VIP Voices

How Nepal Telecom Is Navigating the Fast-Changing Telecom Landscape

Expert Views

5G SA Leads Industrial Applications to a New Era

Special Topic:
Video over Gigabit

Cover Figure | **Dilli Ram Adhikari, Managing Director of Nepal Telecom**

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How Nepal Telecom Is Navigating the Fast-Changing Telecom Landscape

Reporter: Zhu Qing

Dilli Ram Adhikari, Managing Director of Nepal Telecom

Operators in Nepal are facing a variety of challenges such as a stiff competition and keeping up the revenues. However, Nepal Telecom, Nepal's largest telecom operator, sees challenges as opportunities. "I have always concentrated more on opportunities than the underlying challenges," says Dilli Ram Adhikari, Managing Director of Nepal Telecom, who shares with us how the company is catering to the changing technological trends, such as the decline of fixed-line connection, the emerging 5G, and IT/CT convergence, to tap new revenue streams.

You are arguably the youngest Managing Director in the history of Nepal Telecom. What challenges have you faced so far? What's your take on the current voice and data business of Nepal Telecom?

Nepal Telecom has been serving in Nepal under different names for over 100 years. I don't have concrete evidence to claim myself as the youngest Managing Director in its history. However, I was able to cement my place as a Managing Director through an open competition announced by the Government of Nepal in a relatively short career span. I joined Nepal Telecom in 2003 and I was fortunate enough to have this high-flying career.

As an optimistic person, I have always concentrated more on opportunities than the underlying challenges. When I became the Managing Director of Nepal Telecom, we were in a state of roll-out stagnation as far as technology is concerned. We were falling behind other operators on 4G and FTTH expansion. The immediate challenge was to keep these technologies on board and roll-out such projects as quickly as possible. I had the faith and support of my fellow employees, board of directors and ministry with me. This

overwhelming support allowed me to overcome those challenges with ease and we were able to roll-out such projects in the right time and in the right direction.

Another major challenge has been keeping up the revenues in the post-Covid-19 era. As with other operators around the world, we are facing an unanticipated amount of revenue loss in domestic and international voice and roaming traffic. On the other hand, the uptake for data services has been very exciting and encouraging. We have seen nearly 300% surge in our data traffic, and we are very proud to have lived up to the expectation of our public during these tumultuous times.

To sum up, we have more challenges to keep up our revenues for voice traffic whereas we have enormous opportunities to capitalize on data business.

The pandemic has changed the very nature of the global business ecosystem and has left us with an economic future that has never been more ambiguous. What were the technical and operational challenges faced by Nepal Telecom during the pandemic, and what solutions have provided people with reliable connectivity the most?

Nepal Telecom has definitely been an unsung hero in this pandemic offering seamless connectivity at affordable rates. We provided extremely reduced cost packages such as "stay connected", "Zero balance offers" to shoulder our responsibilities in this pandemic. As with other operators around the world, our supply chain or SIM cards and top-up cards got severely affected due to lengthy lockdowns and restricted movements. We were confronted with several impediments for smooth operational and maintenance activities. Our 4G roll-out schedules got derailed. We also faced an astronomically huge demand of internet traffic along the way.

In order to overcome the challenges, we augmented our backbone network capacity and our international IP connectivity capacity. We were constantly in touch with concerned administrative bodies throughout the country to avail passes to carry out our O&M activities. Our core technical teams were working more than 16 hours a day from home to address the hefty traffic that were flowing through our networks. We also motivated our customers to use digital payment methods for top-up services.

In such a challenging environment, do you think there is an increasing need to change the way you serve your customers, with more automation and self-serve tools to improve efficiency?

Indeed, the biggest challenge in present context is to retain our customer base in a stiff competitive environment. The method that we deployed to address our customers' grievances and complaints will not be as effective as it used to be in the past. Customer support automation will eliminate the need for human involvement and perform services with better efficiency. One of the biggest advantages of automation for large corporates like us is to off-load the human-to-human touch points when they're either inefficient or unnecessary. We have already geared up to bring automation and self-serve tools to provide better and efficient customer services. We have already set up enhanced customer contact service and are in the process of procuring Business Intelligence Systems, state-of-the-art automated NOC tied up with our customer contact center. We have re-vitalized our mobile app and websites

with self-serve options to provide better customer services.

However, we are also well aware of the underlying threat that hovers around automation which is the "set-it-and-forget-it mentality". As a result, our customer service executives are also constantly in touch on a human level to handle our customers' grievances.

With fixed-line connection declining and mobile penetration at the saturation point, what is Nepal Telecom doing to develop new revenue streams?

Many operators are faced with this same set of challenges. In order to cope up with declining legacy PSTN lines connection, we are trying to add value to those services through FTTH and providing seamless voice and data services at attractive rates. We've just started to roll-out FTTH services in an aggressive manner and the response for uptake has been overwhelming. We have seen significant uptake of fixed broadband services in exchanges where we have migrated from legacy PSTN to FTTH technology. We will soon be launching IPTV services to cater to our customer needs through FTTH connections. We are well aware that the traditional revenue streams are drying up faster. We are working very hard to introduce new services to existing bundles and add up revenues.

We've also found that customers are happy and willing to pay more for pleasant experiences and strong brand bonding. We are also focusing a lot on verticals. In order to use our existing brand to build our financial services portfolio, we have tied up with Rastriya Banijya Bank, a government bank, and recently, launched our new subsidiary

company called "Nepal Digital Payment Company (NDPC)" for rolling out the digital payment services (Mobile Money) to our customers. We are venturing out in enterprise market segment with bundled services along with IOT and M2M services.

What is your take on fixed-mobile convergence (FMC)?

Fixed-mobile convergence is such an exciting solution for a multi-service provider like us. Through FMC our mobile customers can be seamlessly integrated with the fixed network infrastructure of their organizations, which will be an added benefit. For instance, it will help us provide seamless service experience for N-play services to consumers across connected devices at home and on the move. We

need to deep dive and formulate specific plans as well as contingent strategies to address issues such as backward compatibility, interoperability, CRM and many more before taking initial steps on FMC.

Telecom services in Nepal are mostly centered in urban pockets. So, what is Nepal Telecom's plan for the easy access to telecom services for population living in rural areas?

As a public enterprise, our goal is not limited to improving our financial bottom lines. We have always relished the challenges of being at the front lines of bridging the digital divide in Nepal. Our aim is to improve the quality of life of individuals residing in rural areas through connectivity. Currently, we have signed a

Innovations of latest technologies have immensely aided the development of the telecommunications sector. Which latest technology is Nepal Telecom looking for implementation?

We are keeping our eyes and ears open to 5G. In fact, we are rolling out a few 5G base stations as a pilot project in our existing 4G LTE network upgrade project. Our technical team is already exploring the feasibility of Wi-Fi 6 and also making a realistic assessment of our roadmap towards massive 5G deployments. Once we receive a spectrum confirmation for 5G from our regulator, we will accelerate our 5G deployments. We will also be investing a significant amount of money on Big Data and Data Centers in the days ahead. We've also provided connectivity services to Nepal Electricity Authority for their smart meter projects and are looking forward to launching IOT products for our enterprise customers. We will roll out mobile financial services very soon and provide mobile money/digital payment services to our valued customers.

To what extent will the blending of IT and telecom into a more fully integrated ICT sector impact the structure and strategies of telecom operators like Nepal Telecom?

We are very fortunate to have a very strong IT team in Nepal Telecom and the synergic effect of IT and Telecom will definitely sharpen our competitiveness in the market. Marriage between banking and telecom technologies gave birth to our mobile financial services. In the same fashion, the blending of IT and Telecom sector will provide newer opportunities and added revenue streams. Through blending, our services will not only be limited to providing connectivity but also to offer personalized digital services to our customers. In terms of structure and

deal with our regulator to provide backbone infrastructure in five provinces through the universal service obligation (USO) fund called the Rural Telecommunication Development Fund (RTDF) Mobilization project.

We have already begun our work on field in three provinces. In this same pursuit of rural connectivity, we have already signed a deal with some of the private partners to provide wireless broadband services in rural areas. Our tariff rates are competitive and affordable to the general public. We've recently signed a deal with ZTE Corporation to procure mini OLTs for FTTH deployment in rural areas. Despite enormous capital and operational costs, we will never shy away from our responsibility of connecting the unconnected.

strategy, we may need to build new capabilities, restructure our organizational hierarchies, re-invent business models and tap more complex markets.

How do you assess the market readiness for 5G deployments in Nepal? What's your strategy for 5G?

As far as 5G is concerned, it's just the question of "when" rather than "why". Nepal will eventually have to adopt this technology. Currently, we are building our fiber infrastructure at a brisk pace, developing high capacity backbone infrastructure and nationwide tower infrastructure and we believe that this will be pivotal for our 5G deployment in future.

Most of the debate currently with operators and regulators is on the availability of spectrum for 5G, allocation modality and, most importantly, the costs associated with obtaining them. We are exploring our future strategy, value segments and the opportunities that can be harnessed through 5G via a separate dedicated study committee for 5G.

I firmly believe that 5G as a technology will evolve as the time progresses and we do need to collaborate with ecosystem players to provide our services and reap the maximum benefits out of it. The current 4G LTE services across the nation will also make the market foundation for the 5G services.

With respect to preparing for 5G, where are you now on the journey of core network virtualization?

The current ZTE-made LTE core has virtualization features and is expected to be upgraded to higher version to provide 5G capability. We have a long-term relationship with ZTE and we will have every opportunity for knowledge and experience sharing.

What has been and will continue to be the key to Nepal Telecom's success?

One of the biggest strengths is our people. Nepal Telecom's employees are highly qualified and bring in a wealth of experience in several domains with adequate international exposures combined with a positive attitude. Nobody can undermine the expertise that we carry in terms of technology. Our people will continue to remain our pillar of strength.

In addition to this, we have always been an important part of the government's vision of connecting the unconnected. As a result, we have gained an enormous amount of faith and loyalty from our customers over the years. Also, our transparent billing systems, multiple services, and nationwide presence have contributed significantly to our success till date.

What are your primary objectives for the next three years? What do you think you want to be providing to your customers?

Our main growth engine for the next three years will be data and we will be investing a significant amount of our capital budget in strengthening our data infrastructure and providing new services and applications for our valued customers at affordable rates. Also, our main strategy will be geared to regain the top position in both wired and wireless broadband services. With the commercialization of mobile financial services, we are expecting that we will be the leader in digital payment and help the country in digital transformation. Enhancing customer care, service automation for better customer support will be our primary objectives. ZTE TECHNOLOGIES

A1 Belarus:
Preparing for SA 5G

Reporter: Wei Wei, General Manager of ZTE LLC (Belarus)

Christian Laque, Senior Director for Technology, A1 Belarus

"Standalone architecture enables an operator to have the full richness of 5G features," says Christian Laque, Senior Director for Technology, A1 Belarus, in an interview focusing mainly on how A1 Belarus is preparing its network for the 5G era and why it has chosen the SA mode. A1 Belarus has already launched the first 5G SA test network in Belarus.

Belarus as well as other Eurasian countries is still facing the situation wherein 5G frequencies have not been allocated yet. Nevertheless, vendors and operators are doing their best to be fully prepared when this significant event comes. A1 started to build a 5G-ready network back in 2016. Could you elaborate on how A1 is preparing its network for the 5G era?

Being a member of the telecommunications industry, especially as a mobile operator, we are facing an endless increase in demand for bandwidth and number of devices. This is a trend we cannot stop but to embrace. Nowadays, technology is evolving extremely fast, and we have to prepare our network in advance. It comes in waves: you are investing and then you are embracing the next step.

In 2016, together with our partner ZTE, we started to virtualize the entire core network, which helped us really go to the next generation and understand it. We were the first to do this, not only in Belarus, but also worldwide. It enabled A1 to do the next step—to go fully cloud, and implementing new services became much easier than ever before.

In radio network we faced another challenge. We replaced all the equipment with a software defined technology, which helped us add new technologies just by software, no longer replacing the old hardware. We've shown this first in the area of 900 MHz, adding it to GSM, UMTS, even narrow-band IoT, just with some software on top of it. And this was all planned for 1800 MHz—to do it with LTE, and now we will be ready to do it with 5G.

Between the radio and the core network parts, there is the element of transmission and transport, which was quite underestimated in the early days of mobile networks. Today it plays a key role, because it has to transport the hugely increased amount of data. On the other hand, it is one of the elements that enable reduced latency. Here we need high automation and high scalability. Hopefully, in the next step we will have artificial intelligence to really make it happen.

For the 5G-ready virtual core network project, ZTE and A1 were even shortlisted for the Best Network Software Breakthrough award at the Mobile World Congress 2018. That technology made it possible to seamless evolve to micro service-based network slicing and open API architecture to meet the diversified service requirements of 5G. In addition, A1 implemented ZTE´s fully SDN based end-to-end IP+Optical elastic network solution, which provided high flexibility, efficiency and capabilities, perfectly supporting the needs of 5G core network. And now we are already testing 5G SA.

Yes, exactly. We are testing 5G SA already because we have to prepare our network for the future. We are using our core network, radio part, and all the other frequencies to have an end-to-end test today with 5G standalone to be ready when the frequencies are available in this area of the world—to provide the service immediately to the end users. And we are really advanced in these regards, because, for instance, the service that is important in this new technology—VoNR, has already been very successfully tested by us. By virtue of VoNR technology for 5G packet voice transmission, A1 together with ZTE completed the CIS region's first call within the 5G SA network.

We love A1's marketing approach during Belarus' first 5G standalone test in May 2020. A1 was widely referring to it as a "pure" 5G experience in comparison with 5G non-standalone architecture. Could you explain why do you, being an operator, advocate for 5G SA as a model?

There are two different architectures within 5G—non-standalone and standalone. Non-standalone relies fully on LTE infrastructure, and standalone, as its name stands for, is a "real" 5G network. Standalone architecture enables an operator

to have the full richness of 5G features, like lowest latency, massive number of devices and high capacity. The reason why A1 chose standalone mode is simple. Relying only on LTE, we have a disadvantage, because it is not our network and it would be difficult for us to really find a way.

Standalone, I believe, is the ultimate goal for any mobile operator in the world, and each operator is now starting to look into standalone, and more and more of them. The front-runners are in China, where standalone is the ultimate goal today already. So, if it's possible, we are looking for end-to-end. Even today, we have this capability in each part of the network with standalone, not tomorrow. So, let's go for it, because I believe that standalone will be the final goal.

ZTE, being a vendor, is fully prepared for 5G deployments in terms of equipment. Being an operator, how do you assess the current readiness of consumer E2E ecosystem, especially in regards with SA mode?

It is important that we have it end-to-end, because we need to bring the service to the end user device. In the end you have to use it on a smartphone or application on IoT device. Now we are in a lucky situation, in comparison to any generations before, because devices are already available. In 2020 we see more and more 5G-enabled devices supporting both SA and NSA standards. This is of course highly desirable for anybody investing. For us, as operators, and of course, for an end user, because the end user today is investing in 5G device, getting ready when the networks are enabled to run the service on 5G. This brings a new level of service that we will provide together with 5G.

Regardless of the unpredictability brought by COVID-19, the 5G device

An interview

ecosystem keeps getting bigger, as both 5G standalone and non-standalone networks are being deployed. Meanwhile, these devices are becoming more affordable.
Another trend we are observing now as a vendor is that 5G might become a catalyst for the fixed-mobile convergence. What is your take on this matter— fixed-mobile convergence instead of fixed mobile substitution. And what role Wi-Fi will play in the future?

This is, of course, a long discussion. Will mobile networks be really replacing the fixed networks? It was possible for 3G and 4G to do so. But the capacity that you need because of the tremendous increase in demand for the kind of fixed line at home is tremendous. We are transporting so many folds of traffic in the fixed line compared to the mobile line, because we are having video sessions, watching video or TV, mostly at home when we are not moving. And

in the office, we prefer to use Wi-Fi. This is why now is exactly the time to bring together Wi-Fi at home and Wi-Fi in the office. This is just an example where this convergence is happening, because with VoWiFi and VoLTE in new radio, you have a complete set-up to provide the same kind of service—for messaging, for voice, which is still important.

To free up capacity on the mobile network, the devices like smartphones should use Wi-Fi wherever it is possible. The performance of Wi-Fi at home with xPON access is very advanced in speed and roundtrip time. VoWiFi including messages over Wi-Fi plus xPON is an adequate access to build convergence with 5G networks. This is minimally applicable for home and office environment. Real mobile service usage on the go will be dramatically fueled with autonomous vehicles. The mobile networks in the future will be working in convergence with the fixed networks, but with Wi-Fi as the final access to enjoy the freedom of wireless connectivity. **ZTE TECHNOLOGIES**

5G SA Leads Industrial Applications to a New Era

Deng Wei, Deputy Director of Department of Wireless and Device Technology Research of China Mobile Research Institute

Editor's Note: At the ZTE APAC 5G Summit 2020 virtual event held in November 2020, Deng Wei, Deputy Director of Department of Wireless and Device Technology Research of China Mobile Research Institute, talked about how China Mobile is using the capabilities of 5G SA to extend its offerings to vertical industries including steel manufacturing, mining and port. ZTE has been actively involved in China Mobile's 5G deployment.

China Mobile's 5G+ Plan

To support the Digital China strategy, China Mobile comprehensively implements its 5G+ plans, including 5G+4G, 5G+AI, IoT, cloud computing, big data and edge computing (5G+AICDE), 5G+Ecology and 5G+X, which will eventually make 5G the main artery of social information flow, the accelerator of industry transformation, and the cornerstone for the development of digital society.

China Mobile and two other domestic operators have jointly promoted the development of 5G networks and subscriber base. By the end of September, more than 600,000 5G base stations have been deployed, of which, 300,000 base stations were deployed by China Mobile with the number to swell to over 350,000 by the year's end, covering over 300 cities. The number of devices connecting to the 5G network has exceeded 130 million, which is higher than that in the first year of 4G. At the same time, China Mobile has launched some 5G-enabled services that provide brand-new experience for customers.

China Mobile's 5G Strategy

Almost one year after China Mobile's 5G commercialization, China Mobile has launched a core strategy for 5G development, more specifically, accelerating the introduction of 5G SA and grabbing the opportunities in empowering thousands of industries.

What is 5G SA

5G SA enables network, capability and service innovation and supports diversified

> **China Mobile supports the maturity of 5G SA in terms of standards, the industry, and applications. After more than one year of improvement, SA has become commercially viable.**
>
> **Deng Wei**

application scenarios for vertical industries.

First, SA mainly refers to a totally new core network architecture known as 5G Core. Compared with the 4G core network, the 5G Core has a service-based architecture, software-based functions and network intelligence, which allows the rapid introduction of functions and efficient allocation of network resources.

Second, SA brings many new capabilities to an end-to-end 5G network through innovative technologies such as network slicing, edge computing and uplink enhancement.

Third, 5G SA enables a variety of new services such as customized services, private networks and capability exposure.

Only with these three new features can 5G truly change the society.

The Move to 5G SA

● **New Network**

China Mobile's 5G SA network can be commercially used within 2020. China Mobile supports the maturity of 5G SA in terms of standards, the industry, and applications. After more than one year of improvement, SA has become commercially viable.

● **New Capability**

Taking advantage of network slicing and edge computing, 5G SA brings significant performance benefits such as large capacity, high reliability and high uplink bandwidth. Based on different industrial application scenarios and typical requirements such as customized network, ultra-low latency, HD video backhaul, data on-site, service bundling, China Mobile develops three tiers of private network services, which are preferential, exclusive and premium.

There are also three types of capabilities: basic capability (QoS enhancement, slicing, edge computing, and private uplink); network deployment capability (resource pool, private network element, service offloading, wireless public/private network convergence and frequency coordination); service supporting capability (unified entrance, management orchestration, capability exposure and muti-dimensional billing).

For each type of capability, there exist many principles for matching the private network service. For example, slice isolation and DNN are capabilities for preferential service; edge cloud and carrier aggregation

for exclusive service; private frame structure and whole uplink for premium service. This capability system provides support to private 5G network solutions and empowers thousands of industries.

● **New Service**

The core capabilities of 5G SA bring about new business models, such as multi-dimensional and customized services. We can set value-based operation strategies in relation to different network capabilities (network speed, latency, reliability or capability combinations). We can also set customized strategies based on the service characteristics of customer's requirements. Such business models based on diversified values can avoid barriers brought by traffic-based operation mode when introducing 5G into vertical industries, fully use 5G's capabilities and protect the value of 5G networks.

Expanding into Vertical Industries

Three Horizontals and Five Verticals

China has been going through a digitization process for many years. The digital transformation of the entire society has manifested an obvious feature that can be summarized as "three horizontals and five verticals."

The horizontals refer to the three common demands that arise from the digital transformation, namely online operations, intelligentization and cloudification. The verticals are key application scenarios resulting from the rapid penetration of information technology in the economy and society and specifically refers to the digitalization of infrastructure, social governance, production, ways of working and lifestyle.

5G SA with its capabilities maturing at the right time can effectively match the requirements of "three horizontals", fully empower the vertical industries and greatly widen the scope of the communication industry.

China Mobile deeply understands the characteristics of "three horizontals and five verticals" and has created 100 group-level demonstration projects and 1,000 province-level feature projects across 15 industries, which could realize a large-scale replication of those solutions. With the integration of 5G in areas such as logistics, ports, industry, transportation, healthcare and high-end manufacturing, we have created many industry firsts.

Key Industrial Applications

China Mobile has made some exploration in meeting the requirements of different vertical industries with 5G SA.

● **Smart Steel**

The steel industry is a traditional industry with complicated processes and numerous links, including iron-smelting, steel-smelting, steel casting, and logistics. Considering 5G SA's low latency and high uplink bandwidth, China Mobile proposes the principle of "four alls" (for example, all on-site control rooms centralized and all operation positions using robotic arms). This changes a working environment featuring high temperatures, hazardous areas, and toxic gas to one with large-scale centralized control, remote operations and remote video surveillance, improving the work efficiency and achieving the digital transformation of steel enterprises.

● **Smart Mining**

In the mining industry, safe production is priority, which requires unmanned or less manned operations. After analyzing the production process of open pit mines, China Mobile found that the 5G's low latency, high reliability, high uplink bandwidth can meet unmanned requirements of drilling, shoveling and shipment. China Mobile deployed the 5G SA-based unmanned mining truck in Baiyun Ebo, Inner Mongolia, which has greatly improved production efficiency. The underground mining operation can also use

5G for HD video surveillance and unmanned excavations. China Mobile with the uplink enhancement technology achieved a maximum uplink speed of 1100 Mbps for Yangmei Goal Group in Shanxi so that "clearly and fully seeing the underground mine" was realized.

● **Smart Port**

The port industry, both a traditional and modern one, has a high level of mechanization. In order to improve the production efficiency and reduce on-site manpower, the port also has an urgent need for automatic and intelligent transformation. By analyzing port operation flow, we found that, based on 5G SA's low latency and high uplink bandwidth, the transformation can be realized by meeting three conditions: first, wireless signals should meet the industrial equipment control standard; second, the existing business should not be interrupted when there is trenching or fiber installation; third, the port should be expandable in meeting the future new

requirements in terms of equipment positioning, video surveillance and security protection.

● **Smart Healthcare**

5G has played an important role in tackling Covid-19 in China. 5G applications such as HD video live broadcast, remote healthcare, smart medical robot and unmanned vehicles and drones are used to fight against the pandemic and guarantee work resumption. 5G also accelerates the development of digital governance and digital economy and society. Nowadays, people are already accustomed to digital lifestyles such as cloud video, cloud commerce, cloud classroom, cloud office, and cloud games.

Summary

I believe that through the joint efforts of the whole industry, 5G SA will bring industrial applications into a new era, unleash 5G's full potential, and propel the digitalization of the society. ZTE TECHNOLOGIES

Key Technologies to Accelerate the Development of New Video Services

Wang Jindong, Director of Multimedia Pre-research at ZTE

Painpoints in New Video Service Development

Currently, as videos are developing towards ultra HD, immersive experience and strong interactivity, many new video services are emerging in the media industry, for example, virtual reality (VR), multi-viewpoint video (MVV), and free-viewpoint video (FVV). Meanwhile, the pandemic has accelerated the adoption of online education, making it a must-have for many households. However, when launching these services, telecom operators still face many painpoints.

Painpoints for VR services include: lack of high-quality content, flat videos affecting immersive experience; high requirements for content transmission bandwidth; and high transmission latency, which may cause motion sickness.

Painpoints for MVV and FVV include: poor user experience when multiple views of the same content are displayed asynchronously; high cost and complicated deployment resulting from many cameras required by FVV; and difficulty in meeting users' personalized requirements with unified viewpoint direction.

Those for online education include difficultly in implementing bidirectional interaction on a TV screen; high network latency, severe packet loss and stutters; and high network distribution costs when there are open classes and large classes.

ZTE's Key technologies to Solve the Painpoints

ZTE has developed a series of key technologies to solve the above-mentioned painpoints.

Key Technologies for VR

For the lack of VR content, ZTE developed the image quality enhancement and 2D-to-3D video conversion technologies.
- **Image quality enhancement:** This technology divides video scenarios based on an understanding of the content, implements inter-frame algorithm and single-frame optimization algorithm

> **To reduce the end-to-end latency, ZTE proposed the AI-based viewpoint prediction technology. With the smart prediction algorithm, the time advanced is up to 80 ms, which is leading in the industry.**
>
> **Wang Jindong**

respectively for each scenario based on deep neural networks, and then combines them with audio to generate the final video content. The technology covers all the important functions, including video repair, super-resolution, frame rate conversion, image denoising and sharpening, and color enhancement, and supports enhancement of live and VOD content with various formats, bitrates and frame rates. It has gained impressive achievements in CVPR and many other competitions at home and abroad.

- **2D-to-3D video conversion:** The traditional 2D-to-3D video conversion assigns depths to various regions in an image, then produces a parallax map, and finally synthesizes the left and right images. ZTE's smart depth perception and prediction network automatically and rapidly collects the depth information from the original images and videos to form a depth map, and then adopts the depth image based rendering (DIBR) algorithm to deal with

various complicated scenarios such as smog and running water. In addition, it supports various formats such as left/right, up/down, and interleaved format, as well as various terminals such as VR HMDs, 2D/3D TVs, laptops, and smartphones. After the conversion, the quality indicators such as the overall image brightness, clarity, and sharpness of the object edge, have gained recognition from many operators and have been widely appreciated at many major exhibitions at home and abroad.

To meet the high bandwidth requirements for VR, ZTE proposed four key technologies to reduce the transmission bandwidth of UHD VR.

- **FOV+:** An entry-level (8K) VR content requires a transmission bandwidth of 120-150 Mbps, posing huge challenges on the access and transmission network, the server and client. The latest tile-based FOV transmission overlaps a low-quality background stream with a high-quality FOV stream, which can

save about 50% of the bandwidth. The FOV+ technology, first proposed by ZTE, transmits images with a slightly larger FOV to cope with network and processing latency. If a user rotates head at a speed of 120 degree per second, the transmission of an additional 6 degrees of image in all directions can compensate for 50 ms RTT latency, which means an extra 20% of transmission bandwidth can be saved compared to the tile-based FOV solution.

- **Region-wise packing:** To avoid content gaps when the users rotates their head quickly, ZTE proposed the industry's first viewport dependent transmission solution based on region-wise packing. This solution processes the original omnidirectional spherical videos by using non-uniform mapping. In this way, when serving users, high quality is guaranteed within the viewport while low quality is provided in other regions, which reduces the overall bitrate.

- **mABR+VR FOV:** VR transmits live content based on HTTP unicast by using the four mainstream ABR protocols, including Apple HLS, Microsoft MSS, Adobe HDS, and MPEG DASH. Concurrency of massive VR users may cause considerable pressure on networks. The mABR+VR FOV transmission solution, first proposed by ZTE, overlaps the low-quality background stream transmitted through mABR multicast (originally transmitted through ABR unicast) with the high-quality FOV stream transmitted through unicast, significantly reducing the transmission pressure on networks and CDN nodes.

- **Asymmetric stitching:** Compared to 2D VR, 3D VR content requires twice the bandwidth for transmission. Based on the principle of mask effect (that is, when there is difference in the image quality perceived by the two eyes, sensory experience is determined by the side perceiving better quality), ZTE uses this

characteristic to transmit high-quality content for the left eye and low-quality content for the right eye, which further reduces the performance requirements of 3D VR content on the transmission bandwidth, server and client.

To further reduce the end-to-end latency, ZTE proposed the AI-based viewpoint prediction technology. By predicting changes in users' viewpoints, this technology can download the corresponding content in advance and in parallel, so that users can experience a relatively lower MTP latency while the actual MTP latency is high. Currently, with the smart prediction algorithm, the time advanced is up to 80 ms, which is leading in the industry.

Key Technologies for MVV and FVV

ZTE proposed the SRT+RTP technology and AVC SEI technology to solve the frame-level synchronization problem for multiple channels of videos. Relying on coordination between the encoding and playing ends, it achieves frame-level synchronization for encoding and broadcasting of multiple channels of streams.

Considering the shooting and deployment complexity of the FVV service, ZTE innovatively proposed the surround virtual viewpoint synthesis. For the surround video capture scenario, according to the demultiplied camera images, this AI-based technology automatically and rapidly generates video content of any viewpoint, which guarantees smooth control and operation when users enable rotary viewing and bullet time while reducing the deployment complexity. This technology has successfully helped operators live broadcast large sporting events, for example, the wrestling program of the 2nd National Youth Games of China

and the 2019 World Wushu Championships. It delivers a great user experience, significantly shortens the deployment and debugging time, and reduces the deployment cost.

ZTE also proposed the personalized video solution, which adopts technologies such as AI-powered facial recognition and comparison, automatic tracking, video analysis, and automatic editing to generate personalized multimedia content for each player or actor/actress, meeting the audience's needs to watch personalized content and spread it on social media.

Key Technologies for Online Education

ZTE launched an online education platform which supports display on the TV screen and a C200 AI STB in support of online education together with its accessories, making it more flexible to begin a class and realizing more interactive functions and a more intelligent teaching system. It solves the problem of two-way interactions on the TV screen and protects eyes from damages caused by small displays, opening a new chapter for telecom operators to develop online education on the TV screen.

To address the common and complicated problems of online education, for example,

the difficulty in large-scale concurrency for the traditional MCU, high latency for ABR transmission, low transmission quality and stutters, ZTE launched the RTC-based interaction and distribution solution. This solution reduces the response latency by 30% compared with the average RTC latency in the industry, supports concurrency of massive users, and achieves seamless switching between online watching and real-time interaction. This system has already been successfully put into commercial use by China Mobile.

The CDN over bit index explicit replication (BIER) solution, first proposed by ZTE, efficiently addresses the severe shortage of live streams over the multicast protocol that telecom operators face when launching popular services such as online education, conference live streaming, video surveillance, live broadcast on social media, and e-commerce live streaming, helping them develop their own video services and the video services in the public cloud.

In the future, further development of the key technologies for AI, encoding and transmission will enable a better video experience and more diversified business models and applications. ZTE TECHNOLOGIES

New Gigabit Vision, New Smart Future

Yin Qin

General Manager of
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The latest report from GSA shows that 81 commercial 5G networks have been launched across the globe. China resumed and accelerated its 5G network construction after a hiatus imposed by the COVID-19 pandemic. The country has seen some standalone 5G networks put into commercial deployment, with more than 600,000 5G base stations installed and over 150 million 5G terminals connected. With its 5G connections accounting for 70% of the worldwide total, China is the leader in the global 5G race. It is forecasted that the number of 5G public users in China will exceed 800 million by 2025.

Networks are the foundation of smart homes. To facilitate the rollout of smart homes, China's three major operators are making numerous moves on gigabit network deployment. After ushering in the gigabit era of fixed broadband (FBB), China also started to offer gigabit mobile services in 2019 with the launch of 5G networks. Its three operators began building Wi-Fi 6 networks and initiated the "FBB+5G+WiFi" strategy in 2020. Due to the combination of wired and wireless technologies, home connections will be faster in the future, and whole-home wireless connectivity will be a possible trend. 5G is better suited to outdoor space and mobile objects, while Wi-Fi 6 is more used in smart home scenarios. The two technologies are highly complementary.

As a global leading provider of ICT solutions, ZTE continues to build core competencies around technology leadership, improve operational efficiency based on digital transformation, and enhance core competitiveness through innovation. It offers rich services for gigabit application scenarios, focusing on sectors like video, industry, education and security. ZTE will work closely with operators worldwide to support their efforts to expand into the new 5G-to-business (5G-2B) segment.

Real-Time and Immersive Audio-Visual Entertainment

The installed base of smart TVs in China

exceeded 280 million units in 2020. A large-screen TV has become an important product for any operator who wants to develop at least one hundred million home users. Operators hope that such a massive user base can lay a foundation for their value- and scale-based operations. As the hub for users to experience smart home services, the large-screen TV has attracted much attention from operators as they seek to develop home business.

High-definition (HD) video centers incubate new technologies, application, models, industries, and consumption habits for 5G videos including 4K/8K ultra high definition (UHD) video, interactive video, and extended reality (XR) video. Through the smart TV, the video centers can bring users a brand-new immersive audio visual experience. For interactive entertainment centers, operators will focus on creating vertical applications of music, gaming,

education and health. For example, they will set up three product portfolios—fitness tracking, health monitoring and family healthcare in the smart screen-centered health sector. By using interactive accessories like health monitoring and fitness tracking devices to empower the smart screen, they can build a unified health data platform and establish an open family health ecosystem.

Improving the user experience of cloud gaming requires multiple technologies, including ultra-high density computing power, audio/visual decoding latency reduction, and even massive connections by edge computing, but the key is the bandwidth support of mobile networks. The rollout of 5G has also led to an explosion growth of cloud gaming. In addition to removing restrictions on how games are published, cloud gaming can also help combat illegal gaming industry chains and enhance big data mining and analytics.

Cost-Efficient Smart Project

ZTE, in partnership with China Telecom, is working with the Yantian Port of Shenzhen in China to leverage 5G+HD technologies to implement remote control of shore/gantry cranes and remote driving of container trucks. The project is expected to enhance the overall operational efficiency of the port by around 30%.

In another project, ZTE are collaborating with China Unicom and Baosteel Zhanjiang on a "smart steel" initiative where machines imitate humans to conduct "vision + cognition" work. The project aims to realize unmanned operations in scenarios such as air-ground inspection and machine visual monitoring of bridge cranes and steel belts. It is estimated that the overall production cost can be reduced by roughly 20%.

Convenient and Efficient Education

5G will spur a drastic change in how education is delivered, with smart education set to become a major 5G application. Virtual reality (VR)- and augmented reality (AR)-based learning is a main element of 5G smart education. VR/AR can create an interactive, personalized and immersive classroom experience that keeps students more engaged and helps them learn faster.

5G remote learning is a key link in the "last mile" of smart education. It enables various forms of student-centered interactive education, thereby stimulating interest in learning, improving teaching quality, and promoting the fulfillment of educational objectives. China Mobile recently held a 5G applications launch event titled "Empowering Industries and Serving Shaanxi" in Xi'an to advance the information-oriented, smart transformation of industries in Shaanxi province and to promote the deep integration of 5G networks and applications. At the event, ZTE debuted its online

interactive education products for the first time, which were a range of innovative applications incubated via a 5G integrated video platform jointly created by ZTE and China Mobile Shaanxi. The debut attracted widespread attention from the public.

Based on the 5G integrated video platform, ZTE and China Mobile Shaanxi are enabling industrial applications for scenarios including online education, smart cultural tourism, and smart venues through capability convergence, technology iteration, and model innovation. The 5G platform has empowered the culture, education and sports sectors of the province, assisting China Mobile Shaanxi in rolling out 5G big videos in vertical industries.

Secure and Reliable Protection

As people's security awareness increases, home security system has become another major application of smart home besides audio-visual entertainment and has also caused operators to jostle for the market. In this sector, China Mobile ranks among the top three providers in China for its large user base, and one of its priorities in 2020 is to expand home security services. China Telecom and China Unicom have also launched products called "eSurfing Homecare" and "Wo HomeEye" respectively, which allow users to monitor their homes dynamically and in real time.

The scope of smart home is expanding to encompass smart community, safe village, and other applications. This opens up possibilities to expand the target users of smart home services and applications from homes to industries. Security protection can be planned for neighborhood intelligentization or even wider domains. Applications like home security, neighborhood access control, parking management, and community security will be highly integrated into a unified platform. ZTE TECHNOLOGIES

Smart Profile Empowers TV Screen for Optimized Operation

According to the Ministry of Industry and Information Technology (MIIT), the number of IPTV users in China had reached 312 million as of November 2020, covering nearly 1 billion people, and its growth rate exceeded that of cable television and OTT video. Behind the impressive data, the growth rate of IPTV users has actually slowed down. The average monthly IPTV user growth of China's three major operators was only 1.5 million from July to August in 2020, which was lower than the average monthly growth rate of 4 million in 2019, and much lower than the ultra-high growth in the past three to five years. In the future, it will be difficult to support the operation model with the main goal of increasing user base, and the optimized operation of existing users will be the only way for operators to operate their TV screen services.

Data is the basis of optimized operation. What really empowers the optimized operation is the operational profile model based on data. The smart profile built by ZTE based on the Easyk intelligent data tag system focuses on user profile and leverages the machine learning algorithm model to intelligently manage profile tags in different scenarios. The smart user profile has higher adaptability, matching, and automation over a traditional one.

Building Smart Profile

Overall Process

A smart profile model is built through the following four steps of data processing.

Step 1 Sharing. Allow the operation-related applications and systems to share data, thereby providing a solid data basis for building a profile model.

Step 2 Atomizing. Atomize shared data to unify the data format, naming rules, and indicator systems. Atomization refers to the integrity and independence of a single data, which provides flexible guarantee for the subsequent construction of the tag system. After the atomization of shared data, a structured data dictionary will be generated to provide fast query and retrieval of atomic data.

Step 3 Tagging. Perform statistics, analysis, and algorithm processing on the structured atomic data to form the object-oriented semantic tags that can be identified by the operation personnel.

Step 4 Modeling. Use a specific model to build a profile model oriented to the operation scenario based on the operational object tag system, and finally generate a smart profile model.

Building Tag System

A tag system is the prerequisite and guarantee for building smart profiles, because its design and construction determine the availability and usability of the profile model. Both raw data and data dictionaries are very technical data systems for common operation personnel. They can not be directly operated and used by the operation personnel before being converted by R&D personnel into readable support data. This conversion often needs a few weeks, which reduces operation efficiency.

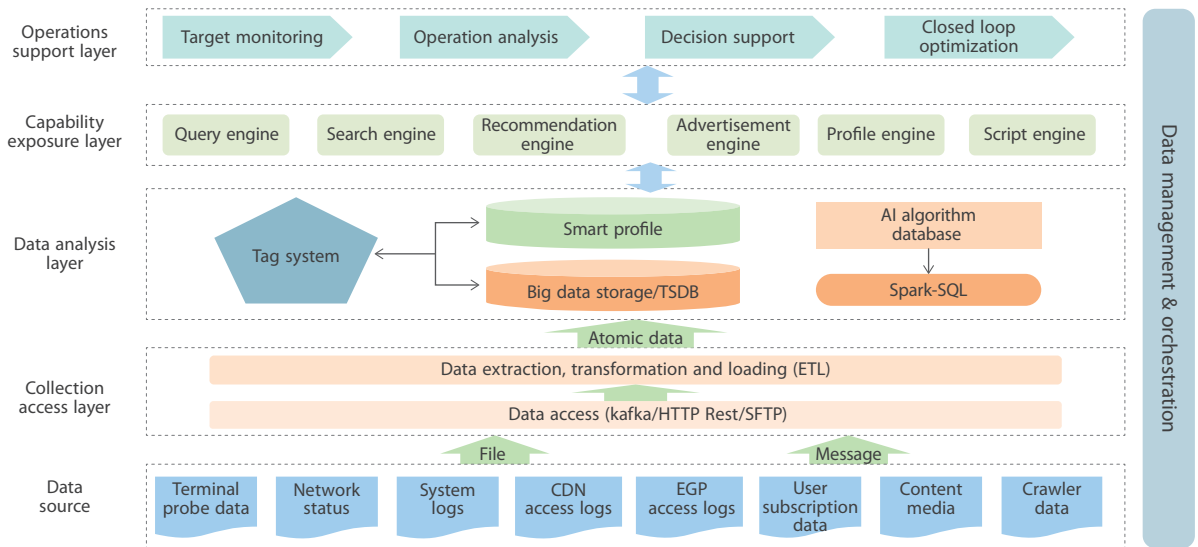The creation of a tag starts with defining a

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Liu Zhijun

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Fig. 1. An optimized operations support system based on smart profile.

tag. The definition of a tag consists of the following information and steps:

- **Tag classification:** Tags are classified based on their objects or scenarios.
- **Tag level:** Tags are graded according to the affiliation of the objects or scenarios.
- **Tag name:** Tags usually have a name associated with the operation scenario, which is easy for ordinary operation personnel to identify and use.
- **Tag value:** The tag value can be automatically given by the data dictionary or manually marked.
- **Tag attribute:** The attributes of tags are mainly related to the features of scenarios and objects. Different attributes of the same tag determine its application mode in different scenarios.
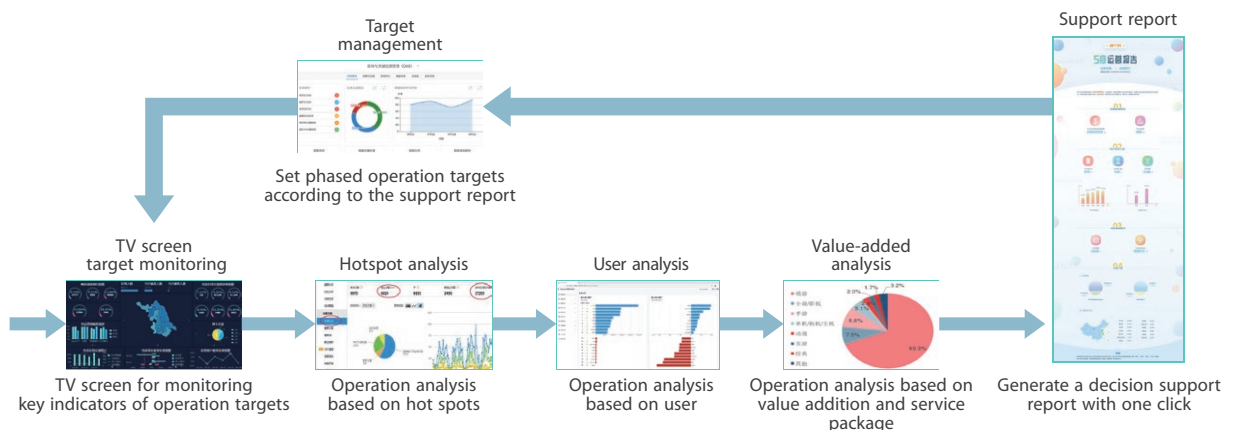
Tags are divided into real tags and virtual tags. Real tags can be created in two ways. One is the relevant atomic fields directly from the data dictionary, called fact tags, 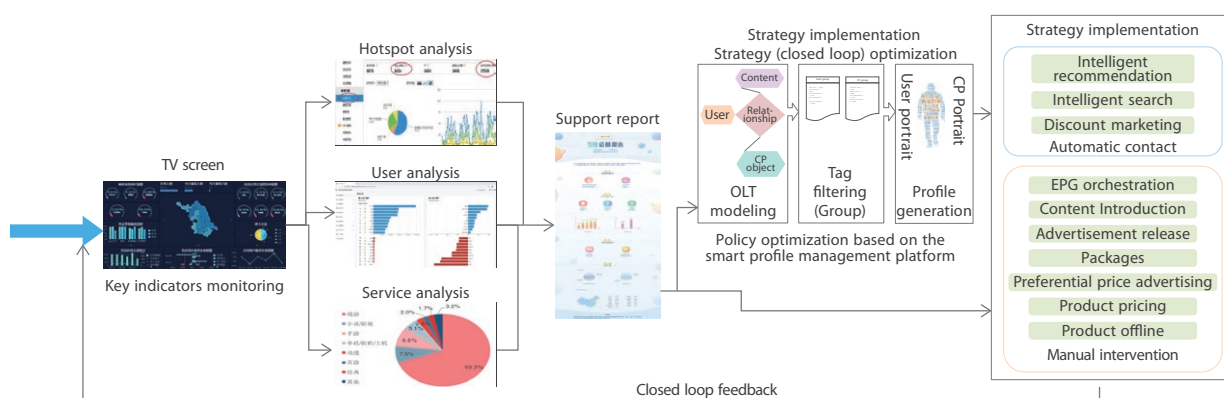while the other is the indicators generated through simple unification and aggregation based on the data dictionary, called statistic tags. Virtual tags can also be created in two ways. One is the tag created based on an event relationship model, called a model tag, which is related to the specific operation scenario. The other is the prediction tag created based on the AI prediction model.

An operation scenario model is a model that correlates the objects involved in operation through the operation time. An operation object can be identified through a specific tag set. ZTE has therefore designed the object scenario tag (OST) model. The relationship among object, scenario and tag is as follows:

- An object is a set of tags that have specific physically associated attributes.
- A tag is a readable indicator that represents the features of an object or scenario.
- A scenario is a set of event tags generated when a specific object has a relationship.

Fig. 2. Closed loop management of operation targets.

Building Smart Profile Based on OST

Building a smart profile based on the OST model involves the following processes:

- Using the tag management platform to generate an OST model manually or through algorithm-based intelligent discovery and association.
- Filtering specific tags through attributes and values based on the OST model and specific operation scenarios, completing group operation of specific objects or scenarios, and generating a model that achieves the targets of operation scenarios.
- Generating a smart profile based on the above model and specific operation data.

There are two output modes for smart profile. One is to output an indicator report, providing a profile analysis report of a specific operation scenario, and the other is to output profile data of a specific operation scenario through APIs, supporting contact operation by related operation tools.

Optimized Operation Empowerment

System Architecture

The architecture of an optimized operations support system based on smart profile is shown in Fig. 1. The system architecture is divided into five layers that are associated through data management and orchestration. The entire system empowers the optimized operation at the top layer that consists of four functions such as target monitoring, operation analysis, decision support and closed loop optimization. Based on these four functions, the system can achieve optimized

management of operation targets as well as optimized operations support.

Closed Loop Management of Operation Targets

The operations support system based on smart profile implements closed loop management of operation targets, as shown in Fig. 2. The closed loop management empowers the operation personnel to monitor the achievement of operation targets in real time or on a regular basis and adjust the operation targets according to the analysis report. In this way, the operation targets can be more in line with the actual investment in operation.

Closed Loop Optimization of Routine Operations

The optimized operations support system carries out data monitoring, target analysis and decision support for routine operations such as recommendations, advertisements and packages. It can also implement closed loop monitoring and optimization based on the results of support strategy implementation, as shown in Fig. 3.

Conclusion

Optimized TV screen operation is the key for operators to transform their business growth model based on a large number of existing users from extensive user expansion to user value exploration. The success of optimized operation depends on data empowerment. ZTE's operations support system based on smart profile transforms data to AI capabilities that support optimized operation through data sharing, atomizing, tagging and modeling, helping operators achieve a qualitative change in the mode of operation. **ZTE TECHNOLOGIES**

New Big Video over Full Gigabit Networks

Xu Huoshun

Planning Director of ZTE Multimedia Products

China had built 600,000 5G base stations by September 2020. Large-scale 5G commercial use of 5G networks by operators, gigabit fiber to the home, and mature commercialization of Wi-Fi 6 all show that the era of full-gigabit networks has completely entered.

According to scientific statistics, about 80% of the information that reaches our brains comes from vision and 10% from hearing, so videos have always been the focus and foundation of digital services. With the advent of full gigabit networks, video business has ushered in a new era. Both short video apps like TikTok and Kwai and IPTV/OTT TV apps of operators are developing rapidly. According to the Ministry of Industry and Information Technology (MIIT), the number of IPTV users (including OTT TV users of operators) in China had reached 312 million by the end of October 2020.

5G networks have three basic features: greatly enhanced mobile broadband, massive connections with low power consumption, and ultra-reliable low-latency communication. These features greatly guarantee ultra-high definition (UHD), low latency and large capacity for video services, especially in the ecosystem field like video capture, editing, broadcasting and transmission, which directly pr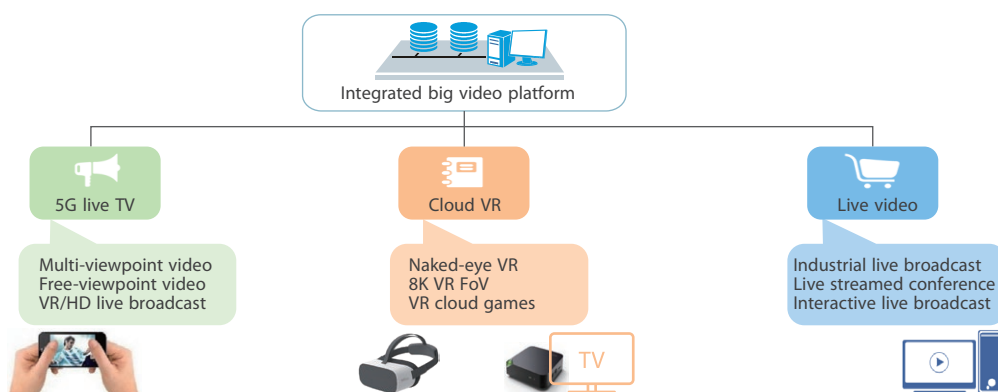omote the application transformation to new audio and video services such as VR, AR, multi-viewpoint video, free-viewpoint video, and holographic display. The fixed-line fiber network based on the rapid development of optical components has unique features of large bandwidth, low latency and long distance as well as low deployment cost, guaranteeing the transmission and distribution for UHD video applications. Wi-Fi 6 features ultra-high bandwidth of 9.6 Gbps, low power consumption of access terminals, and AP capacity up to four times of Wi-Fi 5, allowing for concurrent access of more terminals. Wi-Fi uses channel space multiplexing to support multi-AP deployment in a closed high-density environment, and its smart networking capability also reduces the requirements for home cabling.

The growth of video services also poses higher requirements for networks. The UHD video services such as 8K videos require high bandwidth (80 Mbps in the case of P30 frame rate, H.265 coding, and 8-bit color), and real-time services such as industrial control or remote health care require an end-to-end ultra-low latency at millisecond level.

ZTE's new big video solution consists of two parts: an integrated big video platform that provides service support, and application services in three scenarios such as 5G live TV, cloud VR, and live video (Fig. 1).

- **5G live TV:** It includes multi-viewpoint video,

Fig. 1. ZTE's new big video solution. ▶

Integrated big video platform

5G live TV
Multi-viewpoint video
Free-viewpoint video
VR/HD live broadcast

Cloud VR
Naked-eye VR
8K VR FoV
VR cloud games

Live video
Industrial live broadcast
Live streamed conference
Interactive live broadcast

TV

free-viewpoint video and VR/ HD live broadcast. Multi-viewpoint video refers to shooting a game or event inside a venue at different perspectives and playing the videos via a smartphone or the combination of STB and TV. Free-viewpoint video means to deploy several cameras in a circle for video shooting. After processed by the platform, the videos are played via a smartphone or the combination of STB and TV. VR and HD live broadcast means to deploy VR cameras or ordinary cameras for live broadcasting.

- **Cloud VR:** It includes naked-eye VR, 8K VR field of vision (FoV), and VR cloud games. Naked-eye VR is based on the integrated big video platform. 360-degree VR videos are ingested and then played via a smartphone or the combination of STB and TV of IPTV/OTT. The operations can be performed through the remote control or touchscreen. For 8K VR FoV, a VR packager is deployed to generate FoV segment files that are processed by the integrated big video platform and then played via a standalone VR headset or the combination of STB and TV of IPTV/OTT. The FoV technology can greatly reduce bandwidth requirements. In VR cloud games, a strong-interactive video system is deployed on the integrated big video platform, running through a standalone VR device or the combination of STB and TV of IPTV/OTT. The standalone VR device can cast the game pictures to the TV screen for simultaneous display.
- **Live video:** It contains industrial live broadcast, live streamed conference, and interactive live broadcast. Industrial live broadcast includes VR live broadcast and HD live broadcast. There are slow live broadcast such as cultural and travel live broadcast and daily life live broadcast, as well as fast live broadcast such as provisional outside events and online celebrities live stream while walking. Live streamed conference integrates video conferencing capability to support real-time live streaming of a video conference held in different places by an enterprise, so that more users with access permissions can connect to the integrated big video platform for online viewing. Interactive live broadcast enables live education, supporting online teaching for teachers and students. In addition to real-time audio and video

◀ *Fig. 2. 5G+ Smart Cultural Tourism Development Forum.*

interaction, there are many other functions to enhance teaching and learning, including screen sharing, instant messaging, online attendance and raising hands. Students with access permissions can connect to the integrated big video platform for online learning or watching the recorded teaching videos for review.

The integrated big video platform adopts a hierarchical architecture of platform capabilities and scenario services based on the cloud support environment. The platform capabilities expose the services through the gateway, and the service layer calls the platform service to implement fast service development, debugging and deployment in multiple scenarios.

ZTE has commercially deployed its new big video services in many projects. It offered 5G live TV for the 2nd National Youth Games of China in 2019, launched a successful commercial platform for live streaming of scenic spots for the Lvmama Tourism in 2020, and helped China Mobile successfully hold the 5G+ Smart Cultural Tourism Development Forum in Yan'an in October 2020 (Fig. 2).

4G changes life, but 5G will change society. As gigabit optical networks and Wi-Fi 6 are widely adopted, the technologies and application scenarios of big video over full-gigabit networks are developing rapidly. This will promote the video business towards ultra-high definition, ultra-low latency, immersive and multi-dimensional development. The diversity of video technologies and applications will also pose new requirements on full-gigabit network construction. ZTE has served hundreds of millions of users with its IPTV/OTT products, and its new big video services based on the integrated platform will certainly contribute to video applications in various industries. **ZTE** **TECHNOLOGIES**

5G CDN: New CDN Architecture and Technologies for Video over Gigabit

Zhang Yu

Director of ZTE
CDN Products

As 5G goes mainstream across the world, 5G-enabled networks will transmit high-quality videos on an unprecedented scale and at a super-low cost, which in turn will intensify competition among operators in the video field. Mobile data currently accounts for 14% of global IP traffic, and the figure will rise to 20% by 2022. Of all mobile data traffic, video traffic makes up nearly 2/3, with the proportion forecasted to increase to 82% at the end of 2022.

In the coming years, video is expected to become the main driver of 5G traffic, with short video and livestreaming among the earliest applications to benefit from 5G. China mobile users spent an average of 28 hours online per week in June 2020, a year-on-year net increase of 2 hours. The usage of short video peaked at 11:00 to 13:00 and at 17:00 to 22:00, respectively, with the combined duration of the peaks accounting for 53.7% of the total viewing time. Users tend to watch livestreams in an even more concentrated timeframe, with the usage duration in the 18:00 to 23:00 period making up more than 40% of the overall viewing time. 5G has the advantages of high bandwidth, low latency and massive connections, and so is well placed to eliminate the bottlenecks currently experienced by short video in terms of traffic, rate, and cost.

A dramatic increase in 5G connections and traffic, however, presents the following challenges to operators:

- As the adoption of 5G increases, VR/AR and 8K+ ultra high definition (UHD) services begin to explode and generate increasing volumes of traffic. But at the same time, mobile users demand a better service experience, which can only be delivered with high bandwidth and low latency.
- Scenarios including emergencies, online celebrities, and hit shows, as well as places like stadiums, subway stations, high-speed railway stations, airports and densely populated campuses, produce highly concentrated and provisional traffic that ebbs and flows quickly.

Disadvantages of Traditional CDN

The architecture of traditional content distribution network (CDN) can no longer meet the traffic and user requirements of 5G networks because:

- The traditional CDN uses a hierarchical architecture to provide video streaming service for users. The origin server that is farthest from users has a larger storage capacity to guarantee the integrity and reliability of the stored content while providing users with a small amount of service. The edge nodes nearest to users have a higher throughput and cache the most popular content locally so that the bulk of service requests can be directly terminated on them. However, when content requested by users does not exist at the edge nodes, the request has to go to the regional nodes or further to the origin server after first passing through the regional nodes. Requesting and pushing content in such a cascading way poses a number of problems, including slow

speed, heavy source traffic, and excessive backhaul and backbone traffic.

- To cope with the rapid traffic fluctuations of 5G networks, new edge nodes often need to be added to the CDN and they must begin to process services shortly after installation. With the traditional architecture, content takes dozens of hours to be pushed down to the new nodes, which means that traffic fluctuations cannot be alleviated in a short period of time. However, after traffic peaks disappear, the new nodes are lightly loaded, which causes a waste of resources.

- In the traditional CDN, content is distributed among different devices in the same node. If some devices store popular content, load may be unbalanced between different devices of a node. A few devices may produce poor service because they are overloaded.

## 5G CDN: New Architecture for 5G Networks

5G CDN removes the barriers of the traditional CDN by using a smart distribution system to distribute content more flexibly through multiple layers and hence markedly boost content transfer efficiency (Fig. 1).

Mobile operators can deploy lightweight CDNs on the periphery of a 5G network to supplement traditional edge nodes. Using real-time analysis of popular content conducted by the core scheduling layer, they can rapidly obtain content from CDN nodes at any network layer, thereby providing efficient caching service for users and reducing traffic on edge nodes.

Key Technologies of 5G CDN

Automatic Replication of Popular Content

In the traditional CDN, content is evenly distributed among devices. When certain content becomes popular, a large number of users concurrently visit the device that stores the content, straining the processing capability of the device and degrading the service it delivers.
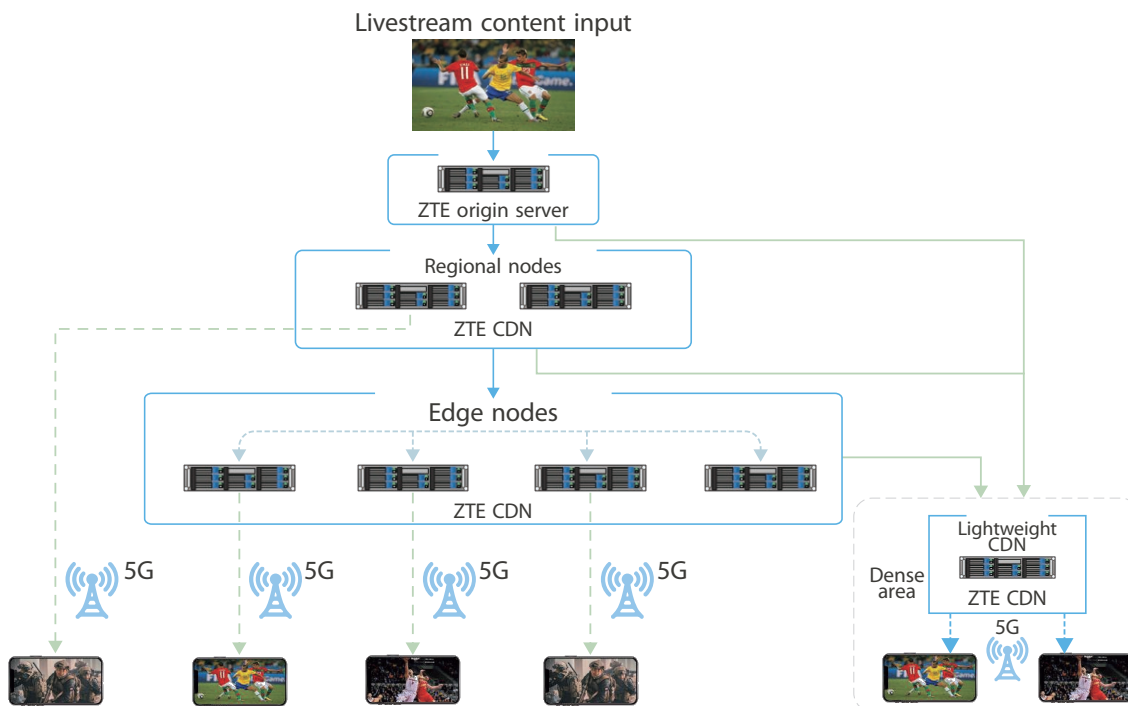
Fig. 1. 5G CDN architecture.

The core scheduling layer of ZTE 5G CDN can automatically analyze the popularity of media content. When the popularity of certain content reaches the preset threshold, the CDN can quickly replicate the content from the device containing it, whichever network layer the device is located at, to other devices so that all the devices can balance the load. Users' service requests can also be flexibly scheduled according to the load carried by the devices.

The automatic replication technology allows content to be effectively shared in the CDN, thus greatly reducing source traffic and lightening the load on the backhaul network. In some circumstances, it can cut up to 50% source traffic for operators.

MEC and Fast Resource Scaling

ZTE 5G CDN supports containerized deployment of virtual content distribution networks (vCDNs). It integrates a multi-access edge computing (MEC) platform to allocate and manage resources for vCDNs in a unified manner (Fig. 2).
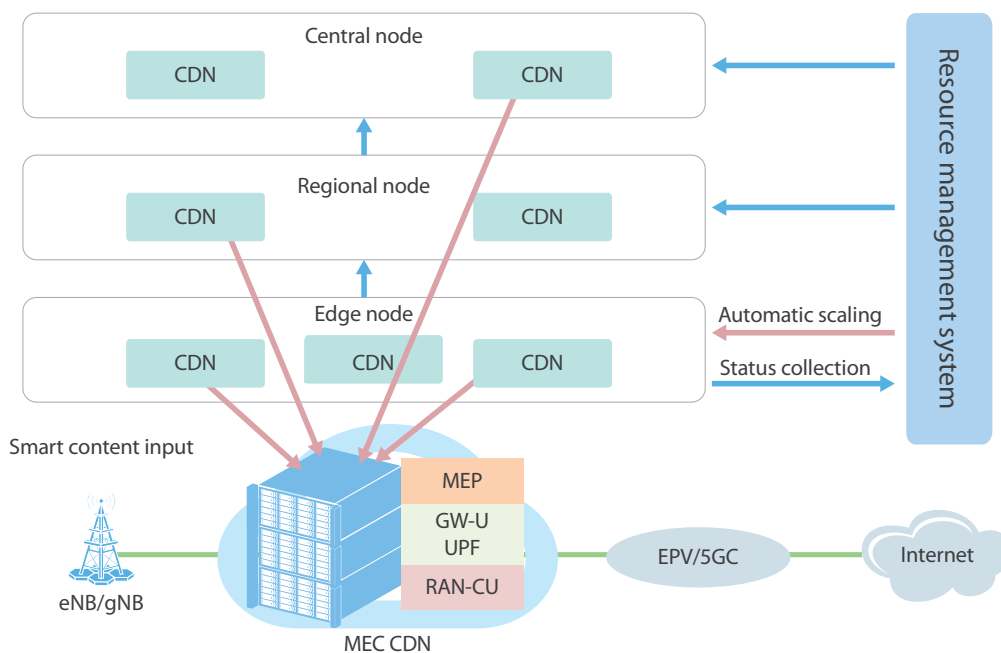
The core scheduling layer monitors the overall traffic in real time and predicts traffic hotspots intelligently. When a traffic storm is about to occur, lightweight CDNs are rapidly deployed using the automatic vCDN scaling technology. The lightweight CDNs employ the multi-layer distribution technique of 5G CDN to obtain popular content from CDN nodes at different network layers and quickly fill themselves up with the content. Within a short time, they can be put into work to address the traffic storm.

Smart Scheduling

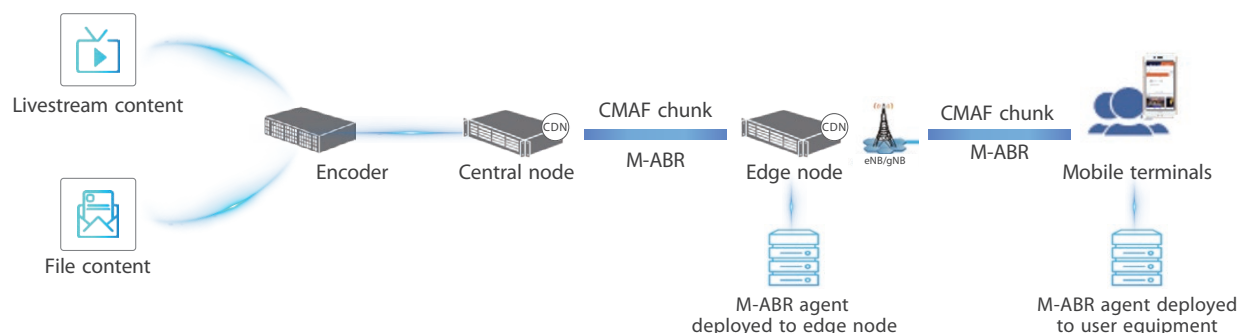The smart scheduling technology can distribute popular traffic evenly among different nodes or different devices within a node.

The core scheduling layer of ZTE 5G CDN uses a smart scheduling decision support system to collect its operational data. The AI technology is introduced to make decisions on handling hot traffic and schedule traffic loads so that load is

Fig. 2. Flexible ▶ CDN scaling

Livestream content

File content

Encoder   Central node   CMAF chunk / M-ABR   Edge node   eNB/gNB   CMAF chunk / M-ABR   Mobile terminals

M-ABR agent deployed to edge node

M-ABR agent deployed to user equipment

◀ *Fig. 3. Low- latency livestreaming.*

balanced among intra-nodes, inter-nodes, areas, and users. This is to prevent a single node or device from carrying an excessive volume of traffic that would stall and degrade service. Meanwhile, high-priority users are allocated to optimal nodes to differentiate service levels.

Low-Latency Livestreaming

ZTE 5G CDN leverages the industry-leading low-latency livestreaming technology to dynamically create live channels and achieve end-to-end latency of less than 2.5 s, which are especially crucial to guaranteeing a superior experience for latency-sensitive livestreaming services such as TV sports and games (Fig. 3).

Evolution to Edge Cloud

Operators have rich network infrastructure resources, unique edge connectivity, cloud-network convergence, and abundant facilities like equipment rooms and hardware. Edge clouds and CDNs are similar in terms of service and deployment location. As the 5G age presents increasing demands for edge clouds, operators are also accelerating the deployment of MEC capabilities on CDNs to take full advantage of their existing CDN resources.

ZTE and China Mobile have started to deploy edge cloud and CDN resources in phases. They will gradually cloudify CDNs and put them on existing edge clouds. On this basis, they aim to enrich the platform as a service (PaaS) components and achieve the coordinated

sharing of platform capabilities.

By coordinating equipment room locations, equipment resources and edge cloud platforms, ZTE deeply integrates 5G networks with MEC CDN service platforms and uses industry-leading technologies to continuously optimize user viewing experience.

Summary

ZTE 5G CDN solution is specially designed for mobile application scenarios and employs technologies that involve containerized CDNs, dynamic scaling, hot content statistics, prediction and replication, smart scheduling, and low latency. The solution can offload around 70% of traffic storms and tackle problems caused by rapid rises in video traffic. By drastically reducing traffic pressure, eliminating traffic overloads, and solving poor quality for 5G backhaul and backbone networks, the solution provides a reliable, cost-efficient alternative to expensive backhaul upgrade. Operators can use the 5G CDN to easily deliver a better 5G video viewing experience to a surging user base.

The architecture design of ZTE 5G CDN fully considers 5G development and industry standards and supports 5G multimedia services like VR, AR and XR that require high bandwidth, low latency and strong interaction. The containerized architecture can also rapidly evolve into edge clouds, helping operators implement a new operation model that features cloud-network convergence. **ZTE TECHNOLOGIES**

vSTB Helps Operators Transform Their Terminal Operation

Pan Hongyi

vSTB Product Manager, ZTE

By September 2020, China's three major operators, China Telecom, China Mobile and China Unicom, had more than 300 million IPTV/OTT users, with a bandwidth penetration exceeding 65%. According to statistics, the total number of home users in China has almost reached 500 million. Considering the share of China broadcasting network users and internet TV users, the growth of IPTV/OTT users is basically close to saturation.

300 million IPTV/OTT subscribers is a huge user base. At present, IPTV/OTT revenues of the three major operators in China come from traditional fields such as live broadcasting and video on demand (VOD). Operators have done a lot to enrich revenue models like basic package, premium package, PPV and advertising, and to improve user experience by means of fast channel change (FCC), forward error correction (FEC), automatic repeat request (ARQ), dedicated live broadcast network (DLBN) and 4K. After the initial great development, revenue growth in the traditional fields is becoming more and more difficult. Increasing revenue in new fields, invigorating existing 300 million IPTV/OTT users and transforming from extensive subscriber increase to optimized traffic operation are big challenges for operators.

Internet services, especially online education and games, have developed rapidly in recent years, and their service quality has kept improving, resulting in huge social and economic benefits. Internet-based IPTV/OTT value-added services have become a trend. However, these services are mainly for smart phones. When deployed in IPTV/OTT, the STB terminal itself is a bottleneck, which can be seen in two aspects.

- **Service support:** The three major operators purchase STBs through centralized procurement. In terms of hardware, traditional video services are mostly considered, while value-added services are considered less. STBs cannot deploy or support large internet services in hardware. For example, the game Strike of Kings needs 1GB memory and 4GB storage to run and also poses higher requirements for image rendering. The current mainstream STBs cannot deploy this game.

- **Service adaptability:** There are more than 20 suppliers of STBs and nearly 100 STB models, and the stock of STBs in existing networks is different. The demand for STBs varies from province

to province, and there are thousands of software versions for STBs. Due to the huge number of STB models and software versions, a variety of services are deployed in the existing network, which requires a lot of adaptation work, and the difficulty in network O&M is also greatly increased.

For the three major operators, the capabilities of STBs seriously limit the development of value-added services and affect the increase in revenue. Although operators can solve the above problems by replacing STBs, the replacement cost is too high due to the huge stock of existing STBs. Even if operators pay a huge cost to replace STBs, they still cannot meet the growing demands for hardware once and for all.

Virtual STB (vSTB) can be a solution. The STB capabilities in the cloud expands services and accelerates their deployment speed. In the field of cloud-based services, cloud phones have emerged and cloud games are very popular. Google, Tencent Cloud, and Huawei Cloud have supported the deployment of cloud services and games on terminals including PC, smart phones and tablets. However, due to the complexity of networks and terminals, the deployment of cloud services on STBs remains a gap in the market.

To achieve cloud-based STB services, two requirements must be met. First, it is necessary to provide full-service support, not only for games but also for education, animation, health care and fitness. Second, it is necessary to decouple software from hardware and decouple service software from platform software.

ZTE's vSTB can well address the above-mentioned issues. Services run in the cloud, and STBs adopt the 4K decoding capability to present services. It transforms value-added services into a video service that can support the deployment of large-scale value-added services and large online games, so that STB users can experience higher quality services.

ZTE's vSTB is designed to improve user experience, reduce deployment costs, and provide easy O&M and high reliability.

- **User experience:** User experience is guaranteed through adaptive bitrate and manual bitrate adjustment. vSTB can support not only real handles but also virtual handles through smart phones, so it is not restricted by the remote control and can attract professional players.

- **Performance:** For audio-visual services such as education, a single server can support 700 online users; for games, a single server can support over 100 concurrent users. This greatly reduces deployment costs of operators.

- **O&M:** Value-added services are played immediately without downloading. With STB services deployed in the cloud, the STB on-site maintenance cost is greatly reduced. Thanks to decoupling of software and hardware, millions of STBs can be upgraded overnight. One-click packet capture, user behavior statistics, active O&M, fault monitoring, and fast fault location are also supported.

- **Reliability:** Relying on years of experience in system equipment and taking comprehensive emergency into consideration, ZTE has developed its vSTB that has no single point of failure (SPOF).

ZTE's vSTB was officially put into commercial use in Hunan Branch of China Telecom (Hunan Telecom) in November 2020. By introducing high-quality education and games, it has brought a brand new service experience to 6.5 million online users, helping Hunan Telecom increase its operation revenue while reducing O&M costs.

ZTE has also been committed to creating a vSTB ecosystem and looking for business partners. To date, ZTE has signed strategic partnership with NetEase, Gameloft, Shanxi Fenteng Interaction, Suzhou Snailgame, Wuhan Huatong Digit, and Shenzhen LutongNet to focus on STB and TV services, working together to improve service quality and build the ecosystem.

Through the home gigabit network, vSTB can provide operators with a breakdown of home scenarios, with the aim to bring users comprehensive personalized services. In this way, some new types of home terminals will emerge, such as terminals that integrate cloud audio-visual services, cloud PC and cloud games in living rooms and public spaces, as well as portable office and audio-visual terminals for remote office works and entertainments in study rooms and private spaces. vSTB can also provide dedicated cloud-based education desktop, so that users can enjoy the service through tablets rather than PCs, which saves the cost of buying computers.

Cloud-based services will greatly change the way users experience and drive continuous innovation in business models. Some new application scenarios will emerge. For example, education services allow parents to remotely view their children while they are learning online, game services allow STB users to team up or fight with mobile phone users, and there are live game interaction, handle/remote control exchange, and value-added service advertising. Instead of passively receiving services, users will enjoy an interesting interactive experience. This change in user experience will definitely lead to a growth in profits and retain more customers. The mode of competing for customers by price-cutting will be completely changed.

With the arrival of 5G, the bandwidth and latency will be further improved, and the service mode will change greatly. The vSTB products feature fixed-mobile convergence, delivering the same user experience and flexible switchover on mobile phones, tablets and STBs. This significantly expands value-added service groups and truly achieves ubiquitous services. With cross-platform characteristics, strong processing capacity and flexible deployment, the vSTB products will effectively support the cloud-network convergence strategy of operators, implement internet-based services, and ultimately help them complete business transformation and revenue growth. **ZTE TECHNOLOGIES**

China Mobile Jiangsu Helps GIAN Technology Implement a 5G+AI Quality Inspection Demo Workshop

Application of 5G+ Industrial Internet

By the end of 2020, China Mobile will have 350,000 5G base stations and provide commercial 5G services in cities above the prefecture-level. In order to accelerate the application of 5G in vertical industries, China Mobile plans to launch 100 group-level key projects and 1000 province-level feature projects, accelerate the building of high-quality 5G demo projects, and promote the deployment of 5G private network products.

Jiangsu Mobile has actively explored the application of "5G+ industrial Internet" in the industrial manufacturing field. The manufacturing cluster in Jiangsu Province is developed but also has the difficulty in improving production efficiency, guaranteeing production security, and an insufficient level of digitalization.

Taking 5G network as the cornerstone and industrial intelligence application as the entry point, Jiangsu Mobile has created 13 key group-level demo projects and 140 province-level demo projects. It has carried out the "5G+ industrial Internet" exploration jointly with 46 industrial customers, including analyzing the industrial informatization scenarios, sorting out network requirements and preparing pilot schemes, and among them, 12 industrial customers have started the "5G+ industrial Internet" transformation project.

5G+AI Empowering Quality Inspection

Changzhou Branch of Jiangsu Mobile, together with ZTE and MICRO-Intelligence, has successfully implemented an end-to-end

Zhou Jianhua

Senior Engineer of ZTE RAN Product Planning

solution for the 5G+AI quality inspection demo workshop at Jiangsu GIAN Technology Co., Ltd (hereinafter referred to as GIAN).

As a professional metal injection molding (MIM) product manufacturer and solution provider, GIAN provides high-complexity, high-precision, and high-strength customized MIM core components for consumer electronics and the automotive industry. GIAN attaches great importance to the R&D of product technology, and has won the second prize in the 2019 National Technological Invention Award for the near-net shape manufacturing technology and applications of high-performance special powder materials. The company's products have been applied to well-known consumer electronics and automotive brands.
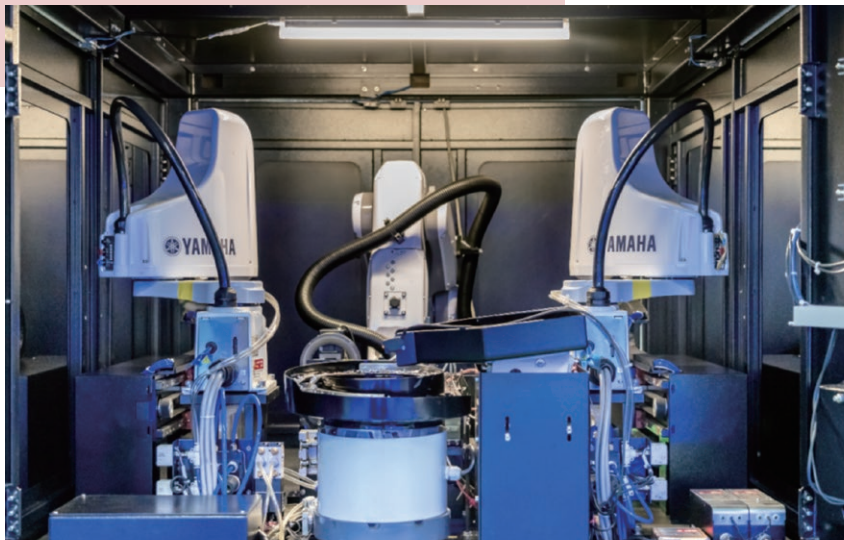
In the actual production of GIAN, the quality inspection of 3C product parts requires a large amount of manpower. In particular, overseas customers impose strict quality requirements. Each part requires the use of industrial electron microscope and takes 30 seconds to 1 minute to complete the quality inspection. Therefore, GIAN invests nearly 3000 workers in the quality inspection workshop, accounting for 50 percent of the total number of workers in the factory. The labor cost per month exceeds 25 million yuan. However, quality inspection in manufacturing has always faced the pain points of unstable manual test quality, difficulty in recruiting, keeping employees, difficulty in training, and high costs.
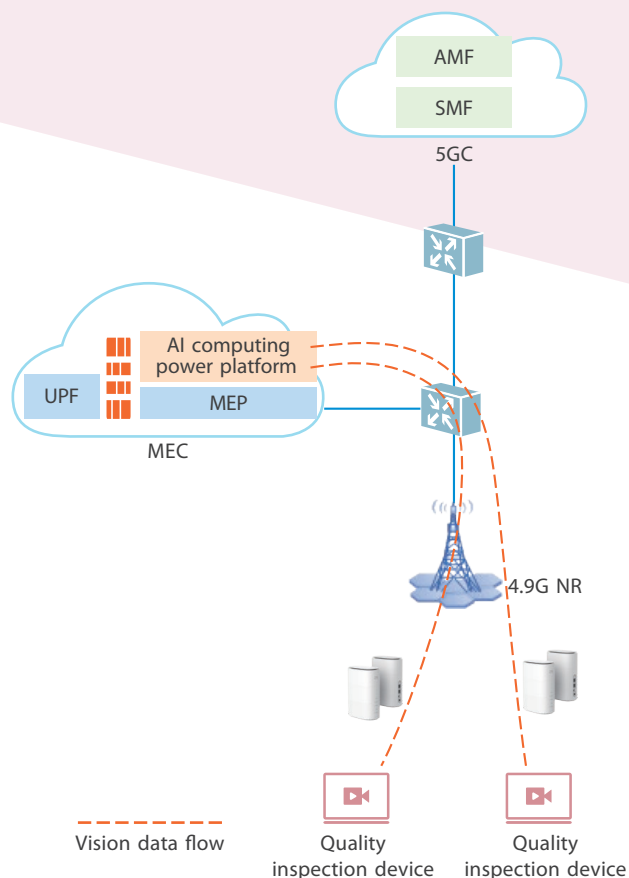
Changzhou Branch of Jiangsu Mobile, together with ZTE and its ecological partner, MICRO-Intelligence, provides intelligent solutions for industrial quality inspection of GIAN (Fig. 1). As a company focusing on the industrial visual inspection and industrial big data platform, MICRO-Intelligence has a leading position in AI-powered quality inspection in China. The AI quality checker customized for GIAN integrates industrial cameras, robotic arms, programmable logic controllers (PLCs), and other components. The AI-powered quality inspection machine takes several consecutive UHD photos of the inspected items, and transmits them to the AI computing power platform for visual inspection and detection. Based on the image recognition technology, the AI computing power platform simulates the surface detection procedure of production line workers, and performs machine learning through samples to achieve accurate defect detection.

The quality control machine sends multiple HD photos to the AI computing power platform. Depending on the number of photos, the uplink network rate required by the network is 150 to 300 Mbps. The conventional 2.6 GHz new radio network with a smaller number of timeslots allocated to uplink cannot meet the machine's requirements. According to the service requirements, ZTE has designed the 5G+MEC private network solution. China Mobile has 100 MHz in the 4.9 GHz band, which can be used for private network deployment without affecting the public network. On the other

▲ *Fig. 1. Implementing 5G+AI quality inspection end-to-end solution in the workshop.*

the basic platform layer, core capability layer, and service application layer with diversified hardware, heterogeneous openness and lightweight management. It coordinates with the cloud to provide edge computing services. The edge network cloud provides comprehensive cloud computing services such as computing, network, storage, acceleration and security at the edge, and provides a stable basic environment for the deployment, scheduling and operation of the NEs and Internet/IT applications. It can reduce the response latency, pressure on the cloud end, bandwidth cost, and meet the diversified edge application scenarios. The data (quality inspection photos) is forwarded locally without traversing the 5G core network of the region. On the other hand, MEC provides powerful computation capability of CPU and GPU to support the operation of AI computing power platform.

Phased Transformation

After the first phase of the 5G+AI quality inspection system is implemented, its commercial value gradually becomes apparent. First, a single quality inspection machine is 10 times more efficient than manual work, with qualitative improvements in both accuracy and stability. Second, investment in the entire system will be recovered in about one year, and will continue to create value in the future. In addition, based on the big data analysis, the mold dimension tolerance in the injection molding process can be precisely adjusted to improve the precision of the mold and reduce the loss, and optimization suggestions and analysis can be made on the sintering process parameters such as the temperature and pressure to improve the yield rate of the product. After the phase-2 and phase-3 projects are implemented in the future, the company will complete the intelligent transformation of the quality inspection production line to bring greater value to its customers. ZTE TECHNOLOGIES

▲ *Fig. 2. 5G+AI networking scheme for the quality inspection system.*

hand, the industrial private network usually requires a much higher uplink rate than the downlink rate. The general 2.5 ms two-period frame structure has a low proportion of uplink timeslots and cannot meet the service requirements. ZTE has developed the 4.9 GHz base station with the 2.5 ms single-period 3U1D frame structure, which enhances the uplink transmission rate. The single-user peak rate reaches 700 Mbps, meeting the uplink rate requirements of the quality inspection machine.

For the AI computing power platform, ZTE provides the enhanced integrated MEC edge cloud solution (Fig. 2). Based on the three-layer NFV architecture, the edge cloud system uses a full-stack integration architecture consisting of

Converge Creates a New Era for Big Video in Philippines

Cui Xiaohua

Planning Director of ZTE Multimedia Products

The Philippines, with a population of more than 100 million, has a strong momentum of economic growth and a bright future for the video market. Converge ICT (Converge for short) is a telecom infrastructure provider, the largest ISP operator, and also a leader in the all-optical broadband access industry in the Philippines. It secures necessary licenses to operate services including fixed-line, cable TV and enterprise private line. It has considerable fiber resources, and its FTTH users increase rapidly, with 50,000 to 60,000 new users per month, which shows great market potential.

Opportunities

By the end of 2019, the national fixed-line penetration in the Philippines was only 18.6%, while the FTTH penetration was only 8%. Converge saw promising prospects in the transition from copper to fiber across the globe and was determined to develop FTTH early in 2018.

With the rapid development of the Internet and the rise of the IPTV/OTT services, users are no longer satisfied with just getting online and simple live broadcast services. They are more interested in high definition (HD) or even 4K videos and immersive video experience. In the Philippines, there are very few operators that can offer high-quality paid video services, and the quality of the content they provide varies from one to another. Converge captures the huge market opportunities, and has devised the development strategy of "binding

broadband with video services" since April 2020. Converge has planned to seek a world-leading provider of big video solutions to empower its fast expansions in the fixed-line big video market with the most competitive big video convergence services.

Challenges

Converge also faces many challenges when developing video services. The major one is how to improve service capabilities of the IPTV/OTT platform deployed on the existing network. Building a new platform may cause a waste of existing devices, while the platform upgrade on the existing network may not support rapid user expansion. Moreover, existing vendors cannot provide the most competitive user experience. It has become a major issue for Converge to decide whether to protect its investment by upgrade or to build a brand new video platform to meet user needs for big videos.

Converge and ZTE have maintained a good long-term partnership. ZTE has been providing Converge with stable and high-speed broadband access products and services. After understanding the difficulties of Converge, ZTE focused on Converge's needs for video development and established a team of experts to help Converge analyze the availability of the existing video platform. After repeated confirmation, both parties agreed that the reuse of existing network equipment would hinder the development of the entire video business, and finally Converge decided to build a brand new video platform to deliver a better video experience.

Partnership with ZTE

After more than six months of frequent online technical exchanges and clarification between the two parties, Converge chose ZTE as its exclusive partner among many global renowned platform providers for video business in early 2020, considering many factors such as technical solutions and comprehensive strength. ZTE's premium video platform (PVP) solution adopts an open and flexible architecture to enable innovative functions while guaranteeing system security and reliability. The PVP solution facilitates fast integration of third-part apps and has been deployed in many countries around the world. Converge can use the PVP solution to provide users with a variety of innovative multi-screen services, including live TV, VOD, TSTV, TVOD, bookmark, parental control, multi-screen interaction, intelligent recommendation, and intelligent search.

With 20 years of experience in the multimedia field, ZTE has built a professional R&D team of nearly 1,000 engineers. It also has engineering delivery experts across the world and rich experience in industrial cooperation. ZTE will continue to focus on technological evolution and service innovation in the big video sector, helping Converge develop ultra-high definition video services and become an excellent model for operators in Southeast Asia. **ZTE TECHNOLOGIES**

ZTE Pushes Green Credentials in 5G Era

Source: Mobile World Live

Bai Gang, Vice GM of RAN Products at ZTE, highlights the company's latest innovations in improving the energy efficiency of communication networks as complexity increases with the deployment of 5G services.

What are ZTE's key achievements in building green 5G networks?

ZTE has long committed to developing and deploying green and energy saving networks. The effort has become particularly critical in the emerging 5G era as operators reply on multiple radio access technologies using more RF units, which can significantly increase energy consumption. ZTE takes a holistic approach to reducing energy usage across its entire line of wireless and fixed assets.

We have long taken energy savings and consumption reduction as a key responsibility. By increasing technological efficiency, ZTE works with operators around the world to build green networks to fulfil its promise of Climate Action in response to the UN's Sustainable Development Goals (SDGs).

Over the past five years, we submitted more than 500 green 5G innovation patent applications. Our cutting-edge design of 5G active antenna units received the iF Design Award 2020. In addition, ZTE and China Telecom developed a smart energy-saving network platform called 5G Greener Telco, which won the Outstanding Catalyst—Impact for Society award from the TM Forum.

What's the impact on implementing energy savings solutions on operators' opex?

Energy consumption can represent as much as 20 to 40 per cent of an operator's total opex. ZTE's 4G and 5G network energy saving solution, PowerPilot, can achieve significant energy savings and lower opex. By identifying service types and their energy efficiency differences, PowerPilot can evaluate service requirements in real time and support the service with networks of higher energy-efficient to maximise energy efficiency in the entire network.

China Telecom and ZTE jointly put PowerPilot into commercial use in the city of Chengdu, resulting in 35 per cent, or 14 kWh, in network energy consumption saved per site on average per day.

Where have you been able to find the biggest reductions in energy consumption?

The cooling system, power distribution and the base station equipment are the three main RAN components, accounting for more than 50 percent of the total network energy consumption.

Using a distributed architecture for base stations, which is deployed in most cellular networks, energy consumption of the radio frequency unit accounts for more than 75 percent of base station equipment power usage. That is using a single band with three sectors. The percentage increases as the number of bands rises. ZTE focuses on the radio frequency unit, which is where we can find the biggest gains in power efficiency.

Bai Gang, Vice GM of RAN Products at ZTE

"We have long taken energy savings and consumption reduction as a key responsibility. ZTE's network energy saving solutions are used in more than 20 networks, with some 600,000 sites deployed worldwide."

How does the efficiency of PowerPilot compare with conventional energy saving solutions?

Conventional AI-based energy saving options enable a more precise per-site energy saving policy based on site traffic and other site-related conditions to improve the efficiency and reduce the manpower required.

In the 5G era, this approach is not enough for mobile operators to deliver the much-needed energy savings. One important thing we can exploit is that different networks have different energy efficiencies, even those delivering the same type of services or running the same generation on different spectrum frequencies. By detecting the differences, PowerPilot directs the services to the optimal network or spectrum for higher network energy efficiency.

According to a model using typical network configurations, PowerPilot can save twice as much energy as conventional AI-based energy saving solutions.

The power savings possible in single-mode networks is significantly higher than for multi-mode and multi-frequency networks. Why is that and what is ZTE doing to change that?

Most mobile network operators run 2G, 3G and 4G networks, and increasingly 5G, at the same time. In most multi-mode and multi-frequency cellular network, service efficiency varies from mode to mode and band to band. Multi-mode is more complex than a single-mode network and more factors need be taken into consideration.

PowerPilot, the industry's first AI-powered service-aware energy savings solution, exploits differences in energy efficiency of different types of services, different networks

or bands to deliver direct certain services to the most energy-efficient network, helping achieve the most efficient energy usage in multi-mode and multi-frequency networks without impacting network performance or the user experience.

If all services or users can be concentrated in part of the network or band, more energy can be saved by shutting resources down or putting them in deep sleep mode.

Beyond 5G networks, what actions are you advising customers to take with their 2G, 3G and 4G networks?

ZTE has been developing network energy saving technologies since the 2G era, enabling multi-dimensional and full scenario energy saving solution across all networks.

Wind Tre in Italy, which uses our solution, saves an average of 0.36 kWh per cell site per day for its entire networking covering 2G, 3G and 4G network with ZTE energy saving solution.

Depending on their existing networks, operators can deploy a basic or AI-based energy saving strategy as well other technologies, such as dynamic spectrum sharing to improve energy efficiency.

How many mobile operators you are working with to improve energy efficiency?

ZTE's network energy saving solutions are used in more than 20 networks, with some 600,000 sites deployed worldwide. Clients includes Wind Tre Italy, MTN South Africa, U-Mobile Malaysia, Telenor Pakistan, China Mobile, China Telecom and China Unicom. **ZTE TECHNOLOGIES**

To enable connectivity and trust everywhere