolation from the ground environment, and anti-interference requirements, the ATG system needs specially customized antennas to enhance signals, suppress interference, increase signal gains, and achieve high-quality coverage from low altitude to high altitude.

## Application Cases of ZTE ATG

The above scenario analysis shows that the ATG system involves complex algorithm customization and protocol modification. In particular, airborne equipment needs not only to meet aviation requirements, but also to be designed by manufacturers with rich experience in commercial deployment. Since 2008, ZTE has accumulated experience in R&D, ground testing, aerial testing, and deployment and construction for terrestrial base stations and airborne CPEs. It constructed the world's first and largest 3G ATG network for Gogo covering the whole United States in 2009, and built the world's first LTE FDD ATG network and completed ATG flight tests on Air China to provide 4G experience for passengers in 2014. It also delivered a live broadcast of the 2016 Spring Festival Gala at an altitude of 10,000 metres. At the MWC Shanghai 2019, ZTE won the Best Mobile Service for Connected Living in Asia Award by virtue of its ATG air broadband solution.

With the advent of the 5G era, ZTE has also launched the research and development and testing of 5G ATG, striving to achieve national 5G ATG coverage by the end of 2021 with industry partners, and ushering in a new era of 5G air high-speed Internet in China. ZTE TECHNOLOGIES

# 5G+ Smart Metro: Driving Service Innovation for Guangzhou Metro

**Jeffery He**

Wireless Solution Director, ZTE

In 2019, ZTE cooperated with Guangzhou Mobile and Guangzhou Metro to launch a 5G+ smart metro demonstration project. After a year of operation, the project has achieved fruitful results: the first to formulate and release a smart metro functional grade system, the first 5G metro demonstration station in China, the first 5G SA private network for metro in China, and the world's first physical recourse block (PRB)-based hard slicing for metro service under 5G SA environment, and the second prize of the 3rd "Bloom Cup" 5G Application Contest hosted by the Ministry of Industry and Information Technology of China.

The 5G+ smart metro demonstration project adopts the innovative "1 + 3 + X" architecture, including one 5G network, three major application fields and X application scenarios. It realizes integrated transport of various metro services in different scenarios and ensures differentiated network performance requirements are met through MEC + UPF sinking and end-to-end network slicing.

## 5G Private Network Customized for Metro

In response to the service scenarios and communication performance requirements of the metro system, the project customizes a 5G private network solution for Guangzhou Metro on the basis of Guangzhou Mobile's 5G network.

- **Qcell digital indoor distribution system for seamless coverage of station hall and platform:** The Canton Tower Metro station consists of a transfer hall located on the first underground floor, a station hall on the second underground floor, and a platform on the third underground floor. The BBU, pBridge and pRRU are used to achieve seamless coverage of the three floors, providing wireless access for metro station services.
- **Dedicated MEC + UPF sinking:** The dedicated MEC + UPF for Guangzhou Metro is built in Guangzhou Mobile's equipment room near the Canton Tower Metro station to realize local service data offloading and ensure that metro service data stay within the metro network. And smart metro applications such as AR intelligent security and high-precision positioning are deployed on the MEC platform.
- **Dedicated VPN transmission:** A dedicated VPN transmission line with a speed of 100 Mbps in both the uplink and downlink is deployed by

Guangzhou Mobile to connect the MEC + UPF equipment room and the data center of Guangzhou Metro.

- **5G terminals, application terminals and application platforms:** ZTE, Guangzhou Metro and its partners offer 5G CPEs, 5G phones, 5G AR glasses, intelligent security inspection equipment, high-definition cameras, gates, side gates, customer service equipment, a positioning platform, a big data platform for passenger flow analysis, and apps.
- **End-to-end slice for metro services:** The project realizes end-to-end metro service slicing covering 5G core, transmission, RAN and terminals, and verifies the capability of the 5G private network in guaranteeing differentiated SLA requirements of various metro services. The core network allows metro data to be physically isolated with the UPF exclusively used by metro services. The transmission network uses L3 VPN to provide a logically isolated transmission path for metro service slicing. The radio access network achieves logical isolation based on QoS scheduling and hard isolation based on PRB resource reservation. Physical isolation between general services and metro services are enabled through different terminals.

## X Demo Scenarios in 3 Major Application Fields

The 5G+ smart metro project focuses on three major scenarios: station operation management, passenger travel services and train base maintenance, in response to the pain points of the operation and management faced by Guangzhou Metro, such as frequent congestion of surveillance videos, largely delayed emergency response, insufficient network flexibility, low accuracy of passenger flow prediction, and lagged passenger flow monitoring. Multiple smart metro applications have been verified and demonstrated.

- **5G-based intelligent security inspection:** Scanned luggage pictures and related information generated on-site by the intelligent security inspection equipment are uploaded to Guangzhou Metro's security inspection cloud in real time through the 5G network. The AI-based image inspection technology automatically identifies the location and category information of the suspected dangerous goods, displays them on the large screen of a centralized inspection room in real time, and helps security personnel perform centralized remote security inspection. This greatly improves the efficiency of security check, saving more than 50% of the manpower.
- **5G-based high-precision indoor positioning:** The integrated positioning technology based on MEC + Qcell achieves meter-level high-precision indoor positioning. In addition to indoor positioning and navigation applications for individual users, the technology in combination with a big data platform can provide metro operational staff with passenger flow heat maps. Thus, the staff can know the accurate passenger flow distribution in time, effectively manage passenger flows, and reduce the safety risk during peak passenger hours. It can also provide data support for merchants' precision marketing through the exposure of network capabilities and combination with the big data analysis system of China Mobile.
- **5G-based wireless HD video surveillance:** The high-definition video streams of the surveillance cameras are sent in real time over the 5G network without the need for network cabling, which allows flexible, rapid deployments of video surveillance system in special scenarios such as tidal passenger flows and difficult cabling areas, and enhances the system's ability to respond to emergencies.
- **5G-based AR glasses for security:** The 5G-based AR glasses capture and send the image data back to a central command platform through the 5G network in real time so as to identify and deal with abnormal situations or suspicious persons in time. Embedded with a facial detection app, the glasses allow the wearer to perform facial detection on passengers. A passenger is identified through facial feature extraction, and the recognition result is pushed to glasses. 5G AR glasses change the metro system's security approach from passive to active and improve its emergency response efficiency.
- **5G-based train base maintenance:** The project demonstrates vehicle frame repair/overhaul through 5G-based visual flaw detection, AI-based early warning, and AR-assisted maintenance. The timely repair rate is increased by 30%, the failure rate is reduced by 20%, and the maintenance cost is reduced by 20%.

The 5G+ smart metro demonstration project has verified the capability of the 5G private network in transporting various metro services. 5G+ smart metro helps Guangzhou Metro enhance its intelligence, flexibility, safety and operational efficiency, and saves more than 30% of the on-site customer service personnel. The next step of the project is to verify more 5G+ smart metro services, form a 5G+ smart metro system architecture and industry standards, and promote the large scale application of 5G in the metro industry. ZTE TECHNOLOGIES


# ZTE and China Mobile Help Xinfengming Group Upgrade Its 5G Intelligent Manufacturing

**Yuan Wenchong**

Director of ZTE RAN Solution

2020 was the first year of 5G deployment in China. The three major operators in the country have basically completed 5G deployment in the core areas to achieve a full 5G coverage. With the maturity of 5G and edge computing, the focus of campus digital construction is shifting from IT infrastructure and chimney applications to local campus service enhancement. In this context, smart campus construction and industrial upgrade & transformation have been placed in a more important position. This will provide reliable and high-performance 5G access services for enterprise digital applications.

China Mobile Zhejiang Branch (Zhejiang Mobile for short) has made every effort to implement the "5G+" plan in recent years, which not only leads the coodinated development of 5G+4G, but also promotes 5G+AICDE innovation, 5G+Ecology co-construction and 5G+X applications. Its 5G development has been in the forefront of the country and even the world. Zhejiang Mobile has been well prepared in terms of network, capability, applications, ecology and operation. It will actively meet the service needs of 5G network in the digital transformation of various industries with the five-new concept, i.e. new network, new terminal, new service, new ecology and new application.

Xinfengming Group is a leading chemical fiber manufacturer of polyester filaments. Its production capacity of polyester filaments ranks second globally. The global chemical fiber industry is entering a critical stage of digital transformation, and the communications in production workshops are also facing great challenges. The traditional network cannot meet end-to-end requirements of low latency, high stability and high reliability for devices in the workshop. Their wiring, operation and maintenance costs are also high. There are a variety of services in the workshop, especially some video services that require high

bandwidth, but the traditional network cannot meet the requirements.

The "5G intelligent and one-stop local network" project jointly built by ZTE, Zhejiang Mobile and Xinfengming Group has been tested and verified. Leveraging ZTE's NodeEngine solution, Xinfengming Group's 5G manufacturing platform has been upgraded to accelerate its comprehensive digital transformation. This is the first commercial deployment of NodeEngine solution by ZTE and China Mobile.

To better serve manufacturing with 5G technologies and provide enterprises with flexible and fast local services, ZTE, China Mobile Research Institute and Zhejiang Mobile have teamed up to provide industrial campuses with the innovative NodeEngine solution, featuring functions of PRB-based hard slicing, intelligent and simple local traffic offloading, EdgeQoS service management and control, and enterprise self-service portal based on the concept of 5G intelligence and simplification. The solution is simple to deploy, quick to commission and excellent in performance and cost effectiveness. In this 5G project, most of the production equipment is dedicated to Xinfengming, such as AGV trucks, visual detection equipment, and automatic assembly equipment. The PRB-based hard slicing and local traffic offloading provide Xinfengming with the 5G private network capability in a short time, enabling the access of these dedicated equipment and the local traffic offloading and clearly separating 2C users from 2B users. This can ensure the access and network performance of different types of terminals. Compared with other existing solutions, the end-to-end delay can be shortened by 20%.

The NodeEngine solution also provides an exclusive local O&M portal for enterprises. The network can be dynamically adjusted to meet different application requirements, and the network performance can be viewed in real time, thereby ensuring flexible management and control. Moreover, the NodeEngine solution implements sophisticated EdgeQoS management and control. On the one hand, the QoS requirements of local services are intelligently identified and distributed through edge AI to trigger network adjustment parameters to match service requirements. On the other hand, according to the service model, the resources such as bandwidth, latency and reliability are dynamically scheduled to match and guarantee real-time requirements, thus achieving differentiated local network services. Through the sophisticated management and control of EdgeQoS, private networks can truly be flexibly adjusted according to services, greatly improving service experience and resource efficiency.

Xinfengming Group has been fully covered by the 5G network, and has carried out applications in many fields, such as mobile office, video communication and data collection. It has also built an industrial internet platform that integrates real-time data, big data, assistant decision-making and industrial APP. The Group actively embraces digital change, and the 5G+ industrial internet platform enables the Group to achieve the first place in terms of main focus, intelligence, annual growth rate and comprehensive profitability, and to consume the least products and carbon emissions. Xinfengming Group has tripled its production capacity in the past three years and is expected to reach 20 million tons of capacity and more than 100 billion yuan in revenue by 2025.

ZTE has been committed to empowering traditional industries with 5G, and has made remarkable achievements in industrial manufacturing. In addition to the Xinfengming Group digital transformation, the Nanjing Binjiang Smart Manufacturing Base and Changsha Smart Factory built by ZTE have become the models in the industry. ZTE has also created typical 5G applications together with leading manufacturers such as SANY Group and Zhejiang SUPCON. Moving forward, ZTE will continue to innovate and become a 5G enabler and ecosystem builder to help industrial manufacturing develop towards a green, low-carbon, digital, and intelligent future. ZTE TECHNOLOGIES

To enable connectivity and trust everywhere