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Special Topic: 5G

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"With 5G, it will be easier for us to address specific things."

— Frederic Chassaing, Nomotech Methods & Quality Director

Nomotech:
Closing the Digital Divide in Rural France

Reporter: Liu Yang

There is a big broadband gap between France's urban and rural areas. In an interview with *ZTE Technologies*, Frederic Chassaing, Nomotech Methods & Quality Director, and Jonathan Arias, Nomotech Chief Technical Officer, talked about how the company uses radio technology to offer high speed internet in rural areas where fiber is not easily available and how it will explore new technologies and opportunities in the future. Founded in 2003, Nomotech specializes in high and ultra-high-speed broadband internet access, covering mainly rural areas using terrestrial technologies.

"Nomotech objectives is to achieve very high speed internet access nationally in France by addressing the two million homes that will be permanently deprived of FTTH connection."

Why is rural broadband so vital in France?

France is keeping a strong will of equality: everyone should get the same quality of broadband, wherever he lives. In France, 20% of the population lives in rural areas. It is therefore very expensive and sometimes too difficult to reach all users with the FTTH.

We know that in 10 years' time or more, there will be two million people without optical fiber in France so Nomotech wants to bring internet to all these forgotten people with high bandwidth. We keep increasing the data rates, and we can actually easily bring 30 Mbps or 50 Mbps to the customers. In the future, we will carry using to the maximum capacity the technology offer.

What efforts has the industry made in bridging the digital divide in rural areas?

The industry has had to organise itself into a big federation, named **InfraNum**. This federation speaks with the government and tries to make sure that the best decisions will be made for the future. ZTE is really involved in this industry to join the effort and create strong partnerships in order to help the digital divide. We have developed thanks to InfraNum, skills empowerment, standardization, relationship with the French government and the local authorities.

What difficulties have you met during your deployments?

All territories are different and the difficulty is to adapt the technology to these territories. Each case is specific. You have in France 100 departments. Each department is very different from the neighboring one. So we must choose and adapt the better technology for each case. However, to deploy it, we always use the same industrial operating method.

Nomotech is very flexible, innovative and resourceful and will always find the best compromise to deploy the right product for each situation.

"This solution (Fixed Wireless Access) must be

adopted in every rural area in France, to help the most isolated and forgotten people"

You have maintained strong growth. How do you attribute your success?

Strategy and hard work. We are focused on our strategy, staying very close to the customer's needs. Regular meetings, calls and follow up on the actions required for the project, give Nomotech the edge to be close to their customers, their needs and objectives. Nomotech is present to each step of the project and can therefore advise the best technological choice and stay the best option for the customer.

But above all, the main factor of success is hard work. No success without work. You can be clever, wealthy, visionary, but without work nothing is possible. Of course, at times we were in a good place at the good time, or signing the good partnership.

What do you think of the prospects of fixed wireless broadband in France?

As explained, the optical fiber will never go everywhere in France. Our customers are becoming more and more convinced that "Fixed Wireless Access" is the better solution to help the digital divide. Thanks to its performances and an increased number of final customers using this technology, this solution is about to be adopted in every rural area in France. The thing that makes Nomotech a leader in France on this alternative technology is because we can deploy one network very fast. For one entire department, we can deploy radio everywhere in 12 months. This becomes an advantage for the departments because they continue to put optical fiber, and as we know it isn't a fast process, so Nomotech can deploy one radio network to help them offer internet access rapidly while waiting for the optical fiber to be deployed fully.

Nomotech ▶ headquarters

Where do you see the biggest challenges?

Thanks to the market opening with the dedicated spectrum, the biggest challenge is now to propose a quality of service and a broadband internet access able to match with what the customers is expecting to get. The whole added value of our model comes from the expertise and experience of the radio engineering. This is one of the reasons why we have picked ZTE. They helps Nomotech closely in all these reflections.

We are now in the process of qualifying a solution to propose 100 Mbps and more to any customer on the network. In the future, we will continue to provide better rates to our customers in order to suit their always increasing needs, using new kind of architecture and more equipment deployed in the territories. This is what we have been facing for 15 years, and it's still the same story: more broadband, higher quality of service and less latency. But we always must balance the cost and the revenue.

"With 5G, it will be easier for us to address specific things."

What do you see as Nomotech's new opportunities going forward?

All the 5G announcements appear to be a strong opportunity for us. The latest technological evolution has always helped us propose better quality and better access to local authorities to the final customers. But we need to understand well the 5G model to understand how we can adapt it to our model because we are not a mobile operator but a fixed access operator.

We are looking at introducing 5G in new

Frederic Chassaing, Nomotech Methods & Quality Director (L), and Jonathan Arias, Nomotech Chief Technical Officer (R)

areas. For example, we can provide services for industrial park or specific customers with specific requirements with very low latency and very high bit rates. Actually, it is not easily possible because we put a base station to cover a large area and all the customers share the services. But with 5G (beamforming and MIMO), it will be easier for us to address specific things. We also launched an IoT activity, using our radio skills to propose new networks and new services, through our company **NomoSense**.

Where do you see the future for Nomotech?

We want to stay leader in France on rural radio technology for a long time. We also want to take one step up. We want to address new markets. We want to work internationally. In the past, we worked in Africa for radio networks (oil companies or Football Africa Cup of Nations). Now with LTE, there could be more opportunities such as the one we have achieved there. What we have done in Africa was very well received. We have got some good references from the oil companies and private operators. Around the world, we have our technologies in the Vinci airports. In Asia and South Africa, we already have a few projects. We want to take more projects in the international scope, and our strategy is to deploy it step by step. We will climb slowly but each step is a good and strong step.

We have an extended experience in understanding our customer's needs, and it is possible for us to dedicate this experience to other countries. 5G will allow many things to happen but we need to understand clearly the perimeters of 5G and all the possibilities there are with it. Then, we can think what would work best in France and the other countries, deploy a model, and address projects.

What are your suggestions and expectations for ZTE?

We can confirm that ZTE is a very good partner and helped us strongly in our development. Our success is also ZTE's. Our partnership is strong and we are happy to work so closely with them, with a very good mutual understanding. When we have questions, there are always quick answers. For the future and our new challenges, we will have to continuously work closely together to propose the next generation of development anywhere the need will be. ZTE TECHNOLOGIES

COAI's Director General Talks About Opportunities and Challenges for India's Telecom Sector in 2019

Reporter: Sun Dong

Rajan S Mathews, Director General of COAI

Cellular Operators Association of India (COAI) plays an important role in the development of India's mobile industry. In October, it hosted the second India Mobile Congress 2018 (IMC 2018), India's biggest mobile and technology event, in collaboration with the Department of Telecommunications (DoT). In a post-IMC interview with *ZTE Technologies*, Rajan S Mathews, Director General of COAI, talked about hot topics at the IMC 2018, and opportunities and challenges facing India's telecom sector in 2019.

What are the top three issues shaping India's mobile market?

a. IOT; b. 5G; c. Mandatory Testing of Telecom Equipment in India

How is COAI driving the development of the mobile industry in India?

COAI has been a major player in leading the various assignments related to regulatory and policy interests of COAI members in this highly regulated sector, for the organization as a whole, involving management of relations with external stakeholders such as government bodies, policy makers, facilitating regulatory compliance across all functions, managing the media, and defining the public policy strategy to maintain a consistent image of the organization.

COAI has today expanded to be a thought leader in the telecom and broadband industry, with members including cellular service providers, telecom infrastructure players, and telecom equipment manufacturers. COAI has dedicated itself towards the training of skilled manpower to ensure efficient and optimum utilization of human resources to the industry. Many major policy outcomes from the Government have been due to concerted efforts of COAI in aligning the views of members along with the Government and related stakeholders.

What achievement are you most proud of as Director General of COAI?

COAI has been instrumental in getting many favourable policy outcomes from the Government of India. One such recent achievement is the issuance of the NDCP-2018 which captures many forward-looking policy statements for the industry. The recent NFAP which is based on major inputs provided by COAI has identified additional bands for IMT to be aligned with the globally harmonized bands.

COAI is also working aggressively towards Digital India mission. In a path breaking initiative, COAI along with Government of India launched the TarangSanchar Portal. It is a complete online, standardized, common platform which enables anyone to view, understand and obtain information on the Electro Magnetic Field (EMF) emission levels of all 20 Lakh Base Transceiver Stations (BTSs) of any technology (2G, 3G, and 4G) located at approx. 5 lakh mobile towers across India. This data base is unparalleled in the world with complete technical details.

COAI has dedicated itself towards the training of skilled manpower to ensure efficient and optimum utilization of human resources to the industry. COAI has played a major role in the setting up and operations of the Telecom Sector Skill Council (TSSC) in India under the aegis of the National Skills Development Corporation (NSDC). COAI also played a major role in setting up the Telecom Centers of Excellence (TCOE) set up in Public Private Partnership (PPP) mode, with the Government, the Academia and the Industry working together for the sustained growth and progress of the country. COAI was instrumental in the formation of the Telecommunications Standards Development Society, India (TSDSI), which aims at developing and promoting India-specific requirements, standardizing solutions for meeting these requirements and contributing these to international standards.

What are the hot topics discussed at IMC? Why are these a priority?

Following are some of the hot topics which were discussed at IMC:

With voice being offered for free, while the data rates are at rock bottom level (data realization at 1.1 paisa per MB), the ARPU of the TSPs continues to be depressed at Rs. 69. TSPs are looking at new business models and opportunities to increase their revenue and ARPU levels. Some of these are:

1. **IoT/M2M** — These services are already being provided by the TSPs, however with new DoT Guidelines on KYC for M2M, implementation of 13 Digit for M2M SIMs and Government allowing use of embedded SIMs, telecom Industry sees opportunity to increase their revenue levels through M2M/IoT.
2. **Smart Cities** — With the Government initiative of developing 100 SMART cities in the country there lies great opportunity for the Telcos. The majority of smart city programmes deployed in 2017-18 so far include partnerships between telecommunication companies with cities, governments, utilities and IoT solution providers.
3. **AgriTech** — Agriculture is now a sector with great potential of triggering growth. The AgriTech sector is witnessing a number of startups in India. Telcos are playing major role in this regard with the other system integrators.
4. **Artificial Intelligence** — With the Government's growing interest around AI applications in India, there has seen a significant growth in interest levels around AI across all industries sectors in India. It has been seen that industries have started working to skill their manpower to enable themselves to compete with other global players.
5. **AR/VR** — It is being discussed that TSPs will also start using VR technologies to reinforce their customer experience. For example, a telecom company could use Virtual Reality to demonstrate its new product/service to customers.
6. **Spectrum Next Generation Technologies(5G)** — The Government envisages positioning India as globally synchronized participant in the design, development and manufacturing of 5G based technologies, products and applications. Several Committees have been formed by DoT for early adoption of 5G technologies.
7. **Ensuring futuristic network** — In order to retain their subscribers, operators are continually investing to upgrade their networks with new technologies, hence more and more discussions in the applicability and adoption of new and futuristic technologies.
8. **Data Privacy and Protection** — With the issuance of Srikrishna report on Data Privacy and Protection, Data Ownership, Security, Privacy, Protection and Localisation has become a hot topic across the industry among the TSPs as well as the content providers, solution providers and OTT players.
9. **BlockChain in telecom** — With the first of the kind in the world, TRAI vide its

Regulation on Unsolicited Commercial Communication (UCC) asked the TSPs to implement Distributed Ledger Technology (DLT) (Blockchain) to address the UCC related issues. Such use of Blockchain in the telecom sector has made the solution providers such as IBM, Tech Mahindra, Tanla, Blockcube, Simplify etc. along with the TSPs very much interested in such technology.

What do you believe are the biggest opportunities for mobile operators in 2019, and what must be done to make the most of them?

IoT/M2M, Smart Cities, Blockchain, Digital Payments (Payment Banks & Mobile Wallets such as Airtel Money, Jio Money, MPesa), In Flight Connectivity communications etc. present some of the immediate short term opportunities for mobile operators in 2019. Indian TSPs are already active in this space and displayed their products, such as connected car, connected fridge and connected home at the IMC 2018.

What challenges do you expect the industry to face in 2019, and how can these be addressed?

The telecom sector is currently facing burgeoning debt, falling revenue and constrained margins leave no room for further investments. The Government has set the tone of a progressive policy framework with the National Digital Communication Policy 2018. The policy lays emphasis on enhancing financial health of the sector. However, the challenges to be dealt with are:

- Spectrum pricing and future roadmap
- Redefine adjusted gross revenue (AGR)
- Bring down levies such as spectrum usage charge (SUC) and licence fee (LF)
- Reduce the tax burden
- Lowering cost of backhaul connectivity
- Development of start-up ecosystem
- Favourable device and component manufacturing
- Robust cyber and data security framework
- Bridging skill gap
- Data privacy
- Public private partnership (PPP) models for roll out of shared infrastructure.

How would you like ZTE contribute to the cellular development in India in the future?

Areas in which ZTE should contribute:

a. 5G trials: co-ordination with COAI TSP members
b. Participation in development of telecom standards for next generation technologies. This may be done through the Indian Friends of 3GPP (IF3) platform at COAI
c. Contribution to Make in India Initiatives of the Government
d. Getting global expertise to India for discussion on equipment related issues. ZTE TECHNOLOGIES

Considerations for 5G Network Deployments

Duan Xiaowei
Wireless Solution Architect at ZTE

5G will not only bring much faster access rates, but also penetrate into every corner of the world through flexible network slicing. It will drive the digital transformation of vertical industries and become the cornerstone of digital society.

With the freeze of R15 standard, the release of 5G spectrum, the maturity of 5G equipment and the accelerated development of 5G terminal chip, 2019 will be the first year for 5G commercialization. At this stage, the focus of mobile operators is gradually shifting from 5G equipment testing and verification to more practical network deployment. This article will discuss the key challenges in 5G network deployment, and give some suggestions to operators who are preparing for 5G deployment.

Choosing the Most Suitable Network Architecture

5G deployment has two architecture options: standalone (SA) and non-standalone (NSA). With NSA, a first-mover advantage can be derived from architecture maturity, but it is only applicable to eMBB services and involves complex coupling with 4G network. SA, as the ultimate target network of 5G, has obvious advantages in new service support, coverage, performance, network flexibility and terminal energy efficiency. At present, the major concerns operators have with SA architecture include network coverage, SA terminal and 5GC maturity.

From the 5G R&D roadmaps unfolded by 5G terminal chip vendors like Qualcomm, Intel and MTK, chipsets released from 2019 onwards will support both NSA and SA at the same time; thus for operators starting 5G network construction after 2019, terminal is not a decisive factor in choosing NSA or SA.

Considering the maturity of 5GC, there is no need to have complete features in the initial stage of 5G deployment. Operators can adopt

the target architecture in one step, open the interfaces step by step, and introduce the functions in stages, so that the commercial time of 5GC can be advanced to Q1 2019. Therefore, 5GC does not constitute a constraint factor to the commercialization of SA.

Taking the obvious advantages of the SA architecture into account, if operators could achieve continuous 5G coverage with reasonable investment and build an independent 5G network, operators are not very motivated to choose the NSA architecture. Therefore, besides the mandatory requirement of new service, we believe that the coverage capability of 5G base station and the operator's 5G network investment are the key factors for choosing SA or NSA, whether 4G and 5G co-site deployment is feasible highly depends on the cell edge speed requirement of 5G and the density of existing 4G base stations.

Once the quantity of antenna elements, the independent transceiver channels and the transmit power of the 5G AAU are determined, the coverage of the 5G base station mainly depends on the available 5G frequency bands, the complexity of the wireless environments, and the KPI requirements for 5G services, especially the cell-edge access rates. And the planning of cell-edge access rates depends on the minimum network performance requirement of 5G services, whether to support seamless mobility, and the acceptable 5G network construction cost.

Based on the above principles, if an operator only has the millimeter-wave spectrum for 5G construction, it is more appropriate to select the NSA architecture because millimeter-wave has larger propagation loss and poor scattering or diffraction capabilities compared with 1.8 GHz or 2.6 GHz band. When millimeter-wave spectrum is used for mobile access service, it can hardly achieve continuous coverage as 4G network, so it's better to rely on the 4G network coverage and only use it as a capacity layer to the ultra-high-speed service in hotspot areas.

If an operator can obtain the mainstream 3.5 GHz spectrum, has reasonable cell edge access rate requirement, for example 50 Mbps downlink (supporting 2K/4K HD video and AR applications), 2 Mbps uplink (supporting 720p video upload anytime, anywhere), and also has enough investment to build a 5G continuous coverage network in dense urban areas, we believe that SA is a one-step and more suitable network construction mode. According to ZTE's field test data, in dense urban scenarios where the inter-site distance is less than 400 meters, it is possible to achieve continuous coverage of 5G through 4G/5G co-site deployment; in the area where the site spacing is more than 400 meters, an appropriate number of 5G macro or micro base stations can be added to meet the uplink data rate requirement of 2 Mbps.

Of course, if an operator has very limited investment at the initial stage of 5G deployment, can only deploy a small number of 5G base stations in 4G network hotspots for marketing purpose, it is more economical and practical to choose the NSA network construction mode.

If the operator has higher requirements for network edge performance, such as increasing the uplink rate to 5 Mbps (supporting 1080p video upload anytime, anywhere), it is recommended to use carrier aggregation of 3.5 GHz spectrum and 1800/900/700 MHz spectrum. Since 1800/900/700 MHz bands have been refarmed for 5G New Radio, the network construction mode is still SA. We think it is very difficult to achieve 5 Mbps uplink data rate in NSA mode with around 400 meters inter-site distance even if the uplink capability of both 4G and 5G is utilized; deploying a large number of new base stations also involves high investment costs, and supplemental uplink solution is too complex.

Maximizing the Value of Existing Site Infrastructure

Besides the network architecture, how to introduce 5G into the existing sites with high-density of RAN equipment is also a major challenge for operators. At present, the majority of operators have multiple bands (such as 900 MHz, 1.8 GHz, 2.1 GHz and 2.6 GHz) and

multiple standards (GSM, UMTS, LTE and NB-IoT) in the same site. It is also very common for several operators to share the same site infrastructure such as towers and cabinets. Most of the sites have dense deployments of antennas and RRUs, making it difficult to add 5G AAUs. Building new sites also faces such problems as difficult site acquisition, high investment costs, and long construction periods.

The introduction of multi-band, multi-port passive antennas, active + passive hybrid antennas, and ultra-wideband RRU provides a new way to solve the problem of tight antenna installation space in the macro base station. Operators can consolidate and optimize the multiple antennas of each sector of the existing network before or during 5G construction. Thus, valuable space will be released for installing 5G AAUs, and each sector will only use one or two multi-band antennas to cover all frequency bands and wireless standards for 2G, 3G and 4G, and one active antenna to serve 5G networks. In this way, the 5G network can be deployed without adding new sites, and the multi-network operation and maintenance (O&M) costs can be reduced.

Regarding the 5G AAU equipment, ZTE recommends using 64T64R AAU in dense urban areas to achieve the highest performance, and 16T16R AAU in urban and suburban areas to make a good balance between coverage and network construction costs. The 64T64R AAU consists of a large number of independent transceiver channels, which can support accurate horizontal and vertical beamforming at the same time, thus achieving ideal capacity gains with space division multiplexing in densely populated areas. In addition, 64T64R AAU has strong beam reflection, diffraction, and anti-interference capability. Even in dense urban areas with complex wireless environments, 3.5G NR can achieve the same coverage as existing 1.8 GHz 2T2R LTE with co-site deployment mode, thus reducing the difficulty and cost of 5G network deployment. For the general urban and suburban scenarios with a small number of data users, low traffic density, a very low pairing probability of MU-MIMO, 16T16R AAU is recommended, because it has higher cost-performance ratio, and also enables 3.5G NR to have the same coverage as 1.8G LTE even with co-site deployment mode.

For 5G network blind spots or hotspots, it is recommended to use pad micro station to improve local performance. The pad-sized 5G micro base station can be installed in a concealed location like the exterior wall of the building, the street light pole and the advertising light box, which significantly reduces the difficulty of the site acquisition and can quickly increase the hotspot capacity and eliminate blind spots.

In terms of baseband processing unit, the future-oriented high-capacity baseband processing unit can support all wireless standards from 2G to 5G, and flexible deployments of centralized units (CUs) and distributed units (DUs). Besides converged 4G/5G networking capability, it can support smooth transfer of hardware processing resources from 2G and 3G to 4G and 5G in the future when the existing 2G/3G network reaches the end of its life cycle, thereby maximally protecting the investments of operators.

Introducing AI to Improve Multi-Network O&M Efficiency

In the 5G era, operators will face the challenges of complex networks, diversified services, and personalized experiences.

The network complexity is mainly reflected in the coexistence of multiple networks; and with the dense networking of large-scale antenna arrays, the complexity of beam control and parameter configuration in 5G is increased by an order of magnitude compared with 4G. The SDN, NFV, and cloud deployments also disrupt the familiar network O&M model of the operator's O&M team. Business diversification is mainly reflected in the fact that 5G exceeds eMBB business and penetrates into vertical industries such as industrial manufacturing, agricultural production, smart home, telemedicine and autopilot. Experience personalization is mainly reflected in the fact

that 5G delivers customized and differentiated services for specific industries or users, builds network access, data analysis and application services covering a user's full business processes and full business scenarios, and allows lifecycle management and continuous optimization of customized network slices. The above three challenges urgently need the introduction of AI to improve O&M efficiency.

AI technology represented by machine learning and deep learning can be widely used in network alarm, fault root cause analysis, network coverage, performance optimization, network capacity prediction, accurate network construction, network-level energy management, dynamic scheduling of cloud network resources, and intelligent network slicing, thereby improving network O&M efficiency and reducing network O&M costs. The application of AI can be roughly categorized into intelligent site equipment, intelligent O&M, intelligent edge cloud engine, and intelligent network planning and optimization.

Summary

Although operators will face various challenges during the 5G network deployment period, 5G's flexible slicing capability and its potential for digitalization and intelligent transformation of vertical industries also give operators confidence about the network profitability in the 5G era. ZTE is willing to closely cooperate with operators to solve the problems in network deployment and O&M, and work together to create a brilliant future! ZTE TECHNOLOGIES

Standalone or Non-Standalone, That Is Not the Question

Alex Wang
Managing Director of 5G RAN Solutions at ZTE

Source: Light Reading

It is broadly recognized that the Asia/Pacific region is leading the race to 5G. Operators in South Korea, Japan and China will be among the first ones in the world to launch commercial 5G networks of significant scale. For example, China is likely to have a pre-commercial grade 5G (soft) launch soon and 2020 is set to be the year for commercial roll out of the next generation mobile services. By then, it is expected that technologies and ecosystems will be fully ready and it will be the right timing for the full-fledged standalone (SA) mode of 5G.

As a decades-long cooperation partner with each and every operator, ZTE can understand their decision and support it. The Chinese operators all aim to be the best in their network quality and the service they can offer, in which case SA mode has its advantages.

To start with, by definition, SA mode means 5G radio built with 5G core networks, therefore it can realise all the new use cases the technologies have promised. Broadly speaking these include two types of cases. The first group is the cases that need vertical 5G environment, for instance network slicing for dedicated domains or locations or customers. The second group is typically in the ultra reliable low latency communications (uRLLC) category—for instance, autonomous driving cars, or advanced industrial manufacturing. In both cases we need end-to-end 5G connectivity.

When it comes to consumer access to 5G experience, although a few smartphone vendors have promised to introduce 5G-compliant handsets in the first half of 2019, the leading vendors (Samsung, Apple, etc.) are expected to bring their 5G flagship products to market in the Q3-Q4 2019 timeframe or even later, which means they are more likely to be available to the mass market towards the end of 2019 or sometime in 2020. This makes 2020 a reasonable target to launch 5G for the consumer markets.

Operationally, mobile operators may also find SA mode more straightforward to implement as the architecture is more simplified. Also, SA mode is the ultimate target network of 5G. Operators that implement SA mode will not have to go through, after a few years of 5G operation, another round of upgrade from non-standalone (NSA) to SA, which can be very

costly, from the perspectives of investment, resources, timeline and operational efficiency. Meanwhile, operators could also find it a good opportunity to extricate themselves from the lock-in of 4G suppliers and to bring new vendors for 5G. This will be more than a good chance for the operators to optimize their Capex structure.

Thanks to the strong virtualization capabilities afforded by 5G architecture, it also makes business sense to bring on board new vendors to selected domains for their strength in these verticals.

Despite the recent momentum of SA mode from Chinese and global operators, there are also quite a number of operators with preference for NSA mode. For some operators this decision is based on speed advantage, the ability to roll out 5G as soon as possible. For others this option is also heavily related to cost, as by definition, NSA mode is 5G radio with LTE core networks, therefore saving the cost of building out the 5G core network, at least at the initial stage.

Some 5G use cases do not need end-to-end 5G coverage, and NSA mode will already be able to deliver good enough experience: For example, enhanced mobile broadband (eMBB) access like the service rolled out by Verizon Wireless; or most consumer IoT connections on cellular, which would need massive capacity but only generate small volumes of data traffic. Most OTT services are already operating on 4G, therefore what 5G can offer is an enhancement. For example, HD video streaming will be able to deliver on 4K or 8K, or virtual reality experience will become more life-like and more immersive. If these are their main target market segments, operators do not need to wait for all technologies and ecosystem components to be ready before they roll out 5G services.

To speak as a long-standing cooperation partner with many of the world's leading operators, ZTE can understand their preference for NSA mode and support it. As a matter of fact, one of ZTE's most successful operator partnerships, the one with Hutchison Drei in Austria, has been built on the evaluation of Pre5G technologies. ZTE also believes that most operators starting with NSA mode will migrate to SA mode when the 5G technology and ecosystem are more mature and more cost efficient.

Backed by its strong track record of R&D leadership (over 1,000 essential 5G patents are only the tip of the iceberg) and commercial successes (decades of experience working with telecom operators all over the world), ZTE is happy and able to support whichever route to 5G its operator partners may choose, SA or NSA. It is encouraging to see that 5G is gathering momentum in many countries, especially in Europe. Spectrum auctions have been completed in Italy, the UK, and Finland, while auctions in Austria and Germany are going to be held early 2019. Meanwhile, ZTE also noticed that in some cases the prices paid out by operators to acquire 5G spectrums are so high that their reserves are almost dried. This may be worth bringing to the attention of the regulators and governments. Although the attempt to maximize return for a precious public asset (the electromagnetic spectrum) should not be faulted, draining operators' funds may not be the most sustainable result for the industry in the long run. ZTE TECHNOLOGIES

Common Core Facilitates Rapid 5G Deployment

Zheng Xingming
Architect of ZTE CCN Products

Problems in 5G Deployment

As there are more pressing demands for high-speed bandwidth in services like AR/VR, HD video and 3D video, for massive terminal access in services like smart city and smart meter reading, and for low latency and high reliability in services like internet of vehicles, industrial control and telemedicine, the pace of 5G network deployment is getting closer and the industries are full of expectations for 5G networks supplied by operators.

Operators also have big problems with how to deploy a 5G Core. On the one hand, they have to consider whether the traditional EPC network can meet the ever-changing needs of 5G vertical services, but on the other hand, the 5G Core using the service-based architecture (SBA) has brought a great impact on traditional telecom networks. Changes are made on the interoperability of existing devices and their operational mode.

The major problems operators have to face when deploying the 5G Core are how to meet the needs of industry users, how to coexist with existing networks, how to swap users seamlessly, and how to operate and maintain their networks.

Solutions for 5G Core Deployment

Deploying 5GC Directly vs. Upgrading EPC

To meet the user need for internet connection via 5G, the core network is chiefly deployed in two ways (Fig. 1):

- Path 1: Upgrade the evolved packet core (EPC) to support 5G wireless access (5G architecture Option3)
- Path 2: Deploy the 5G core network (5GC) directly (5G architecture Option2)

Upgrading EPC to 5G faces a big problem: it does not support network slices that are required by 5G vertical industry. The upgrade solution is just a transition to 5G evolution. After the 5G core network is deployed, the cost of upgrading the original EPC will be wasted. However, deploying the 5G core network directly can best meet service needs and avoid unnecessary investment waste, so it is the preferred solution for current 5G deployment.

Another important factor for deployment path selection is whether the industrial chain can meet the requirements of commercial time. Currently, the 5G Core R15 specification has been officially released by 3GPP. The system equipment and terminal devices in compliance

with the specification can meet the time requirements for commercial use in the fourth quarter of 2019.

Therefore, deploying 5GC directly (using 5G architecture Option2) is the best deployment path for 5G evolution.

Using Legacy Interfaces to Reduce Network Changes

The key issues in deploying a new network are what changes made on existing network devices and how to coexist with them.

In order to make full use of the legacy network, the general principle adopted for network construction is new network for new users while legacy network for old users. In other words, the existing EPC provides access service for original 2G, 3G and 4G users, and the newly built 5G Core offers access service to 5G users.

To enable service continuity when handover is performed from newly-built 5G Core to existing EPC, operators need to upgrade existing network devices to support necessary interworking interfaces. For example, connect 5G terminals to the new 5G Core to make them identified, and introduce the N26 interface for smooth and fast handover between 4G and 5G. However, there are two issues in changing existing network equipment: one is waste of investment, and the other is that the R&D cycle caused by the network change may affect the time of commercial deployment. Therefore, making full use of legacy network interfaces has become the best solution for the initial 5G deployment.

The 3GPP 5G standards have also made a great change to the billing system, so operators need to change their billing systems. The online and offline billings are integrated and use service-based interfaces. However, the existing network's offline billing system is generally undertaken by the BOSS, and its online billing is undertaken by the OCS, which makes it difficult to change. Therefore, the newly-built 5G Core expands a small number of fields with 5G features based on the original EPC billing architecture and interfaces. This makes the least change to the existing billing system and is the best billing deployment solution.

ZTE has rolled out its Common Core that converges EPC and 5GC capabilities. Without any upgrade or change to the existing EPC, the Common Core solution can achieve convergent access and smooth handover in the 4G/5G overlapping coverage area, while guaranteeing service continuity and requiring a minimum change to the existing billing system. Therefore, the Common Core solution is the best choice for initial 5G deployment.

Smoothly Evolving to 5G Network without Changing the SIM Card or Phone Number

After deploying a new network, what makes

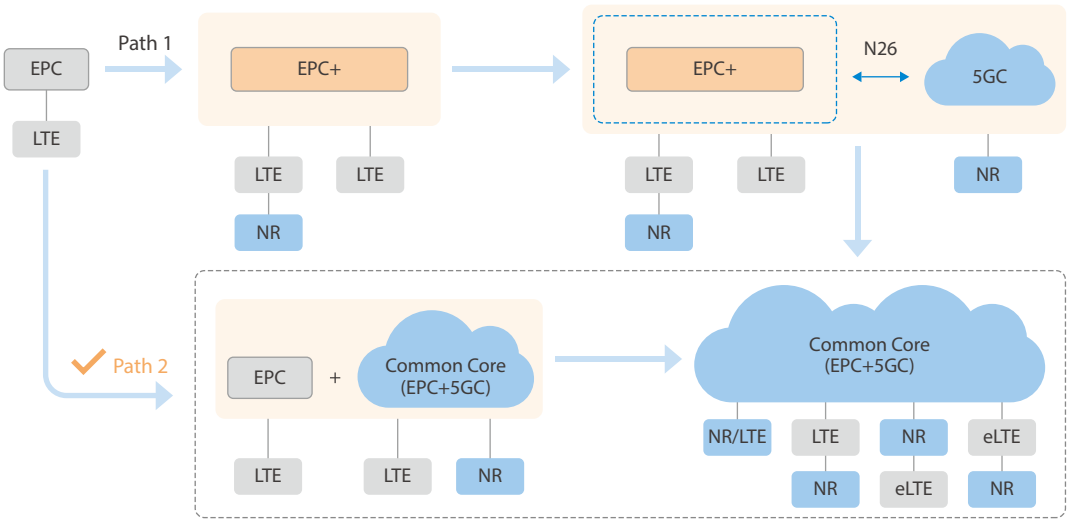


Fig. 1. Deployment of the core network in two ways.

operators headache is how to migrate users of the legacy network to the new network.

For the transition from 2G/3G to 4G, a user needs to install a new SIM card and the operators have to invest a lot in offering free card replacement service. However, a 5G network will be compatible with the original 4G SIM card, that is, the user only needs a new 5G mobile phone to enjoy 5G high-speed data service without changing the SIM card and phone number. This will find favor with users.

To migrate original users from 2G, 3G and 4G to 5G, it is necessary to sign up such users to 5G services. Usually, there are two ways to migrate the user number segment to 5G:

- Single user migration: The user can choose whether to enable 5G services. The solution helps operators carry out independent billing and special package offerings for 5G services. The existing 4G network signing system can also be fully used.
- Batch migration of user number segments: The system directly migrates existing user number segments to the newly-built 5GC. Though the solution does not require users to modify their subscription network, it is not conducive to the development of differentiated 5G packages.

One-Button Deployment Opens the Road to Intelligent Operations

The 5G Core adopts a slice network architecture based on the NFV technology. The software and hardware integration of traditional NEs becomes the architecture with a hardware resource pool, a virtualized resource pool and separated network functions. The traditional installation and operations cannot meet the operational management under the NFV architecture.

ZTE CloudStudio network slice management system supports E2E network slicing and lifecycle management. Combined with AI technology and automated software framework, the CloudStudio system enables slice-based automation design, orchestration and deployment, and intelligent slice selection, achieving a complete autonomous network without human intervention (Fig. 2).

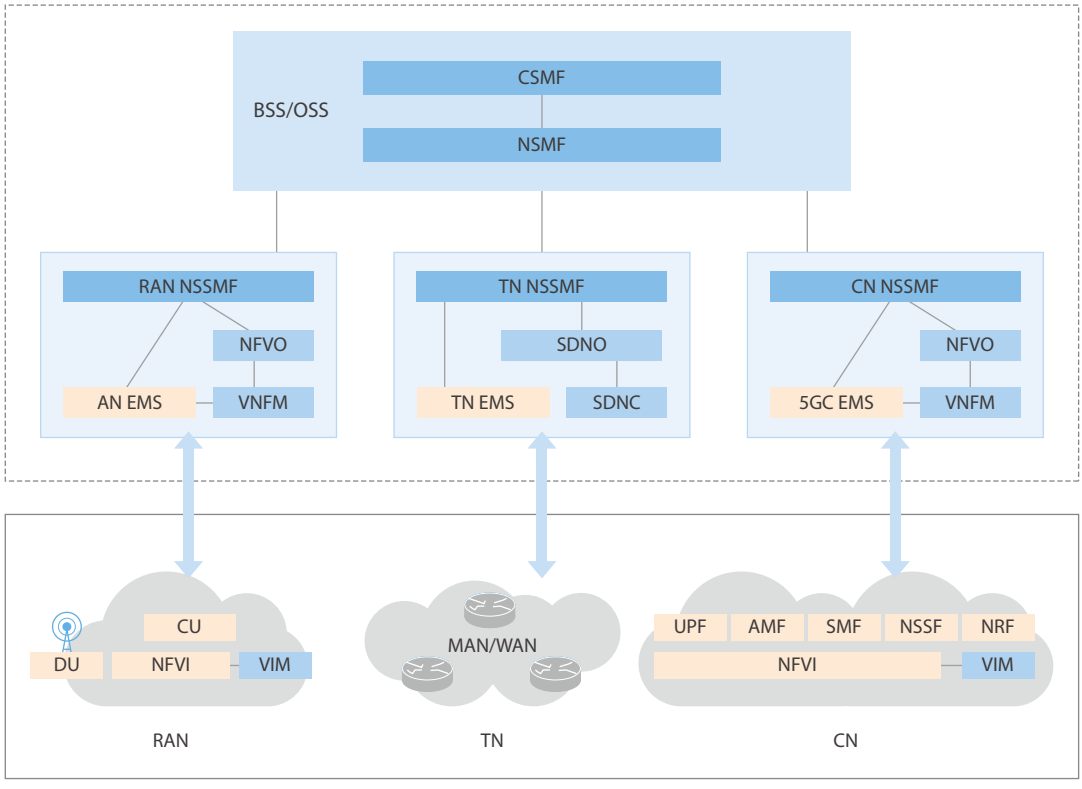


Fig. 2. ZTE CloudStudio architecture.

ZTE CloudStudio introduces DevOps to facilitate agile development and deployment of innovative services that are characterized by on-demand design, automated deployment, SLA assurance, intelligent analysis and prediction, security isolation and tenant management. Operators can develop appropriate network slicing SLA as required by the industry, regions, virtual operators and other scenarios. The CloudStudio system is used to implement comprehensive automation management that involves resource pool construction, network function deployment, daily monitoring, fault operations, as well as upgrade and expansion. This can lower the requirements on operating personnel.

Suggestions for 5G Core Evolution

ZTE suggests that the existing network could be evolved to 5G in three phases:

Phase 1: From 2018 to 2019, a convergent 4G/5G core network will be introduced to run 5G trials. Virtual EPC (vEPC) in the convergent core will also be used to expand the existing EPC. The existing network in this phase does not need to be upgraded.

Phase 2: From 2020 to 2021, 5GC will be commercialized on a large scale. The 2G, 3G and 4G users will gradually migrate to the 5G network. In this phase, vEPC in the convergent core will interoperate with 5GC to realize smooth handover between 4G and 5G users in hotspot areas. If service continuity across 4G and 5G networks is required, it is necessary to upgrade the existing EPC for interworking with 5GC.

Phase 3: From 2022 to future, traditional devices will gradually withdraw from the network. Slice-based operations management will provide diverse end-to-end network slices that can meet different service needs in eMBB, mMTC, and uRLLC scenarios. ZTE TECHNOLOGIES

Tapping Potential of 5G Through Spectrum

Shan Yanzhen
Wireless Planning Manager at ZTE

4G changes life; 5G will change society. 5G will not only improve the bandwidth but also extend from human-centric communications to include both human-centric and machine-centric communications. 5G will open a new era of IoT, unlocking possibilities that are beyond our imagination. The whole society has great expectations for 5G, and spectrum is key to 5G's future.

Worldwide Spectrum Allocations

Spectrum is the core resource of the mobile communication development. Spectrum planning determines the development patterns of the industry. As 5G development accelerates, the spectrum has become the focus of the entire industry chain.

At present, governments of different countries have all elevated the 5G network construction to the strategic level of the ICT industry. Considering the progress of global 5G trials, the United States, South Korea, Japan, and China will become the first countries to deploy 5G networks, followed by some European countries. Some Middle Eastern countries also have the need to rapidly deploy 5G networks. For example, the UAE will host the World Expo in 2020 and Qatar will host the deployments. Most African countries still have low 4G penetration rates, and will be relatively lagging behind in 5G deployment.

Countries represented by China, the United States, Japan, South Korea and regions represented by Europe have announced plans to use spectrum in mid-bands (around 3.5 GHz and 4.9 GHz) and high bands (around 26 GHz and 28 GHz), seizing the first-mover advantage in 5G.

As early as 2016, the US Federal Communications Commission (FCC) unanimously voted to free up almost 11 GHz of high-band spectrum above 24 GHz for 5G use, comprising 3.85 GHz licensed spectrum in the 27.5–28.35 GHz, 37–38.6 GHz and 38.6–40 GHz bands and 7 GHz of unlicensed spectrum in the 64–71 GHz band.

In December 2018, China's Ministry of Industry and Information Technology officially released the plan to use 2515–2675 MHz, 3300–3600 MHz and 4800–5000 MHz bands for 5G, with 3300–3400 MHz limited to indoor scenario. China is also the first country to release a 5G mid-band plan.

UK's Ofcom has identified three bands to support 5G: 700 MHz (low band), 3.4–3.8 GHz (mid-band), 24.25–27.5 GHz (high-band). Ofcom has completed the auction for portions of 3.5 GHz spectrum, and four operators (Vodafone, 3UK, O2 and EE) won a total of 150 MHz of spectrum in the 3.4 GHz band (3410–3480 MHz, 3500–3580 MHz). According to the outcomes of the auction, the price per Hz paid for 3.4 GHz is 48% higher than that for 2.3 GHz (the 4G spectrum that was auctioned at the same time). This proves the importance that each operator attaches to 5G spectrum. Vodafone took the largest share of 5G spectrum, taking 50 MHz; O2 and EE won 40 MHz each; and 3UK only got 20 MHz. How to give full play to 5G's advantages with such narrow-bandwidth spectrum will become a focus of attention for UK operators.

South Korea has also been at the forefront of spectrum auctions with the 3.5 GHz and 28 GHz spectrum auction complete. In the 3.5 GHz band, 280 MHz of spectrum in the 3420–3700 MHz range was auctioned, of which, SK Telecom and KT each acquired 100 MHz, and LG U+ got 80 MHz. In the 28 GHz segment, all three operators obtained 800 MHz. From the perspective of spectrum allocation, South Korea is in the forefront, and the fact that each operator has obtained large-bandwidth spectrum is more conducive to 5G construction and service development.

In Europe, both Spain and Italy have auctioned portions of 3.5 GHz spectrum. In Spain, the 3.4–3.6 GHz band has been assigned before, and the spectrum allocation is relatively fragmented with some spectrum being used for TD-LTE. The remaining 200 MHz of spectrum in the 3600–3800 MHz band was auctioned in July 2018. This auction has specified an operator's bandwith but not the frequency ranges. If you look at the overall spectrum allocations in the 3400–3800 MHz band, except the newly auctioned spectrum, the spectrum each operator has in other frequency bands is non-contiguous. This is not conducive to 5G construction, and there is the possibility of switching frequency bands between operators.

In Italy, the 3400-3600 MHz band has been occupied. The auction of spectrum in the 3600–3800 MHz band has been completed. In the 3600–3720 MHz range, Vodafone Italia won 80 MHz, and Iliad and Wind Tre won 20 MHz each. Telecom Italy captured 80 MHz in the 3720–3800 MHz range.

Which Band is Better?

It is believed that many operators are constantly thinking about which band is better. There is no best band but only suitable band. Operators' use of bands should be fully aligned with their business plans for 5G. In view of the current trends in the industry, sub-6 GHz will be the best choice for the early 5G phase, and then high frequency millimeter waves. Among the three bands in sub-6 GHz (2.6 GHz, 3.5 GHz and 4.9 GHz), 2.6 GHz and 3.5 GHz will take off a little earlier. For China, to use the 2.6 GHz and 4.9 GHz bands, efforts are required to build, cultivate, and constantly improve the market. This brings opportunities as well as challenges to China Mobile with trial spectrum in the 2.6 GHz and 4.9 GHz bands. With 2.6 GHz that offers obvious advantages in coverage, operators can deploy 5G in SA mode while reusing existing network assets. To match China Mobile's 5G deployment plans, ZTE is actively promoting the development of the industry chain, working hard on its equipment, terminals or IoT devices. Both China Telecom and China Unicom have received the 3.5 GHz band, which is the mainstream 5G frequency band in the world. The 3.5 GHz industry chain is a bit more mature with a larger scale and lower costs. At present, 3.5 GHz progresses faster in trial activity and is the best opportunity for China Unicom and China Telecom.

Considering many factors such as spectrum usability, 3.5 GHz has become the preferred band for 5G deployments for most operators, and can be the global roaming band for 5G in the future.

Considering many factors such as spectrum usability, 3.5 GHz has become the preferred band for 5G deployments for most operators, and can be the global roaming band for 5G in the future. 5G construction needs to consider both coverage and capacity. Utilizing antenna technologies such as massive multiple input multiple output (Massive MIMO), 3.5 GHz can offer coverage that is comparable to that of FDD band of 1800 MHz. With 3.5 GHz, operators can reuse existing sites to build 5G networks. Although large contiguous bands and rich spectrum resources are available in high bands for 5G, there are challenges in network coverage. The 3.5 GHz mid-band will still be the primary band for initial 5G deployments.

Getting Ready for 5G

The global mainstream operators' 5G spectrum battle is in full swing, but the wireless spectrum resources are always limited and scarce. Improving spectrum efficiency has always been the key to the upgrade of mobile networks from generation to generation. Multi-antenna space-division multiplexing is the only technology that can double the spectrum efficiency. As the most important space-division multiplexing technology, Massive MIMO supports more precise beam control and a higher number of concurrent streams, and has become the core technology of 5G.

ZTE has innovatively proposed Pre5G, a technology that applies Massive MIMO technology to 4G networks in advance. The technology won the "Best Mobile Technology Breakthrough Award" and "Outstanding Overall Mobile Technology—The CTO's Choice" awards at MWC 2016. It has successfully been put into commercial use, which will significantly accelerate the commercialization of 5G Massive MIMO. ZTE expects that Massive MIMO will offer more possibilities to operators who has less spectrum for 5G.

In 2017, with the joint efforts of the entire 5G industry, breakthroughs was made in 5G standards, key technologies, and industrial environments. In 2018, 5G entered the phase for large-scale field tests and pre-commercial roll-outs, and standards and technologies were further improved. In 2019 and 2020, large-scale commercial deployments of 5G will begin, and there will be continuous deepening and expansion of the 5G commercialization.

5G is coming, and ZTE is ready to go! ZTE TECHNOLOGIES

UniSite:
Building a Simplified and Convergent Site for 4G to 5G Evolution

Ding Guanghe
Director of ZTE Wireless Solution

As the pace of 5G commercialization is getting closer, the industry's focus has gradually shifted from 5G technology verification to actual network deployment. 5G sites, as the top priority of 5G networks, account for more than 80% of the operator's investment. Therefore, the deployment of 5G sites has become a major concern and challenge in the industry, especially for operators and equipment vendors.

Challenges of 5G Site Deployment

Deployment of 5G network is more complicated than that of 2G, 3G, 4G and NB networks because of the complexity of 5G spectrum and service characteristics. Especially the deployment of 5G wireless sites poses even greater challenges which involve:

- More sites: The first phase of 5G deployment is chiefly based on the 3.5–5 GHz frequency bands. Compared to 2G, 3G, 4G and NB networks within the sub-3 GHz bands, 5G needs more sites to achieve continuous coverage with better rate experience. This leads to huge capital costs for operators.
- More difficult site acquisition: There is a challenge in the acquisition of new sites, especially in the early 5G deployment starting from urban areas. It is quite difficult to obtain new sites in these areas. There is also difficulty in acquiring existing network sites because of stricter spatial constraints and higher rents.
- More devices: The introduction of 5G brings more devices to the site. It is more complicated to deploy and operate these devices of different systems on multiple frequency bands apart from the increasing rental fees.
- How to protect network investment: Operators need to protect their network investment. They will consider maintaining and adding the value to their newly-built networks on the long run while making full use of their existing networks.
- How to reduce the impact on existing networks: The major concern in the 5G deployment is to avoid or reduce the interruption of existing services. Another concern is to avoid the impact of 5G network such as interference on the performance of existing networks.

ZTE UniSite Solution: Simplifying 5G Site Deployment

Relying on the deep understanding of the

challenges faced by operators in their 5G deployment, ZTE has proposed some ideas to help them address the challenges.

- Maximize existing site utilization: Existing sites are valuable resources, so operators try their best to find ways to maximize site utilization. For example, they introduce multi-mode multi-frequency convergence devices, high-capacity devices, highly integrated devices, and high-order MIMO to reduce the number of devices used, so that a single site can accommodate more systems and more frequency bands and improve its spectrum efficiency.
- Rapidly deploy new sites at low cost: Match the corresponding site solutions according to site environments, make good use of environmental resources, and avoid public discontent. For example, light poles are used to build a site to cover hotspot areas in the commercial street.
- Reduce the impact on existing network services: Protect and make full use of existing network devices to reduce as much as possible the impact on existing services. Deploy a new 5G network while reconstructing or swapping existing network devices unless they are outdated and cannot be evolved. Decouple 4G and 5G, and make independent 5G configuration, maintenance and networking except the co-site infrastructure sharing.

Based on these ideas, ZTE has launched its UniSite solution (Fig. 1). UniSite incorporates the concept of convergence to completely simplify the radio site and maximize site utilization, so that 5G can be rapidly introduced at a low cost. UniSite brings the following attractions to operators:

- A full range of site solutions meet diverse coverage needs: UniSite involves several scenarios such as Macro site, QCell site, Pad site, and iMacro site. These site solutions are cost effective to match different 5G scenarios.
- Multi-mode BBUs create a high-performance network: The new-generation BBU V9200 based on a virtual platform can be commercially deployed. The BBU V9200 supporting 2G, 3G, 4G, NB and 5G is the industry's largest-capacity BBU with a height

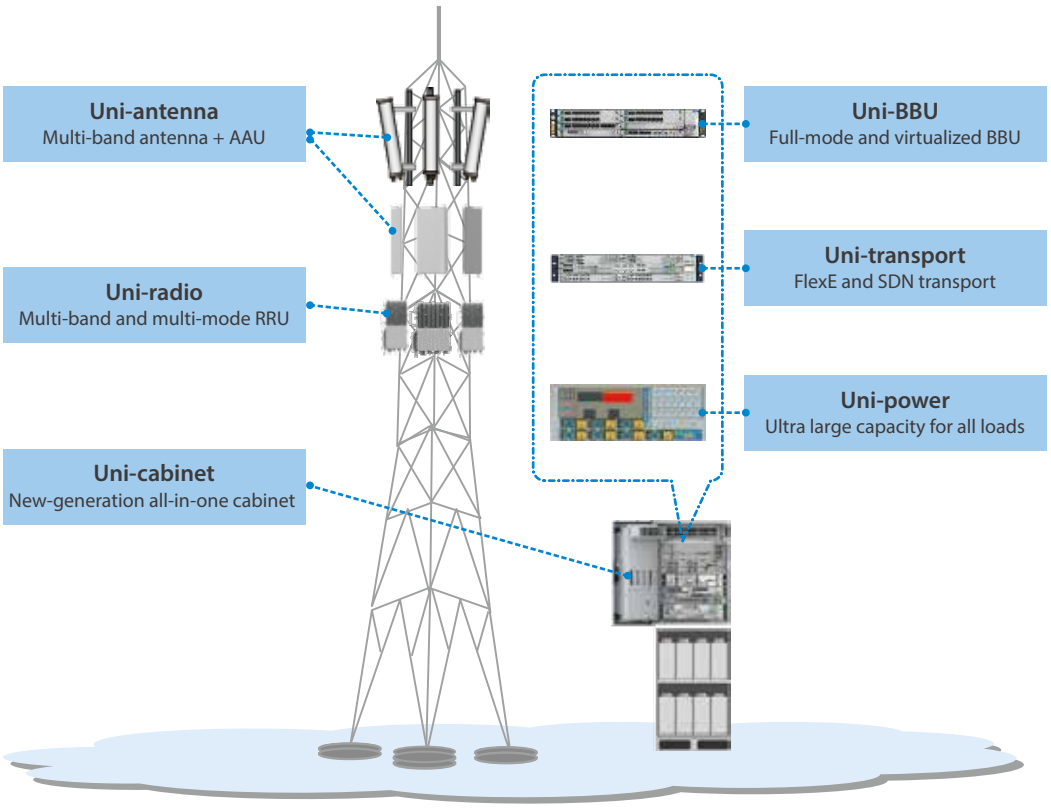


Fig. 1. Schematic diagram of the UniSite solution.

of 2U. It integrates virtual and IT platforms to offer elastic RAN capacity and open interfaces, enabling local innovative services and supporting flexible CRAN and DRAN networking.

- Multi-mode multi-band RF units simplify the site and reduce TCO: Considering the coexistence of multi-mode multi-band sites, ZTE has launched a series of ultra broadband RF units (UBRs) based on its multi-mode SDR platform. There are UBRs operating on 800M+900M bands and UBRs operating on 1800M+2100M bands, which significantly reduce the number of site devices, simplify the deployment, and lower the requirements and TCO for the site. ZTE has also rolled out a variety of 5G AAU/RRU products to match different coverage scenarios. For example, 64TR is developed to cover urban high-traffic areas, and 16TR is used to cover ordinary areas. These devices support smooth evolution to 4G/5G mixed mode through software upgrade.
- Antenna integration facilitates the introduction of 5G: The traditional site has a large number of single-frequency antennas, which result in the lack of antenna space and difficulty to expand network capacity. ZTE has launched a variety of multi-frequency multi-port antennas to reduce TCO by integrating antenna space. The typical integration solution integrates all sub-3 GHz passive antennas in one antenna and forms 1+1 antenna system after introducing 5G AAU. The sub-3 GHz antenna and RRU are integrated into a multi-frequency AAU, which makes the RF units require less antenna space and also reduces TCO.
- New-generation Flexhaul transmission devices meet 5G service bearer requirements: A new generation of bearer products based on FlexE and SDN are characterized by industry-leading 5G transport applications, ultra-low latency, ultra-high clock accuracy, and high reliability. They can fully meet the needs of 5G services.
- New-generation outdoor cabinets and power supplies meet the need of 4G+5G for large capacity: Considering the introduction of 5G, ZTE has developed a new outdoor large-capacity cabinet. Although the new cabinet greatly improves its capacity, its size is exactly the same as that of the old one. Its installation interfaces are also similar to those of the old one. This ensures good compatibility with existing network devices and cabinets. The new-generation cabinet supports B8200+V9200 overlay deployment and can embed 5G transmission equipment to achieve all-in-one deployment. The next-generation power module is also embedded in the cabinet and provides a maximum DC output of 350A. The new power module can be connected to a maximum of 21 RRUs and AAUs due to more breakers, and its system efficiency reaches as much as 98%.

Conclusion

UniSite is a cost-effective solution that comprehensively addresses the challenges faced by operators in deploying their 5G sites. The UniSite solution has the advantages of high performance, low TCO and easy deployment.

The UniSite solution provides high performance. It has super large-capacity site, new-generation large-capacity BBUs based on a virtualized platform, ultra broadband RF units, new-generation 5G transmission devices, and new-generation large-capacity outdoor cabinets. Multi-mode BBUs or RF units can be converged and collaborative. They are highly reliable and adaptive to various scenarios. The solution reduces TCO. It makes good use of existing network devices, so that the operator's investment can be protected. The multi-band multi-mode site reduces the number of devices used and allows for long-term smooth evolution. This saves more space and consumes less energy. The solution also provides easy deployment. Its multi-band multi-mode converged devices and all-in-one highly integrated outdoor cabinets simplify site installation, and its flexible site schemes facilitate rapid deployment. ZTE TECHNOLOGIES

ZTE 4MIX Distributed Cloud Solution Builds 5G-Ready Cloud Infrastructure

Ma Chirong

Planning Manager of ZTE CCN Products

Cloudified reconstruction of telecommunications networks is already the consensus of global operators. Virtualization technology brings many advantages such as cost reduction and flexible scale-in/out. However, with the advent of 5G, new challenges and problems are constantly emerging.

5G has three major application scenarios: enhanced mobile broadband (eMBB), focusing on 4K/8K HD videos, VR/AR and other high-bandwidth services, requiring a transmission rate 10 times faster than 4G; high reliability and low latency communications (uRLLC), focusing on high-reliability and low-latency services such as self-driving car and telemedicine, requiring a delay as low as one millisecond; and massive machine type communications (mMTC), focusing on smart city, smart home and other massive connection services, requiring support for accessing one million devices per square kilometers, 10 times that of 4G. Therefore, 5G networks need to have higher performance and more powerful management capabilities, and also need to be flexible and intelligent to meet a wide variety of application scenarios. At present, the early NFV network infrastructure cloud solutions have bottlenecks in many aspects, and need to be further reformed in terms of deployment architecture, network performance, and operation and maintenance (O&M) convenience.

Distributed Deployment

5G completely realizes control and user plane separation (CUPS), driving the network evolving to a distributed deployment architecture. On the one hand, flexible, high-performance edge nodes are built at the edge of the network to get close to end users: through the local offloading of high-bandwidth services such as 4K/8K and AR/VR, the occupation of the core network and backbone transmission network is reduced, the utilization of bandwidth resources is effectively increased. The high-speed processing capability is moved to the edge, effectively supporting services requiring ultra-low latency such as self-driving car and telemedicine. Edge nodes also need to be flexible and scalable to meet diverse 5G application scenarios. On the other hand, a

network-wide intensive central node is constructed to provide a resource pool shared across regions, improve resource utilization, achieve efficient centralized management of massive nodes, and cope with rapid network development. The central node can also support a capability exposure platform to provide digital services and help operators achieve value innovation. Therefore, a distributed deployment architecture with features such as flexibility, high performance, and high efficiency will be the main development trend of telecom cloud network.

Hardware Acceleration

Early telecom network cloudification solutions turn traditional network infrastructure based on dedicated hardware into the unified resource pool based on common X86 servers, breaking down resource silos and achieving flexible resource scale-in/out. However, with the advent of 5G, facing the challenges from the performance requirement for ultra-low latency and exponential growth of service scale, common servers lose competitive edge in performance and cost. Hence, hardware acceleration technology is tightly concerned by the industry. Current mainstream hardware acceleration technologies involve offloading the data switching function of virtual switches on the telecom cloud platform to the FPGA SmartNIC to improve forwarding performance, and incorporating the graphics processing unit (GPU) into the unified cloud resource pool as a high-performance computing resource that can make full use of GPU's excellent processing capabilities to improve computing capability of the telecom cloud platform and to provide better support for HD video and AR/VR services. ARM processor virtualization can also be used. The new-generation telecom network cloudification solution needs to converge these hardware acceleration technologies to comprehensively improve both forwarding and computing performance.

Best New Cloud Infrastructure award

AI - Based Intelligent O&M

5G drives network functions (NF) moving to edge nodes close to end users. This trend leads to the dramatic growth of edge nodes by ten times even hundred times, and the O&M workload gets doubled accordingly. Besides, after the cloudified reconstruction of network structure, though layered decoupling significantly reduces hardware costs, more complicity is brought to O&M work. Therefore, telecom operators are looking for more efficient O&M approaches. To this end, deep applications of AI will become the key driver for automated and intelligent O&M. The AI technology is capable of analyzing multidimensional complicated problems across layers and domains, brings higher processing efficiency to multiple aspects of O&M which involve rapid root cause analysis (RCA), real-time dynamic resource adjustment, and capacity predication and analysis, and gradually enables fully automated O&M mode to release manpower and reduce Opex.

Container + Virtual Machine

5G NFs will be based on components and microservices. With less resource occupation and easy migration, container is considered as the resource carrier more fitting to 5G microservice architecture. However, the container technology

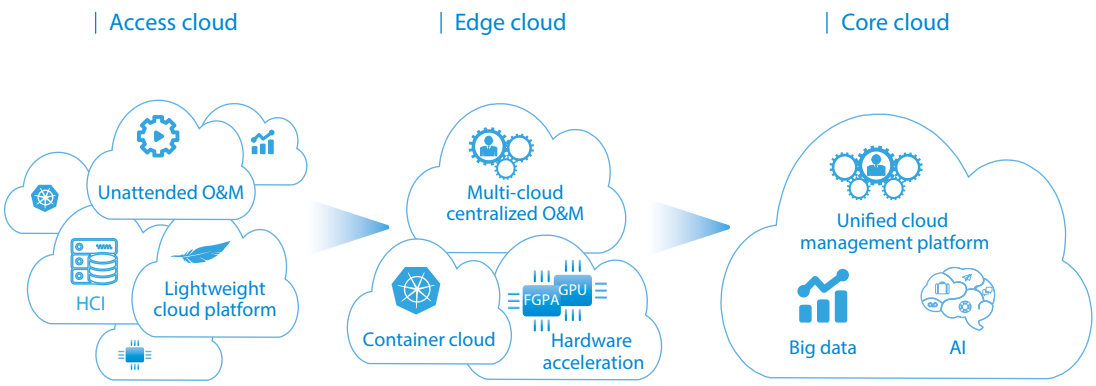


Fig. 1. ZTE's 5G-ready 4MIX distributed cloud infrastructure solution.

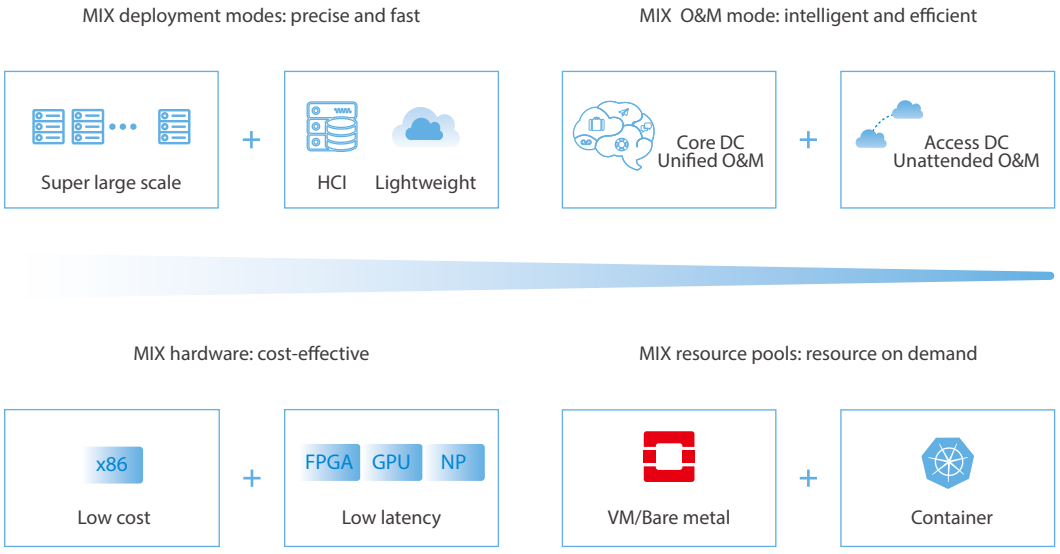


Fig. 2. Features of the 4MIX distributed cloud infrastructure solution.

has not yet matured in the telecom field, as it has weaknesses in orchestration capability and security. Moreover, most of current cloud projects use VM solutions which are constantly evolving in long-term practice and have many advantages. Thus, both the container and VM technologies are quite important to 5G, and the industry is also actively exploring how to choose and balance between them.

To address such challenges, ZTE has developed the 5G-ready 4MIX distributed cloud infrastructure solution (Fig. 1). It is based on the distributed architecture with "core cloud + edge cloud + access cloud", and integrated with HCI, container, hardware acceleration, AI and other advanced technologies to build the 5G-ready cloud infrastructure featuring green, energy-saving, flexible adaption, performance acceleration, intelligence, and high efficiency.

The 4MIX distributed cloud infrastructure solution has the following features (Fig. 2):

- MIX deployment modes: The solution provides auxiliary deployment modes rapidly and accurately for different data centers, such as automated large-scale deployment for core cloud and green lightweight deployment for edge cloud.
- MIX resource pools: The solution combines two mainstream open source cloud platforms, OpenStack and Kubernetes, to build an integrated resource pool, to carry out unified management and orchestration of VM, bare metal, and container sources, and flexibly allocate resources according to upper layer applications.
- MIX hardware: The solution combines X86 servers and acceleration hardware such as FPGA properly and carries out unified management through the same cloud platform to significantly reduce hardware investment, guarantee high performance of the network, and finally offer the most cost-effective solution to users.
- MIX O&M mode: The solution builds an end-to-end closed-loop automatic O&M for the entire distributed cloud through remote control and AI technologies, bringing an efficient O&M mode with unmanned remote sites and centralized control at the center.

The 4MIX distributed cloud infrastructure solution creates the optimal configuration for excellent user experience and precise deployment to meet the requirements in different 5G scenarios, facilitating the construction of 5G-ready cloud infrastructure. The solution won the "Best New Cloud Infrastructure" award at the SDN NFV World Congress 2018. This award fully showcases ZTE's innovation capability and leading position in the SDN/NFV field. ZTE TECHNOLOGIES

5G FWA: Solution to Last Mile Deployment

Bai Wei
International Marketing Manager of ZTE TDD&5G Products

In October 2018, Verizon began to launch its 5G Home service in parts of four cities in the United States. Although this launch was based on proprietary rather than fully standardized 5G technologies, it marked a new milestone for global 5G commercialization.

5G has three application scenarios: eMBB, mMTC and URLLC. Fixed wireless access (FWA) is a special application of eMBB and also one of the earliest commercial use cases in the 5G era. 5G-based FWA (5G FWA) provides three-dimensional coverage and fiber-like experience, satisfying multiple needs of operators.

Three-Dimensional Coverage

The last mile access is a complicated process that involves a long period of engineering practice, difficult secondary construction, and high maintenance costs as well as high complaints caused by the destruction of property and decoration. All these result in a deployment problem in the last mile.

However, FWA using electromagnetic waves instead of cables as the medium for signal transmission avoids the problems of traditional deployment including digging trenches and cabling (Fig. 1). The traditional wired access solution provides one-dimensional coverage, that is, signal transmission is provided where there are cables. FWA offers two-dimensional coverage, that is, when a site is established, users in the site-centered coverage area can enjoy high-speed access service. 5G-based FWA can even provide three-dimensional coverage, that is, users in the high-rise buildings covered by the site can enjoy high-speed data access service.

FWA is the only option in many scenarios such as rural areas or the areas where fibers cannot reach the home. In developing countries, only 20% of households have access to fixed broadband networks. FWA is a better choice of broadband connection for the remaining 80% of households.

Fiber-Like Experience

The reason why 5G FWA can address the growing needs for broadband data access is mainly due to the improvements and breakthroughs that have been made on key 5G technologies including new radio (NR) interface, massive MIMO, as well as network slicing and QoS guarantee. 5G FWA provides users with fiber-like experience.

New Radio Interface

The overall design of 5G NR protocol layer is based on LTE and has been enhanced and optimized. At the physical layer, NR reduces air interface overhead by optimizing the reference signal design and enables flexible bandwidth configuration by using more flexible waveform and frame structure. The new channel coding and modulation scheme allows the 5G physical layer to have more flexibility and better performance for adapting to different application scenarios.

Massive MIMO

There will be a significant increase in the number of 5G base station antennas and ports, which will enable a large-scale antenna array with hundreds of antennas and dozens of antenna ports. Depending on the accurate and mature channel estimation algorithm and multi-user MIMO (MU-MIMO) scheduling mechanism, Massive MIMO supports spatial multiplexing transmission of multiple users, which leads to several-fold increase in 5G spectrum efficiency and is beneficial to enhance user experience in user-intensive high-capacity scenarios.

Network Slicing and QoS Guarantee

Network slicing is an important enabling technology for 5G networks. Provided that key indicators such as spectral efficiency, system capacity and network quality are not affected, wireless network slicing places emphasis on the utilization efficiency of air interface time-frequency resources and uses a combination of flexible frame structure and QoS differentiation to achieve intelligent scheduling of radio resources. Moreover, differentiated

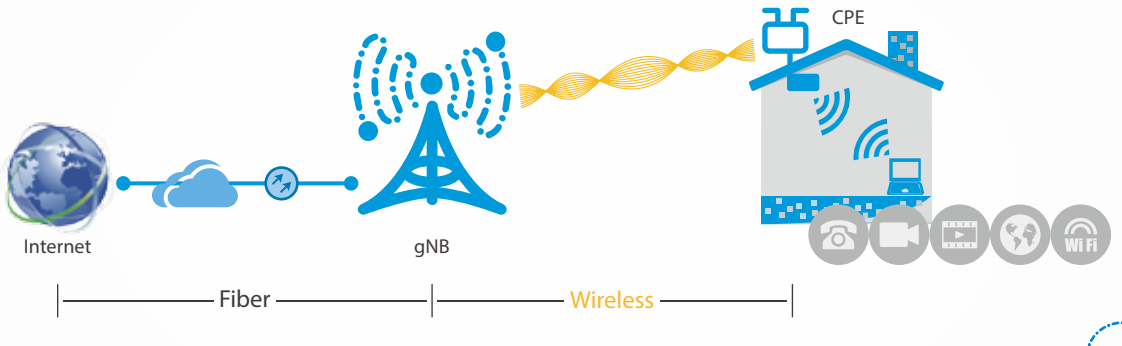


Fig. 1. 5G FWA provides three-dimensional coverage.

network slicing comes true through flexible re-configuration of radio network parameters.

The current test made by ZTE shows that 5G offers a user experience rate of 1 Gbps (100 times that of 4G) and a peak data rate of 20 Gbps (20 times that of 4G). This implies that making full use of every bit of spectral resource available in a 5G network improves the data speed, capacity, latency, reliability, efficiency and coverage to a new level, so that the need for last mile access can be completely satisfied.

Choice of Bands

Which frequency bands should be used for a 5G FWA network? Verizon uses 28 GHz and 39 GHz bands to deliver 5G Home services, but views from the industry are not exactly the same. In fact, the 5G FWA solution has no specific requirement for frequency bands. The frequency bands used by FWA need to be strongly related to band strategies, user and business development, and existing network conditions of operators.

The transmission distance of sub-6 GHz (below 6 GHz) primarily depends on path loss and indoor penetration loss. As sub-6 GHz meets the needs of both coverage and capacity, it can reach an ideal compromise between peak rate and coverage. Therefore, sub-6 GHz is more suitable for suburban or rural areas where MBB services are needed.

Millimeter wave (mmWave) spectrum above 6 GHz provides ultra large bandwidth, larger capacity and higher speeds. But in addition to path loss and indoor penetration loss, mmWave is also affected by trees, radio-wave scattering and rain attenuation. Despite the lack of continuous coverage, mmWave is a better option for short-distance FWA (below 200 meters).

At present, fourteen countries and regions in the world have made 5G plans on the sub-6 GHz bands, while six countries and regions have planned 5G on the bands above 6 GHz. To meet the requirements of different countries and regions, ZTE has released a full range of new-generation 5G base stations operating on sub-1G, sub-6G and mmWave to fully support commercial deployments of FWA around the world.

Satisfying Multiple Needs

5G FWA provides mobile operators with the opportunities to expand into the home and enterprise broadband market without the need to build a fixed-line network. Introducing hybrid service products into the home and enterprise market in the form of FWA bundled eMBB services, and binding home broadband to voice and video services are the most effective solution to attract users and increase the monthly average revenue per user (ARPU). In this way, users can cut costs, and operators can enhance user stickiness, increase network revenue and gain more market share.

FWA allows traditional fixed-line operators to rapidly deploy wireless broadband networks based on their existing transmission networks, so that they can quickly attract users and occupy the market. Utilizing the 5G network, FWA services can be launched to enable broadband access for households, enterprises and individuals in different scenarios. With the existing transmission resources, FWA and FTTx can complement each other.

FWA can help emerging operators quickly enter the regional market for its small investment, rapid deployment and short return on investment, laying a sound foundation for their future network expansion.

Summary

FWA has become one of dominant broadband access solutions for last mile access and has also been considered one of the earliest mature use cases in the 5G era. ZTE has successfully deployed wireless broadband services based on TDD networks in many countries and has accumulated rich deployment experience. Incorporating its successful experience into the increasingly mature 5G system, ZTE can respond quickly to the needs of fixed wireless broadband and offer tailor-made products and solutions. ZTE TECHNOLOGIES

AI to Boost 5G Mobile Network Operations for Future

Tang Liang
Wireless Solution Manager of ZTE TDD&5G Products

With the cloud and NFV transformation of telecom networks, integration of 5G and IoT, and development of diverse industrial applications, the operations of telecom networks will face unprecedented challenges in the 5G era. These challenges involve complex networking, diverse services and personalized experience.

- Complex networking. Coexistence of 2G, 3G, 4G and 5G networks brings difficulties in network synergy and interoperability, difficulties in fault demarcation and location under the hierarchical decoupling architecture, and also challenges of unified resource scheduling and operations due to the dynamic change of cloud and virtual networks.
- Diverse services. The single man-to-man communication mode has gradually evolved into a full-scenario communication mode that involves man-to-man, man-to-machine, and machine-to-machine communications. The business scenarios will be more complicated and thus bring about differentiated SLA requirements such as high bandwidth, massive connections, ultra-high reliability and low latency, and the associated complex network management.
- Personalized experience. Relying on 5G network capabilities and abundant business modes, 5G service experience will also tend to be diverse and personalized, such as immersive experience, real-time interaction, and accurate perception of emotions and intentions. The network's support for the experience will subvert the traditional model and usher in new challenges.

Therefore, the challenges of network operations that come with the 5G era will be significant. The advanced automated operations are gradually forming a gap with the traditional operations based on expert experience. Automated and intelligent network operations will be the just need in the 5G era. Artificial intelligence (AI) technology has intrinsic advantages in solving high-volume data analysis, cross-domain feature mining, and dynamic strategy generation, and will create new modes and capabilities for 5G network operations.

In the future, based on the cloud infrastructure, the network that combines 5G, AI and IoT will gradually become the intelligent center of digital society and promote intelligent interconnection of all things.

As the world's leading telecom solution provider and 5G leader, ZTE has actively combined the AI technology with 5G to carry out automation and intelligence in related fields covering 5G wireless, cloud, slicing, bearer and operations services. Moreover, ZTE has also

actively participated in the development of relevant standards and contributions to open source technologies.

A 5G network serves as the fundamental infrastructure that can support digital development of various industries and provide differentiated services for all industry scenarios. To support a variety of industry applications and business scenarios in a flexible and on-demand manner, the 5G network will be built with cloud service-based architecture (SBA) to meet the future long-term development needs. 5G RAN implements CU/DU separation. The CU can support cloud or dedicated hardware deployment, flexibly adapting to various scenarios. The service-based architecture allows for a converged core of 2G, 3G, 4G and 5G networks, meeting the needs of smooth evolution, collaborative development and long-term coexistence.

5G cloud and service-based architecture is the foundation to support various industry applications and business scenarios. Enabling efficient, flexible, low-cost, easy operations with openness and innovation will be the core competitiveness of operators in the 5G era. This is also a key trend of 5G network intelligence and its main requirements involve:

- Flexible radio and cloud resource management: The 5G network needs to support on-demand allocation of radio air interface resources including spectrum, frame structure, physical layer, and high-level processing flow. It needs to implement software and hardware decoupling, dynamic allocation of processing resources, and agile creation and adjustment of network capabilities. Dynamic allocation of cloud and bearer network resources, intelligent management of global strategies, and automated management of end-to-end slices are also required.
- Air interface coordination and site collaboration: It is necessary to optimize the interference and site collaboration in dense 5G networks. There is also a pressing need for designing a more efficient and more intelligent mobility management mechanism in ultra-dense 5G networks.
- Flexible function deployment and edge computing: AR/VR, industrial internet, and internet of vehicle (IoV) have placed higher requirements on communication latency, reliability, and security. The 5G network moves some functions from the core layer to the edge to form edge computing capabilities. By shortening link distance and improving intelligence of the edge network, operators can save backhaul bandwidth, reduce network latency and intelligently ensure user experience.
- Enhanced network intelligent management: 5G network requires multi-system coexistence and coordination, cloud-based hierarchical decoupling and fault location, SBA-based holographic perception, and on-demand scheduling of bearer resources. This greatly increases complexity and difficulty in network management and optimization. It is therefore necessary to introduce AI to improve automation and intelligence of network management, reduce artificial interference, save costs, and thus enhance network QoS and user experience.

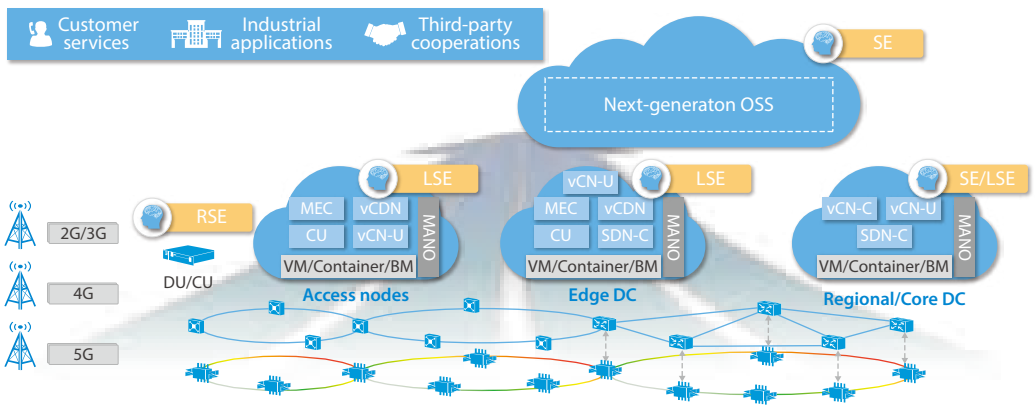


Fig. 1. ▶ Architecture of ZTE 5G AI solution.

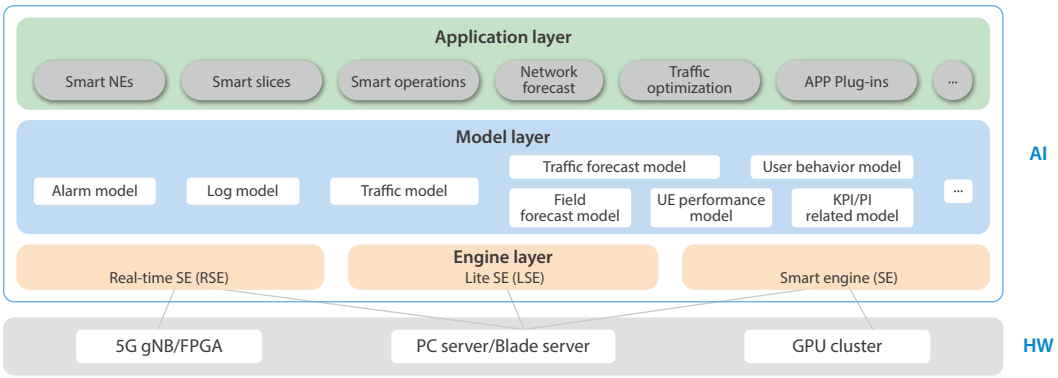


Fig. 2. 5G AI capability architecture.

Faced with the challenges of 5G development and the needs to introduce intelligence, the combination of AI and telecom networks will be ubiquitous in 5G networks. An intelligent 5G network can be achieved by introducing algorithm models and intelligent engines into different levels of the network, as shown in Fig. 1.

Based on the cloud and service-based architecture, 5G network has distinct differences at different network levels. The upper layer is more centralized and has higher requirements for cross-domain analysis and scheduling capabilities such as E2E slice orchestration and management and global cloud resource coordination that rely on the centralized smart engine (SE) for centralized global strategy training and reasoning. The lower layer closer to the end side focuses on intelligence enhancement of professional subnets or single network elements. Access network, bearer network, and core network introduce Lite SE (LSE) to enhance intelligence of subnets or the sub-slice domain such as management strategies and smart operations. Edge devices such as MEC and 5G gNB introduce real-time SE (RSE) to achieve real-time or quasi-real-time intelligence at the edge.

The AI algorithm model and smart engines at various levels can be deployed based on the hardware computing environments in 5G networks. The combination of engines, model components, and application algorithms with different network functional entities enables 5G network intelligence.

The basic hardware environments where AI capabilities are deployed in a 5G network can be centralized GPU clusters, general-purpose servers or blade servers, or 5G base stations. The intelligent capability layer (AI layer) contains the engine layer, model layer and application layer (Fig. 2).

- Engine layer: It supports smart engines at different levels including centralized AI and big data SE, LSE, and real-time or quasi-real-time SE, as well as visual modeling component AI Explorer and machine learning, and deep learning framework, flexibly meeting the needs of different deployment scenarios.
- Model layer: It supports abundant general-purpose capability model components in a 5G network, such as alarm correlation model, capacity prediction model, user behavior model and traffic model, flexibly supporting the calls of the application layer.
- Application layer: It is oriented to 5G intelligent applications, flexibly supporting a variety of application scenarios such as intelligent prediction, RF fingerprinting, intelligent slicing, and root cause analysis.

The combination of various AI capabilities can be integrated into ZTE 5G products including 5G NR, 5G cloud core, 5G UME, VMAX and BigDNA to meet specific needs of network deployment. ZTE's AI-assisted intelligent networks will help operators plan their networks more scientifically with more accurate fault location capabilities, lower operation costs, and business capabilities that better meet user needs, so that they can survive the fierce competition in the coming 5G era. ZTE TECHNOLOGIES

Progress of 5G Standards in 3GPP

Cai Xiaoliang
5G Solution Marketing Manager at ZTE

Mobile internet has overturned traditional business models of mobile communications. In 2020 and beyond, mobile internet will promote further upgrades in the way human society interacts with information, providing users with ultimate service experience such as augmented reality, virtual reality, ultra-high definition videos, mobile cloud, autonomous driving, and smart city. As new services continue to emerge, there is a pressing need for new mobile technologies that will be faster, smarter and more efficient.

5G has completely subverted 4G technical standards and there needs huge technical updates. The ITU sets requirements that 3GPP must propose pre-standard 5G before 2018 and put forward the first formal commercial 5G standards in 2020. 3GPP faces the pressure of tight time and heavy tasks in formulating 5G standards.

5G Standardization in 3GPP

According to the 3GPP plan, 5G standards are completed in two phases. The first phase of 3GPP 5G R15 standards was completed in June 2018. In this phase, 5G standalone (SA) standards were completed, enhanced mobile broadband (eMBB) and ultra-reliable low-latency (URLLC) IoT were supported, and network interface protocol was completed. The second phase of 3GPP 5G R16 standards are expected to be completed in March 2020. In this phase, the complete 5G standards will fully meet all ITU requirements.

At the 82nd plenary session of 3GPP RAN that just ended, 3GPP decided that the R15 Late Drop would be frozen in March 2019 and the R15 Late ASN.1 Drop would be completed in June 2019. The R15 Late ASN.1 Drop will contain Option7, Option4 and NR-NR dual connectivity. R15 is the first version of 5G commercial standards and has synergy with the R16 standards. R15 supports eMBB and URLLC in three 5G scenarios, and the massive machine communication (mMTC) scenario will be defined in the follow-up study. R15 focuses on the 5G NR interface (waveform, coding, parameters, frame structure, and large-scale array antennas) and network architecture (NSA, SA, and CU/DU separation) in the eMBB scenario.

Release of 3GPP R15 Standards

The 80th plenary session of 3GPP RAN was held in San Diego in June 2018, where participants witnessed the birth of two milestones in the 5G standardization process. The first milestone was that 3GPP completed on time 5G NR specifications for R15 SA. The new specifications will deploy 5G NR with 5G core networks, supporting end-to-end new features including network slicing and more granular QoS models. In addition to 5G NR specifications for R15 NSA released in December 2017, 3GPP has completed the first phase of global 5G standards and is ready for commercial deployment in 2019.

The second milestone is the approval of 5G Phase-2 projects that will have a significant

impact on 3GPP R16 specifications. Some projects focus on further improving mobile broadband performance, while more projects will be based on the flexible framework of Release 15 to extend 5G support for new use cases. The expansion of 5G chiefly depends on 5G NR and also includes LTE evolution.

ZTE's Contribution to 5G Standards

ZTE has a total of 800 experts devoted to telecom standardization work. Among them, more than 200 are 5G experts who are fully involved in the major international standards organizations and promotion platforms such as ITU, 3GPP, IEEE, NGMN, ETSI, OpenFog, CCSA, IMT-2020, 5GIA and 5GAA. ZTE has submitted over 4,700 international proposals to 3GPP and has become the editor in three 5G key specifications and the vice chair in 3GPP RAN3. By the end of 2017, ZTE had accumulatively achieved over 2000 5G-related patents and most of them were core patents. As an active contributor to 5G standards, ZTE has proposed a number of 5G original core technologies in terms of LDPC coding, ultra short frame, M-MIMO, NOMA, high frequency, new waveform, unified frame structure, and network slicing.

- LDPC coding: ZTE was the first to propose the compact LDPC matrix framework. The proposal has been accepted in 3GPP.
- Ultra short frame: ZTE proposed the mini-slot DL preemption mechanism. The proposal has been standardized in R15.
- M-MIMO: ZTE proposed M-MIMO based on CSI feedback of TDD reciprocity.
- NOMA: ZTE established the NOMA project successfully in 3GPP, introducing the non-orthogonal multiple access scheme to the physical layer.
- High frequency: ZTE determined the hybrid channel modeling. The channel modeling has been included in the ITU reference framework.
- New waveform: ZTE proposed the FB-OFDM scheme for effective intersymbol interference suppression.

5G was just a vision or even a hype for everyone two years ago, but with the completion of R15 standards, 3GPP made 5G possible in a short time. The 5G R15 standards not only provide users with higher data rates and bandwidth but also meet communication needs of different industries through an open and flexible design. 5G will be an integrated platform for diverse industries.

It is difficult for 5G to arouse such a great interest in the industry if it only increases network rates. The charm of 5G is to transform the industry. 5G experience that consumers can clearly foresee in the short term is indeed double speeds. This has also been verified in some 5G labs or field tests. 5G spectrum efficiency is more than five times that of 4G, its peak data rates reach gigabits per second, and its network energy efficiency exceeds 100 times that of 4G.

5G has a greater impact on the industry. According to the *White Paper on 5G Economic and Social Impact* of CAICT, by 2030, the direct contribution of 5G will bring about 6.3 trillion yuan of total output, 2.9 trillion yuan of economic value added and 8 million employment opportunities, while the indirect contribution of 5G will bring about 10.6 trillion yuan of total output, 3.6 trillion yuan of economic value added and 11.5 million employment opportunities.

Internet of vehicles, mobile health and industrial internet used to only exist in concepts or preliminary intelligent application scenarios. Their potential cannot be maximized until 5G appears to support them.

5G is not only the evolution of communications technologies, but also the revolution of business models. Network architecture and core network have undergone tremendous changes in the 5G era, which can better meet the needs of vertical industries. This is one of the important signs of 5G revolution. Therefore, expanding the 5G ecosystem to allow more vertical industries to join the work related to promoting 5G development and to exert their potential is also the direction of the whole industry. 5G standards are settled, but this is only the beginning. ZTE TECHNOLOGIES

ZTE and China Mobile Jointly Provide Wireless Coverage for HongKong-Zhuhai-Macao Bridge

Shang Boxing
Wireless Solution Manager at ZTE

As Chinese President Xi Jinping announced the opening of the HongKong-Zhuhai-Macao Bridge (HZMB) on October 23, 2018, the 55-kilometer bridge crowned one of the "seven wonders of the modern world" was officially put into operation. ZTE teamed with the Guangdong arm of China Mobile to provide a comprehensive solution for customized wireless network coverage for the world's longest sea-crossing bridge.

On the first day of opening, the peak number of 4G network users of the HZMB exceeded 5,000, the wireless connection rate exceeded 99.6%, and the VoLTE connection rate exceeded 99.7%.

The on-site VoLTE user experience was good. Whether in the bridge steel frame structure or the 6.75-kilometer submarine tunnel, the mobile 4G download and upload rate reach up to 50 Mbps and 18 Mbps respectively at a high speed scene, recording the world's advanced level. As of the bridge's first month of operation on November 23, the cumulative traffic was 67.4T and the cumulative number of users reached 378,000. The number of single-day traffic and users reached a peak of 2.76T and 16,800 respectively on October 27. All indicators on site were within the design range.

After eight years' consecutive construction and investment of over RMB 100 billion, the 55-kilometer HZMB is the first "Super Project" integrated with bridges, tunnels and artificial islands.

The complex structure poses a big challenge on continuous coverage of bridge network signals.

The bridge belongs to special linear coverage scenarios and is located in the South Coast of China where typhoon, thunderstorm, high temperature and other extreme weather regularly rage in this region. Many wireless signals in Hong Kong and Macao form mutual interference on the bridge.

Faced with this challenge, ZTE and China Mobile have a clear aim, that is, to build a ubiquitous, powerful and easy-to-manage

full-coverage wireless network for HZMB to ensure safe and smooth use of the network when crossing the sea. However, deploying a wireless network on the world's longest sea-crossing bridge is not an easy task. The two sides set up a joint project team of over 100 technical experts to solve the problems one by one.

In respect to the equipment model, the project adopted ZTE's TDD LTE multi-mode RRU and FDD LTE high-power RRU for the purpose of supporting varied modes of network coverage while addressing the storage enhancement resulting from eMBB in future.

As the waters of the Pearl River estuary where HZMB is located are wide, the bridge will be subjected to various harsh environments such as strong winds, huge waves, heavy rains, and lightning that impose stringent requirements on equipment. ZTE customized the fastened component in case of extreme weathers. All the components are specially treated to protect equipment from high humidity and salinity. On September 15, 2018, the subtropical super typhoon "Hawthorn" was registered in the northeastern part of the South China Sea. HZMB was in the center and withstood the test of the 16-level typhoon. All communication equipment on the bridge was operating normally, providing stable communication guarantee for the real-time update of disaster information and the follow-up disaster relief work. The wireless coverage scheme for HZMB provided by ZTE has been convincingly proven in practice.

To address the linear coverage scenario of HZMB, ZTE located the equipment rooms on the Zhuhai-Macao Artificial Island and West Artificial Island beside the bridge, extending the range of RRU to over 10 kilometers. Considering space, future 5G deployment and fiber core resources, ZTE also adopted "two directional single core" solution, thereby saving 75% of fiber core.

In collaboration with China Mobile, ZTE spent 43 months in formulating a comprehensive solution of customized wireless network coverage for HZMB. In fact, during the 43 months, it only took three months to complete base station construction (from September to December 2017), and the rest time was spent on solution verification including the use of special technologies, the requirements for ultra-long coverage, and the design of special bows. ZTE creatively proposed to employ the crane on the land to carry RRU in order to conduct an efficient field trial on the bridge. This ensured complete compliance and one-time construction completion.

GPS is a clock synchronization signal used by a conventional 4G network, but it may be artificially interfered during special periods such as major festivals. To prevent potential social security problems, GPS signals need to be improved. ZTE used wireless GPS and wired IEEE1588 V2 to provide stable clock synchronization signals to ensure stable operation of wireless equipment on the bridge.

The bridge network signal coverage provided by ZTE can not only meet the existing 4G network coverage requirements but also take into account the smooth evolution of the 5G network coverage in the future. By means of 5G-Ready and Cloud RAN solutions, ZTE's network enables GSM/FDD/NB-IoT/eMTC/TDD multi-mode, multi-band integration and deployment while adopting the architecture of shared MEC and CU server for future 5G. It is a huge challenge for both telecom operators and equipment vendors to provide wireless coverage for the super HZMB project

ZTE's equipment room on the Zhuhai-Macao Artificial Island

because of its extremely high requirements for delivery capabilities, network quality and user experience. The success in this super project shows that China's mobile coverage technology has reached the highest level of performance and specifications in the world. ZTE will customize and develop more innovative technologies in the future, providing integrated telecom solutions as well as quality and reliable products for overseas wireless communications. ZTE TECHNOLOGIES

How ZTE's Common Core Will Help Telcos to Evolve from Existing Networks to 5G

Source: RCRwireless Juan Pedro Tomás November 6, 2018

ZTE's Common Core is already helping mobile operators globally to evolve from existing networks to target 5G networks, Jason Tu, Chief cientist of NFV/SDN Products at ZTE, told *RCR Wireless News*.

Commenting on the main features of ZTE Common Core and how this technology can help carriers evolve towards 5G, the executive said that the ZTE Convergent Common Core for 2G/3G/4G/5G fixed network provides a complete, 5G-oriented cloud-native core solution, which can be introduced to build an independent 5G core or upgrade the existing EPC network.

"It is one unified network that can not only work as EPC/EPC+/5GC or any combination of them to support non-standalone or standalone 5G, but also adapt fixed access to the 5G Core. It provides the best way to save investment on 4G expansion and smooth evolution to 5G," Tu said. "With the introduction of 5G and the long-term coexistence of 2G/3G/4G networks, operators are facing the challenge of complex and diverse network architecture and rising costs," he added.

The executive said that ZTE Common Core offers benefits to operators, end-users and partners. Operators can build a 5G-oriented common network for all generations of access technologies. The network can be working as a standard EPC/EPC+/5GC with fixed access on the unified architecture with minimum costs. The network will allow new 4G and/or 5G services to be developed and generate new revenue for operators.

Meanwhile, end users can have a smooth access to any network to enjoy their services with unified authentication independent of access technologies. Besides, ZTE Common Core will always provide service continuity when handover between any access technologies occurs, the executive said.

Tu also highlighted that ZTE Common Core provides end-to-end network slicing to collaborate with partners to pave the path to 5G.

"ZTE Common Core is based on a full three-layer decoupling architecture which follows standards of NFV/SDN and open-source communities. It is able to smoothly integrate with hardware and software from multiple vendors in the ecosystem such as HP, Dell, Red Hat, and VMware," he said.

Jason Tu

Chief Scientist of NFV/SDN Products at ZTE

"ZTE Common Core offers benefits to operators, end-users and partners. Operators can build a 5G-oriented common network for all generations of access technologies. The network can be working as a standard EPC/EPC+/5GC with fixed access on the unified architecture with minimum costs," said Jason Tu, Chief Scientist of NFV/SDN Products at ZTE.

Common Core also reduces Capex for existing EPC network upgrades.

"ZTE Convergent Common Core product is not only fully compliant with EPC, but capable of providing new 5GC features. Licenses between 2G/3G/4G/5G/Fixed can be shared or converted flexibly," the executive explained. "The total migration costs can be saved because it only takes one step to migrate to the target common core network instead of multiple upgrades," he added.

Common Core also allows telcos to reduce Opex due to its simplified network topology, according to Tu. "All network functions apply the unified management topology, the unified user interface, and the unified platform, resulting in a significant reduction in Opex," he said.

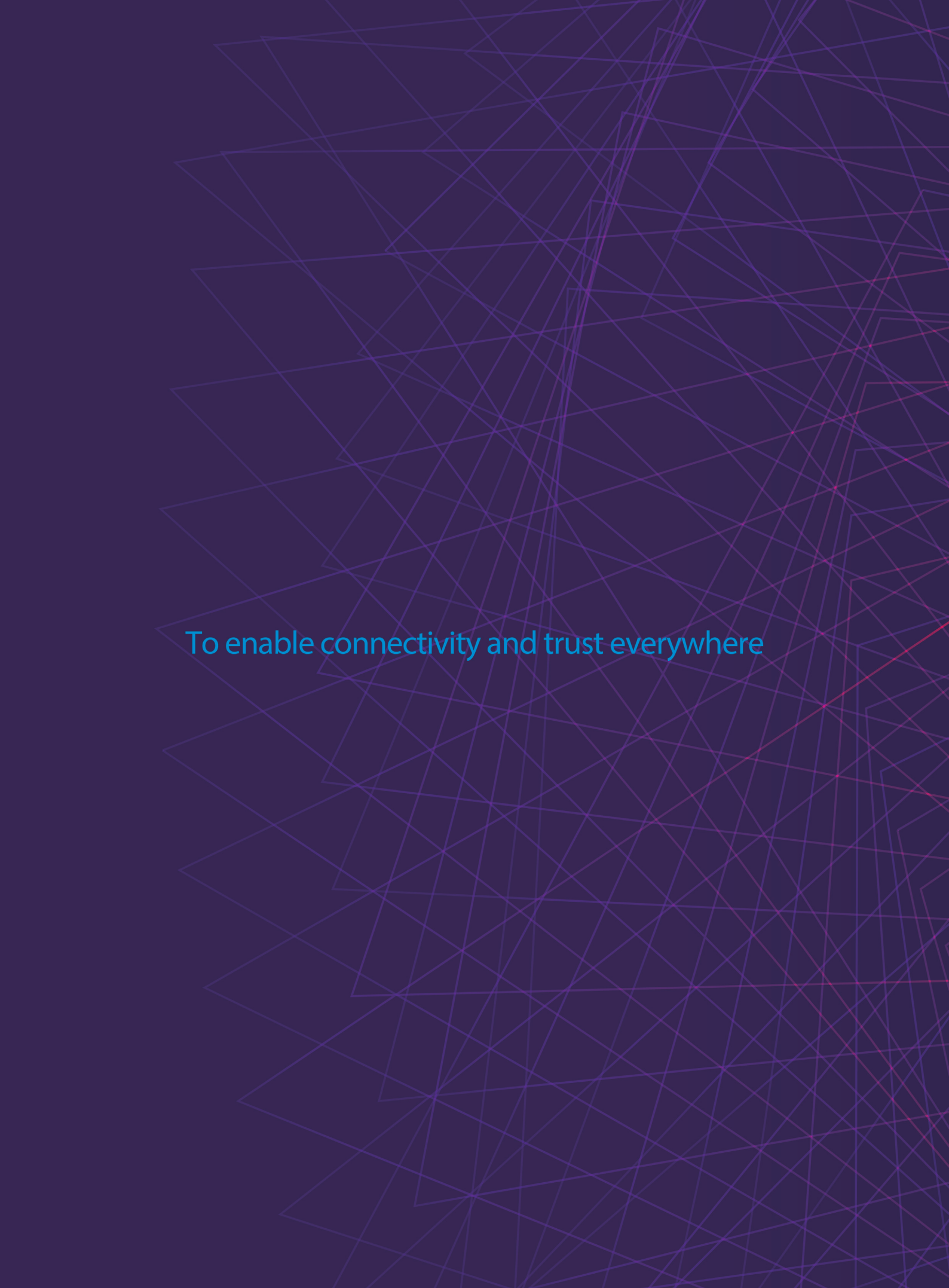
"All network functions in 2G/3G/4G/5G/Fixed can be deployed automatically via intelligent network slicing and cloud native architecture. Operators can shorten time duration of network deployment and speed up the deployment of new services. This improves operational efficiency significantly even for cases of a great number of industry slicing," he added.

According to the executive, the introduction of artificial intelligence/machine learning and end-to-end network slicing will enable intelligent operation and agile deployment of the network.

ZTE CloudStudio solution is in charge of the end-to-end network slicing management and the Slice/NS/VNF lifecycle management to achieve the orchestration and management of network services. Based on AI technology and an automation software framework, it provides end-to-end CI/CD (continuous integration/continuous delivery) capabilities for telecommunication networks and has large data processing capabilities for telecom operations to achieve full network autonomy without manual intervention.

Through the use of ZTE CloudStudio automatic network slicing solution, operators can reduce the operation and maintenance manpower, while the O&M efficiency can be improved, and the on-line service time to market can be shortened, Tu said.

ZTE Common Core is now conducting a field trial in China's Guangdong Province and expects to launch its commercial version during the first quarter of 2019. ZTE TECHNOLOGIES


To enable connectivity and trust everywhere