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Embracing ubiquitous intelligent connectivity

Carriers play a pivotal role in the construction and operation of telecom network infrastructure and have a key part to play in developing the global digital economy. Today's telecom networks power people-to-things and things-to-things communications, and the rise of new technologies like 5G and AI is creating an era where intelligence powers ubiquitous connectivity. Carriers should therefore approach ubiquitous connectivity by emedding intelligence into fixed fiber and mobile connections.

4G has changed our lives, but 5G will change the world. The ability to connect things will create great value across industries, building on the rapid growth we saw in 2020. 5G applications were deployed in more than 20 industries globally, including coal mining, iron and steel, ports, and manufacturing. And carriers worldwide have signed more than 1,000 contracts on 5G industry applications. In terms of fixed fiber connections, Fiber to Everywhere is now possible due to continual technological innovation in flexible bandwidth, devices, and product integration. The ubiquitous gigabit network is taking shape.

Connectivity needs to be upgraded in terms of technology, quality requirements, and the scenarios it can address. Best-effort services need to become differentiated services with deterministic experience. The focus of services should move beyond individual and office scenarios to include production scenarios. And an upgrade from 100 Mbps connections to ubiquitous gigabit connections is required – connections are only intelligent if they provide ubiquitous gigabit speeds, deterministic experience, and hyper-automation.

Many industry players are striving to make intelligent connectivity a reality. Carriers have a key role to play in the digital transformation of industries and the development of the global digital economy. However, they must build all-scenario intelligent connectivity alongside cloud service capabilities to deliver superior service experiences for individuals, households, and industries. Huawei is as committed as ever to customer centricity. We will continue to pursue innovation in our products, solutions, and services, and we will work with carriers worldwide to seize the new opportunities brought by the intelligent connectivity of everything. After all, the move from connectivity to intelligent connectivity will be an era-defining advance.

Layla Zhang

Layla Zhang, Editor-in-Chief

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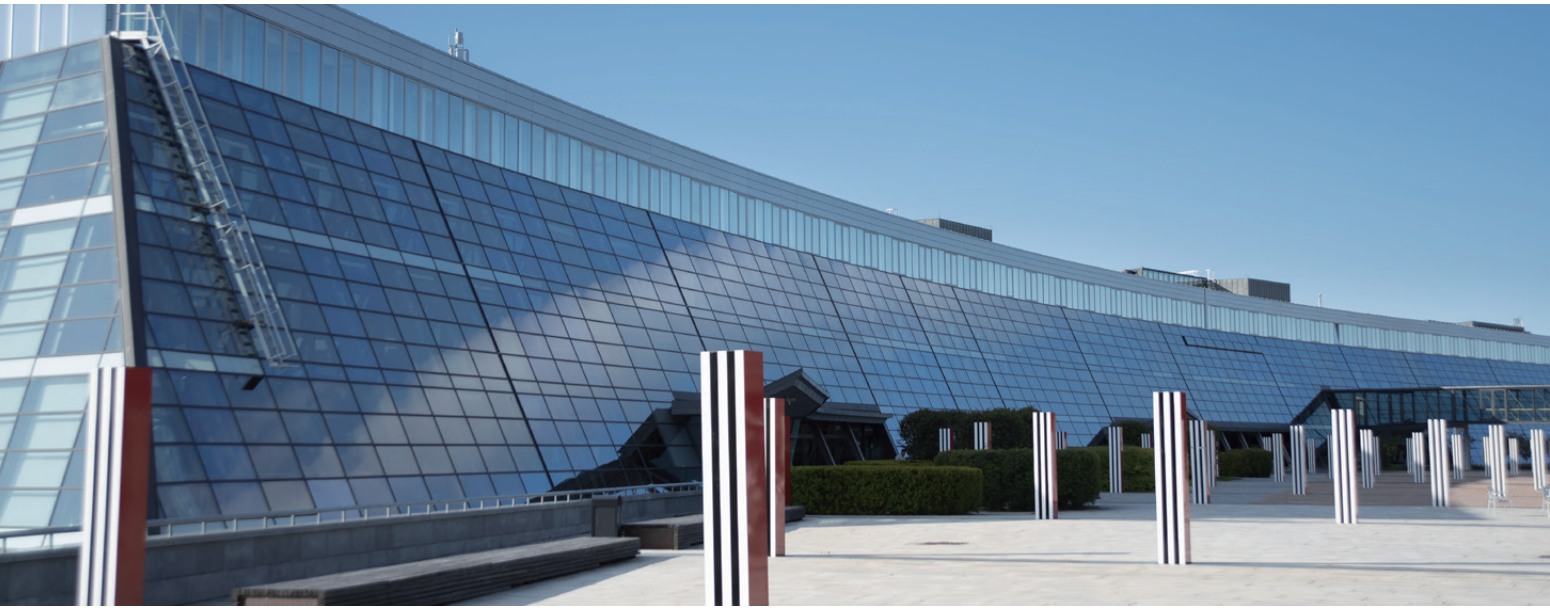
Telenor talks 5G trends and applications

Patrick Waldemar, Vice President of Telenor Group, examines how deploying 5G networks is just the first step in operators' journey and that close collaboration is the key to unlocking industry-specific new services.

By Linda Xu

More than connectivity

5G is more than just blazing data speeds. It promises to be a game changer in how we live our lives and do business. Among the biggest forces driving the development of 5G are the manufacturers of 5G-enabled equipment such as automotive manufacturers, Internet technology companies, the media, the medical industry, and telecoms companies. Since 5G's infrastructure and capabilities rely more on software than 4G ever did, we're seeing much greater interest from companies outside the traditional telecoms industry in developing the next generation of mobile networks.



> When it comes to 5G, mobile operators need to work together with various industry domains and collaborate with other telecom and IP actors to understand their needs.
>
> —Patrick Waldemar, Vice President, Telenor Group

> When you look at the needs that the various industries have, it's a combination of those three use-case areas [eMBB, mMTC, URLLC] and the ability of 5G to provide this in a targeted way.

Waldemar believes that 5G is not just about mobile operators simply deploying networks and then leaving them for customers to use, as they've done with previous generations. "When it comes to 5G, mobile operators need to work together with various industry domains and collaborate with other telecom and IP actors to understand their needs and how the partners can work together to co-create a lot of the services," he states.

Waldemar, who is also head of technology at Telenor Research, noted that 5G technologies have been specifically defined to provide communications services for industry, as opposed to earlier mobile generations which mainly delivered advanced communications capabilities via handsets. The new standard defines three main use case areas: enhanced mobile broadband, massive machine-type communications, and ultra-reliable low-latency communications. "When you look at the needs that the various industries have, it's a combination of those three use-case areas, and the ability of 5G to provide this in a targeted way," he says.

He explains that unlike 3G and 4G, which were more fixed systems and mainly offered broadband communications, new 5G networks can provide more capacity, the ability to deploy dense networks of sensors, or the ability to deliver some kind of guarantee for low latency or other parameters. According to Waldemar, "This combination, with this concept of network slicing where you can target your communications to the needs of an industry or a certain area, is what makes 5G special."

Telenor is coordinating the EU's 5G Verticals INNovation Infrastructure (5G-VINNI) project, which was designed in 2018 to expedite 5G uptake by providing an end-to-end facility to validate the performance of new 5G technologies across various verticals such as public safety, healthcare, shipping, transportation, the media, entertainment, and the automotive industry. "We're proud to be given the opportunity to coordinate the 5G-VINNI project and to explore valuable future solutions for vertical industries. Being one of three large-scale test platforms for Europe, 5G-VINNI will help propel the development of 5G. Our aim is to make it as easy as possible to utilize and test the platform and we now call on industry

> Being one of three large-scale test platforms for Europe, 5G-VINNI will help propel the development of 5G. Our aim is to make it as easy as possible to utilize and test the platform.

players in Europe to engage with the project," says Waldemar.

Tip of the iceberg

The first phase of 5G network deployment around the world, which by now exceeds 100, he says, is mostly focused on the enhanced mobile broadband part.

"While the very first wave is about fixed wireless access and offering higher capacity, there are several industries that are already benefitting from this. For instance, our research has found use-cases in the health sector, such as the use of remote ultrasound remote operations and also in the automotive industry."

All smart cars on the market today have one big weakness in common: they rely solely on their own sensors and cameras for maneuvering and navigation. 5G mobile networks, however, have been designed with the automotive industry in mind. Waldemar believes that even though the technology of tomorrow will bring amazing new capabilities in terms of connectivity, capacity, and speed, it will not happen in a vacuum. By supporting the development of 5G, and in turn defining the specifications that smart cars need, they're speeding up the progress of 5G leaving the test labs and making its way into the real world.

"We'll see a gradual shift towards smarter and more connected cars over the next few years", says Waldemar, which is evidenced by the fact that trials of true 5G connected cars are already taking place today.

Telenor also supports 5G applications in the fish farming sector, where access to better upload speeds are enabling farmers to better monitor conditions and optimize feeding.

Telenor has been working in conjunction with the salmon farming company SalMar on the island of Kattholmen in Norway and also with Sealab in the Horizon 2020 project 5G-Heart. 5G-Heart will use 5G to achieve higher upload capacity from the fish farm and improve the feeding process through enhanced video analytics. SalMar will use 5G equipment to process readings collected in its nets, which among other things, will enable it to spot

“In just a few years, the price of 5G-connected sensors will be so low and the availability so high that everything can be connected without worrying about losing the sensors.”

unusual fish behavior. Currently, the fish farming firm monitors its nets by constant video streams to a feeding fleet or feeding center, which requires large capacity. 5G enables it to supervise its nets in real time and will eventually provide better conditions for the use of AI and big data. Other applications of the technology include supporting the feeding process in farms and powering autonomous boats.

Waldemar forecasts that deploying future standalone (SA) 5G networks will give rise to applications taking advantage of massive-machine type communications, improved reliability, and lower latency. According to GSMA Intelligence, six operators had deployed SA 5G networks globally by the end of October 2020, with another 11 announcing plans to do so.

“In addition, we'll get the ability to do network slicing in an efficient manner. This will open up a lot of industrial use-cases where you make use of all these sensors, the reliability and the low latency. And all this can be tailored using network slicing,” says Waldemar.

B2B impact

Waldemar sees B2B applications already impacting society in a good way, and as the industry moves towards more tailored communication services, enabled by SA networks, there will be an even more positive impact on society as new services emerge in the health, transport, and education sectors.

5G isn’t without challenges, however. Some of the bigger obstacles the technology needs to overcome are: 1) finding space for much more data in an already saturated wireless spectrum; 2) figuring out how to efficiently manage a large number of differently sized packages of information; 3) creating computer systems able to handle the vast amounts of data that will be created by IoT communications; 4) reducing both the size and power consumption of network devices to meet the needs of the increasingly large number of applications using IoT.

“In just a few years, the price of 5G-connected sensors will be so low and the availability so high that everything can be connected without worrying about losing the sensors. The low power consumption of IoT devices also enables a long lifetime without the need

> I'm excited about how 5G is creating a wide range of new use-cases and adding new value across nearly all aspects of society. Telenor's purpose is to empower societies, and there are so many potential new applications that can answer that purpose.

for replacements," Waldemar states.

"This all makes me really happy about the future and excited about working with technology that helps industry and society. I'm excited about how 5G is creating a wide range of new use-cases and adding new value across nearly all aspects of society. Telenor's purpose is empowering societies, and there are so many potential new applications that can answer that purpose."

Paving the way towards a 5G-powered digital revolution

As attention turns to 5G's evolution and development, Denis Depoux, Senior Partner at Roland Berger China, believes that technology will lead a digital shake-up across industries.

By Mobile World Live

At Huawei's 11th Mobile Broadband Forum in Shanghai in 2020, attention turned to the evolution of 5G and how the leaders in the mobile sector are now looking to sustain growth of the technology while enabling a robust ecosystem through cross-industry collaboration.

Denis Depoux, Senior Partner at management consultancy Roland Berger China, believes that industrial digital transformation will be an area where the technology will thrive to enable new, lucrative use cases and facilitate the use of the technology in numerous different sectors.

Indeed, in the COVID-19 era, digital transformation across industries has become crucial for businesses to continue to operate, with Depoux identifying the global crisis as "a wake-up call" for companies to take digital tech more seriously.

"Suddenly, you realize that communication channels, supply chains, and infrastructure were not really resilient to such a crisis," he noted. However, as the world and its consumers, citizens, and businesses have been forced to operate in new ways, the pandemic has had at least one upside: advancing digitalization across

> COVID-19 is doing much more for digitalization than state leaders, corporate leaders, or consultants, because you're either digital or you're lost.

the board.

"COVID-19 is doing much more for digitalization than state leaders, corporate leaders, or consultants, because you're either digital or you're lost," said Depoux. "For the next few months, the question of resilience will be put on the table by shareholders, and by authorities...digitalization is the response. But it's not only about one technology, it's about covering the full value chain."

Industry opportunity

More than 18 months have passed since the commercial launch of 5G, and operators, vendors, and corporations are now looking beyond the initial enhanced mobile broadband use cases to what else the technology can offer. Depoux has observed that the ICT industry is preparing for more consumer cases around huge video use, and that use cases are emerging that combine both mobility and massive connections of industrial objects, which in his words would "justify 5G and generate a good return on investment."

However, there's also added hype around the technology's use in industry – a hot topic of discussion even before 5G launched. Roland Berger China believes the next generation of mobile has the potential to power digital transformation across a broad range of sectors. For example, the company sees vital use cases emerging in the mining industry, as well as in oil and gas.

According to Depoux, "Some attempts are being made in the fracking industry, in the oil, shell, and gas industries. These will attempt to use 5G because drilling has to move from place to place, so mobility is important. And obviously, this needs massive amounts of data and fast processing to optimize drilling and operations."

However, he adopted a cautious tone, adding that these solutions were still in the early stages. Providing some context on industrial efforts to adapt their businesses in the past, Depoux said there was "quite some disappointment" over the past few years, as digitalization had not yielded the returns expected. He explained that in some cases companies wanted to scale-up their digital approach, but that the "start-up mentality" led to hurdles.

"Other scenarios we saw was the massive production

of data through industrial IoT, especially from new factories or new machines in existing factories, machine tools producing a huge amount of data, but no capability to process that data and make something out of it," said Depoux.

5G can however make the difference by connecting all these objects and enabling large cloud computing processing of this data to solve that issue. And 5G, Depoux believes, can usher in new cases such as the use of robots in logistical warehouses and connecting assembly plants with high speed and low latency, linking together a large number of objects and enabling interaction with each other.

"That's the typical use case of 5G, as opposed to existing technologies that don't have the speed or mass connections that's needed," he said.

So what needs to happen to enable widespread industrial digital transformation through 5G? The Roland Berger executive pointed out that widespread transformation doesn't necessarily come with advancements in technology, but with an internal analysis of what's needed and what the customer is willing to invest in.

"What are the opportunities for enhanced productivity or efficiency? What can be automated to decrease costs and labour, or to simply improve safety? It doesn't start with technology, it starts by identifying very concrete use cases and that may not

even need to spread to a whole company, maybe to just one side, or to one workshop within a site. That can represent the lighthouse project, that can demonstrate a case that can gradually scale," believes Depoux.

Operators are at the edge

Industry and industrial use cases alike will play a key role in the advancement of 5G. But, where do mobile operators fit in?

Depoux highlighted the fact that the first role of the operator is to deploy the infrastructure and be ready with the equipment and software required. But, now an expectation exists for them to go beyond this traditional function.

"It's not only the infrastructure, it's also helping the client develop a very adequate solution," Depoux said. "And this is quite difficult because it's the total opposite of standardized products. Even in the B2B world, our observation as consultants is that every use case is quite different."

He continued to state the operator role was indeed evolving, and they have a requirement to think about different industries when planning and developing solutions that don't need to be standardized.

According to Depoux, "It needs to be adequate enough to incentivize the industrials to actually go a bit further and explore solutions and adopt, which is a key hurdle, simply because we're talking of something quite new, and not fully demonstrated."

Providing the network capability is of course one of the operator's main priorities in the 5G era. However, could private mobile networks, another touted 5G use case, mean that operators eventually lose their status as a default service provider?

Roland Berger China doesn't believe so. Depoux said that while alternative providers could deploy private networks in a certain site to develop a specific use case, an operator's overall scale means they will still hold the edge.

"Without the scale, you need to replicate such a solution across multiple sites, multiple locations and develop a different business model. The dominance of mobile operators could be partially challenged by vertical operators and that can happen. But, at the end of the day, if you look at other industries, such as utilities, there's a premium to scale. When more solutions are deployed and standardized, the more scale matters because it will drive costs down."

Huawei conducts the orchestra

Moving from operator to vendor, Depoux believes companies like Huawei have numerous roles to play, and it all starts with the actual development of the technology. He said that bringing the technology to the fore was the first challenge, and there was now a need for it to be optimized and gradually bring the price down to converge with the cost of 4G, which was "really quite paramount for B2B use."

The second role vendors need to play is to lead deployment and identify how the technology can be used across different sectors, again reiterating the importance of data and ensuring that it's processed and analyzed across each part of the organization to make it valuable.

"Vendors need to play the role of conductor, because a digitalization project is like running an orchestra," said Depoux. "You have different instruments but they all need to play the same music."

How China Unicom Beijing is maintaining its 5G lead

In China, 2019 was the year of 5G construction and 2020 was the year of 5G operations and management. In 2021, the 5G Capital project is set to ensure that China Unicom Beijing maintains its 5G leadership in terms of network, technology, and service capabilities.

By Gao Juan, Journalist, C114

Carriers, equipment providers, device manufacturers, chip manufacturers, and other industry players have worked together to develop 5G applications for various industries. However, for projects covering entire cities, there's a lack of proven practices that carriers can replicate, particularly in areas such as securing financing, developing cost-effective, innovative solutions for 5G network construction, and promoting innovative applications.

For China Unicom Beijing, the 5G Capital project is the key to solving this problem. C114 spoke to Yang Lifan, Deputy General Manager of China Unicom Beijing, about the project.

A 5G development strategy for maximizing ROI

The development of the mobile communications industry has slowed, along with profits. However, 5G requires large investment. So, how does China Unicom Beijing stay ahead of the pack in 5G?

"This is a real headache for all carriers, and China Unicom Beijing is no exception," says Yang. When asked why China Unicom Beijing decided to take preemptive action on 5G deployment, Yang cites the following reasons: "First, as the capital of China, Beijing is where efforts are organized to implement the national cyber development strategy. Therefore, Beijing should not lag

> Most industry players are focusing on B2B applications. But to achieve commercial success with 5G, B2B applications are far from enough. A high volume of B2C services is a must for 5G networks.

behind in terms of 5G network construction.

“Second, most industry players are focusing on B2B applications. But to achieve commercial success with 5G, B2B applications are far from enough. A high volume of B2C services is a must for 5G networks.”

He went on to explain the challenges of providing B2C services, "For B2B applications, 5G network construction can be focused on a specific project, but for B2C applications, 5G networks need wide coverage and large capacity." A third common problem that carriers are running into is slow revenue growth, says Yang, and their revenues will inevitably decline if they don't invest in 5G. Finally, if something as imperative as this relies on scarce resources, “then you have to take preemptive action to gain an advantage.” He believes that site locations are the scarcest resource for 5G deployment.

"These four reasons strengthened our conviction. China Unicom Beijing anticipated the current development of 5G two years ago, so we are determined in developing 5G," states Yang.

He also points out that the best way to secure financing is to build and share 5G infrastructure with other carriers. In 2019, China Unicom Beijing and China Telecom Beijing decided to fully share their 5G NSA networks. In 2020, they continued to work closely to share their 5G SA and 4G networks. By the end of 2020, the number of 5G base stations within the 5th Ring Road in Beijing exceeded 4G base stations by more than 30 percent, also providing villages and towns beyond the 5th Ring Road with continuous coverage.

To maximize ROI, China Unicom Beijing strictly controls the target areas and the distribution of 5G base stations. "Actually, this imposes very high requirements on the management of 5G construction," says Yang, “Because the quality of 5G networks not only depends on the number of base stations, but also on how they’re distributed.”

The value of optimization

According to Yang, 5G optimization solutions can boost China Unicom Beijing's profits by more than 10 percent. "This would not be possible without the use of innovative optimization tools, even if we were to install 10 percent more base stations." He adds that since

> Our 5G base stations are supported by a high-speed transport network with 10 Gbps bandwidth covering the entire city.

optimization, the carrier's 5G maintenance capabilities have equaled or even surpassed those for its 4G networks.

China Unicom Beijing has developed innovative solutions for network planning, construction, optimization, and maintenance to maximize its ROI. Its intelligent operations platform for 5G is key to cutting costs. According to Yang, China Unicom Beijing has invested 20 to 30 million yuan (US$3.09 million to US$4.6 million) in the operation platform, roughly the same cost as installing 200 or so base stations.

"To achieve the desired outcome of the intelligent operations platform, information technology and communication technology need to be deeply integrated, which is another key capability of China Unicom Beijing," he says, adding that the profit generated by the platform will be equivalent to 1,000 base stations.

How China Unicom Beijing secured leadership in 3 aspects of 5G in 2020

In late 2020, industry customers experienced China Unicom Beijing's 5G leadership in network, technology, and service capabilities at the 5G Slicing Product Experience Day hosted by China Unicom Beijing. "Slicing products best reflect a carrier's capabilities," says Yang.

In terms of network capabilities, China Unicom Beijing began building 5G base stations in 2019. Now, the carrier has brought full coverage to the areas within Beijing's 5th Ring Road, and outdoor 5G sites now outnumber 4G sites by a ratio of 1.3:1. Many major sites in the city also enjoy indoor 5G coverage.

China Unicom Beijing has rolled out a leading transport network to ensure that users enjoy an excellent 5G service experience. "Our 5G base stations are supported by a high-speed transport network with 10 Gbps bandwidth covering the entire city," says Yang. China Unicom Beijing is also the first carrier in the industry to implement the commercial trial of an SA core network. China Unicom Beijing's SA commercial trial started on June 20, 2020, and was open to all users. The carrier was also the first to implement NSA/SA dual-mode networking on all of its 5G sites in Beijing. That means that all 5G

> Our slicing products integrate wireless, transport, core, and MEC technologies to deliver a consistent experience without perceivable drawbacks in any specific area.

users have access to the carriers' 5G SA network from anywhere in the city.

China Unicom Beijing has deployed a large number of edge data centers throughout the city to meet users' diverse needs, including the requirements of campuses. The carrier also provides end-to-end network slicing products.

"We provide our customers with not only technologies in certain specialized areas, but seamless experience from end to end," Yang emphasizes. "Our slicing products integrate wireless, transport, core, and MEC technologies to deliver a consistent experience without perceivable drawbacks in any specific area."

In terms of service platform capabilities, China Unicom Beijing's 5G slicing products are efficient, flexible, and visualized to address different consumer and business needs. According to Yang, four factors are crucial to China Unicom Beijing's success, "First, an ecosystem that promotes open collaboration for shared success. Second, end-to-end networking capabilities, and the capability to quickly rollout multiple services. Third, specialized collaborative support capabilities. Fourth, capabilities that allow us to integrate the front end and back end, as well as integrate IT and CT."

Innovating to make 5G Capital a model for the world

With leading capabilities in networks, technology, and services, China Unicom Beijing is at the forefront of 5G development. Its next goal is to make its 5G Capital project a model for the world. This would be impossible without the support of its partners, one of the closest of which is Huawei. Dating back more than a decade to the 3G era, the two companies have deepened their cooperation during the 4G and 5G eras. In April 2020, they announced the 5G Capital joint innovation project: trialing six solutions, monetizing four smart services, and delivering two showcases. With this project, China Unicom Beijing is implementing improvements in every aspect of its 5G model, from applications and devices to networks and business. China Unicom Beijing is promoting scenario-specific 5G applications and setting the bar for 5G around the world.

According to Yang, the partnership between China Unicom Beijing and Huawei has led to the application of a range of solid technologies. The two companies

> We will pursue the massive application of slicing products in the consumer market, while focusing on lower latencies for the 2B market.

deployed a 200-MHz network on Beijing Financial Street, covering an area of 7 square kilometers. Test results show that the network's download rates exceeded 2 Gbps, two to three times higher than current 5G speeds. This ubiquitous high-speed access reflects China Unicom Beijing's pursuit of excellence in networks and a superior user experience.

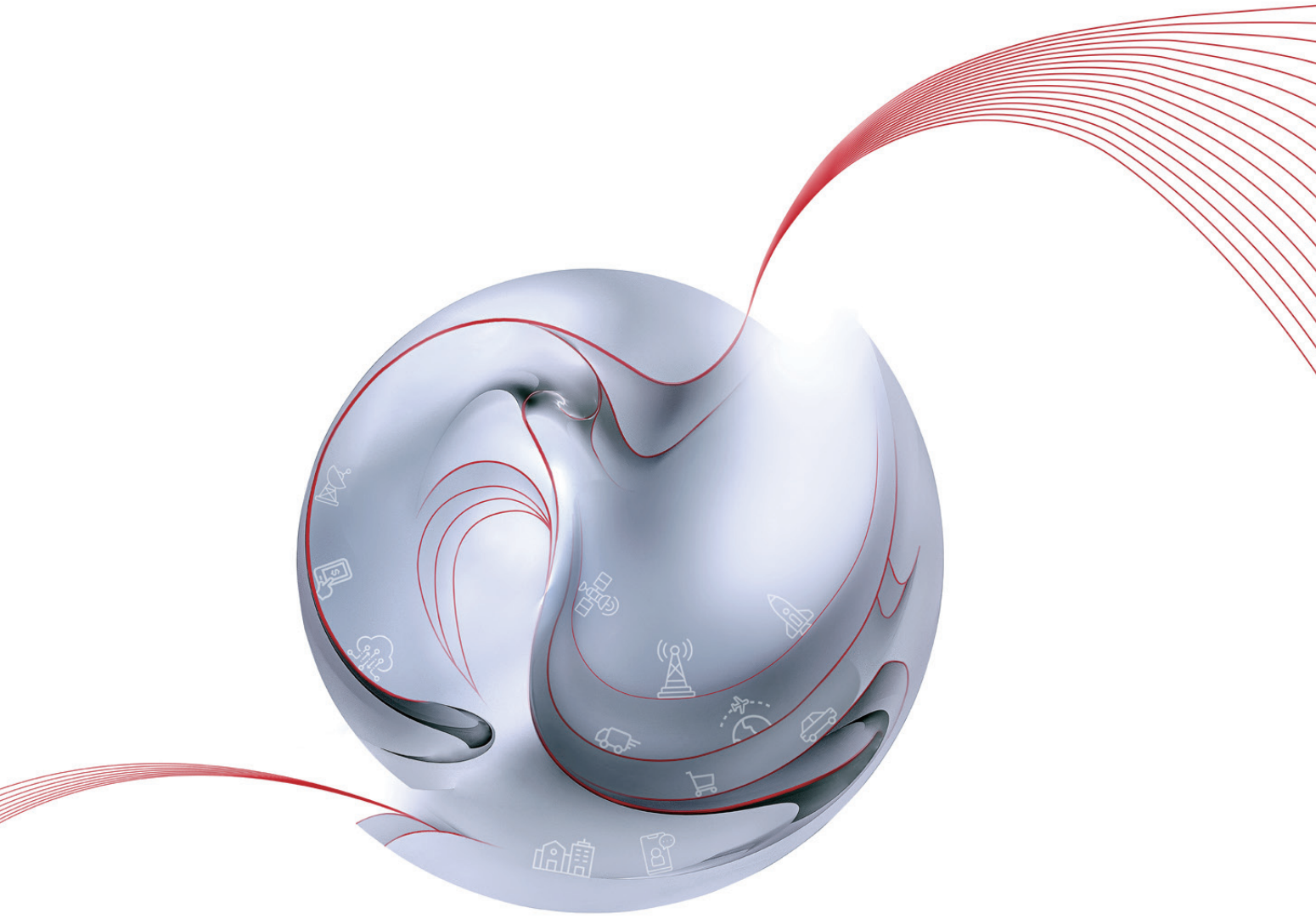
On March 16, 2020, China Unicom Beijing and Huawei implemented the world's first commercial deployment of the 5G LampSite 300 MHz digital indoor system at the Beijing Long Distance Call Building. The system increased network capacity threefold and the tested peak rate reached 3.4 Gbps, and the commercial deployment of the solution was one of the first fruits of the 5G Capital project.

The two companies collaborated closely on the construction workflow, allowing them to work smoothly together over the entire 5G deployment process. They coordinated decision-making on China Unicom Beijing's network evolution and technology roadmap, and Huawei supported China Unicom Beijing on developing a range of platforms, including the slicing management platform and intelligent 5G operation platform.

"2019 was the year of 5G construction and 2020 was the year of 5G operation and management," said says Yang. In 2021, China Unicom Beijing's goal is to maintain its leadership in 5G networks, technology, and services. Keeping one step ahead of the competition, and with base station numbers no longer an issue, the focus of the carrier's 5G development has now shifted toward operations.

In terms of networks, China Unicom Beijing's 5G outdoor coverage will outperform 4G in targeted areas, and 5G indoor coverage will soon be deployed in key areas and buildings. The carrier is building on its strength in technology, and plans to deliver 5G networks with 200-Mbps bandwidth in key areas and beyond. It will increase the proportion of its SA users and take the lead in deploying applications that comply with R16 standards. China Unicom Beijing intends to shore up its lead in services by focusing on two goals for its slicing products. "We will pursue the massive application of slicing products in the consumer market, while focusing on lower latencies for the 2B market," says Yang.

"In 2021, China Unicom Beijing will continue deepening its vision for smart operations."



For Intelligent Upgrades, Go for Intelligent Connectivity

Ubiquitous Gigabit
Deterministic Experience
Hyper Automation

5G | F5G | Wi-Fi 6 | Intelligent IP + Optical | ADN

Building a Fully Connected, Intelligent World

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Real industry value & real business opportunities with 5G

As 5G is poised to transform the way we live, connect, and work, the telecoms sector is deeply invested in creating more value beyond the consumer market. We're already seeing great progress in all sorts of industries. But there's no out-of-the-box approach to innovation. To create new value, Huawei needs to focus on real needs in real scenarios, and build up the capabilities to meet those needs. We also need to work with ecosystem partners to explore the unique value that 5G can bring to different industries around the globe.

Ken Hu, Deputy Chairman of Huawei

China began rolling out 4G networks in 2014. By 2020, it was already deploying 5G on a massive scale, with 5G services ready for broad commercial use. Over the past six years, we've witnessed the rapid development of China's mobile communications industry.

5G is transforming the world and empowering vertical industries

Global 5G rollout has entered the fast lane. As of today, there are 101 commercial 5G networks worldwide, with more than 400 5G devices available on the market. In particular, China stands out for the breadth of its 5G deployment. As of October 2020, China had already deployed over 600,000 base stations in more than 300 cities, reaching more than 160 million users across the country.

Right now, China has the world's best 5G network. For people with 5G connections, what stands out most is the sheer speed. In Shanghai, people already have

With 5G, things like remote diagnosis, remote ultrasound, and remote-controlled robots became a practical reality. 5G has since played an important role in preventing and controlling the spread of the pandemic.

gigabit download speeds, which is about 10 to 20 times faster than 4G.

But 5G brings more than just a faster speeds. It's transforming the world.

Fighting the pandemic

During the initial outbreak of COVID-19 in China, Wuhan set up two field hospitals in just 10 days – Huoshenshan and Leishenshan. At the time, Huawei worked with operators to build an emergency 5G network to connect these hospitals, and we got the network up and running in only three days. With 5G, things like remote diagnosis, remote ultrasound, and remote-controlled robots became a practical reality. 5G has since played an important role in preventing and controlling the spread of the pandemic.

In Huoshenshan hospital, the most urgent request we got was not simply Internet access, but to find a way to help medical staff properly don their personal protective equipment (PPE). Before the pandemic, most doctors and nurses never had the need to wear extensive protective equipment, like hoods, gowns, and air-tight masks. Putting it on properly is fairly complicated, and there are strict procedures to keep healthcare workers safe. To prevent cross-infection, medical staff are required to put on and remove their PPE in an isolated room, and only one person is allowed in at a time. So those who had never gone through these procedures before didn't know how to do it. No one was around to help them or check whether or not they had donned their PPE properly, so as a result many frontline workers would spend 30 minutes to an hour putting on their PPE.

That's where 5G came in to play. Huawei worked with the hospital to deploy 5G CPEs and HD cameras in the changing room. With HD video, experts walked medical staff through the PPE donning process and made sure everything was in order before they entered the quarantined areas of the hospital. This solution helped keep everyone safe and greatly improved efficiency.

Empowering smart ports

In the Port of Ningbo, 5G has totally changed the way

> With 5G, crane drivers at the Port of Ningbo now operate their equipment remotely in the comfort of an air-conditioned office.

gantry cranes are operated. In the past, engineers had to operate the cranes from a small control room suspended more than 20 meters above ground. They had to keep their heads down the entire shift, looking down at the containers below them, operating the equipment with both hands. Eight long hours of work like this is exhausting, and it really took its toll. Many had serious neck and back issues.

With 5G, crane drivers at the Port of Ningbo now operate their equipment remotely in the comfort of an air-conditioned office. With HD video, they can accurately locate containers, position the crane, and transfer cargo to trucks without overtaxing themselves.

This has improved operational efficiency by 20 percent, and the port has cut labor costs in half, because single engineers can now operate multiple cranes with ease. Most importantly, unmanned operations have made the workplace much safer, and engineers are able to work in a far more agreeable environment. This makes the job a lot more appealing to new applicants, as well.

5G is seeing broad adoption in many other industries, from steel and power grids to mining and manufacturing. As of September 30, 2020, 5G had enabled more than 20 different industries, generating over 5,000 innovative projects and over 1,000 5G business contracts across the country.

5GtoB: No ready-made path forward

Many industries are already putting 5G to use, but China is a huge market with many untapped opportunities. What Huawei has achieved today is just a drop in the ocean. We are all eager to seize these opportunities and convert them into real business value. But how? There's no such thing as a one-size-fits-all solution, because every industry has very different requirements.

It's fair to say that all of us in the ICT sector have questions about how to better enable industries with 5G. Here, I've listed some takeaways from projects we've worked on.

Exploring scenario-based needs

Everyone is eager to use 5G, but the challenge lies in finding where the real needs are. To do this, we have to dive deep into the scenarios that might use it and develop a set of criteria for what 5G can actually help with. This is how we can identify real needs that are

> Industries with mature integration capabilities and a strong developer community can more readily embed 5G into their existing portfolios.

worth investing in.

Based on our experience, we would recommend four main criteria: technical relevance, business potential, value chain maturity, and standardization.

Technical relevance is about assessing whether or not 5G is the best choice for a specific application compared to other connection technologies. For the remote control of gantry cranes in ports, optical fiber is too unwieldy to work with and the costs associated with laying new fiber are way too high. Wi-Fi can meet mobility requirements within a certain range, but it doesn't support the high uplink bandwidth required for uploading HD video. In this instance, 5G has the right technical specifications to solve all these problems.

Business potential means whether or not we can replicate a given demand in other industries at scale, and whether or not we can come up with a business model that works for everyone to encourage ongoing investment.

As for value chain maturity, industries with mature integration capabilities and a strong developer community can more readily embed 5G into their existing portfolios. This will help expedite wider adoption of 5G.

The last criterion is the degree of standardization, which is very important but often ignored when we're trying to identify the best scenarios for 5G adoption. The fact is, it's far easier to promote 5G in highly standardized industries and scenarios. For example, the port sector is highly standardized: At the end of 2020, we released smart port communications standards jointly developed with our customers and partners. With common standards in place, it will be much easier to adopt and promote the use of 5G in all ports.

After measuring different scenarios against these four criteria, we have identified several distinct scenarios that can greatly benefit from 5G, such as remote control, video upload, machine vision, and real-time positioning of people and equipment. These scenarios are commonly found in most industries, and they demonstrate a real need for 5G, so we believe they are very much worth investing in.

Networks need to adapt to different scenarios

Network connectivity is the basis for providing 5G services. However, businesses and consumers have

When operators look to develop a 5G portfolio for the enterprise market, they need to consider their customers' broader needs, rather than simply providing connections.

different requirements for connectivity, so operators need to be able to adapt their network equipment and approach to network planning, construction, maintenance, and optimization. Close, in-depth collaboration between operators and equipment providers – centered on specific industrial scenarios – is key.

Industrial 5G devices: More types and lower costs

As more industrial 5G applications begin to appear, devices are likely to become a bottleneck. To ensure that we have a thriving 5G device ecosystem, we need to diversify the kinds of modules available and keep them affordable.

Since the first 5G module was launched more than two years ago, we have seen the emergence of more than 20 module developers worldwide. They offer over 60 different 5G modules that power more than 140 different industrial devices, including things like 5G-powered AGVs, cameras, drones, and inspection robots.

Currently, there are roughly 1,400 4G modules on the market. We're confident that, as 5G sees broader application, the number of 5G modules on the market will quickly catch up – if not surpass – those for 4G.

In addition to more types, keeping the price of modules down will be critical to expanding the 5G ecosystem. Most estimates predict that the costs of 5G modules will keep going down.

During the Double 11 shopping day in 2020, China Mobile released a 5G module that only costs 799 Chinese yuan (US$122). This is a very positive sign. Huawei predicted that average 5G module prices would go down to about US$40 by the end of 2022.

5GtoB: New capabilities

5G applications for businesses aren't just about selling connections; they're about enabling digital transformation. In addition to connectivity, both applications and architecture are essential to going digital. So when operators look to develop a 5G portfolio for the enterprise market, they need to consider their customers' broader needs, rather than simply providing connections.

To go digital, organizations need to build their technology architecture on a strong foundation of connectivity and telecommunications, where 5G is key. Organizations also need cloud capabilities in the middle, and all sorts of different industry applications on top. This type of architecture is critical to enabling

the full integration of communications technology, IT, and operational technology.

Operators have the connectivity part down, but an urgent need exists to expand capabilities in cloud, application development, and end-to-end integration. There is a real lack of comprehensive solutions for enterprise digitalization at the moment, system integration in particular. For digital transformation, system integration touches on architecture planning, solution design, verification, integrated delivery, O&M, operations, and ongoing iteration. This is a new type of integration that most industry service providers aren't yet equipped to handle.

So who can fill this gap? I think that, by answering this question, we will be able to provide new momentum for growth in the industrial market for 5G.

More know-how, stronger positioning

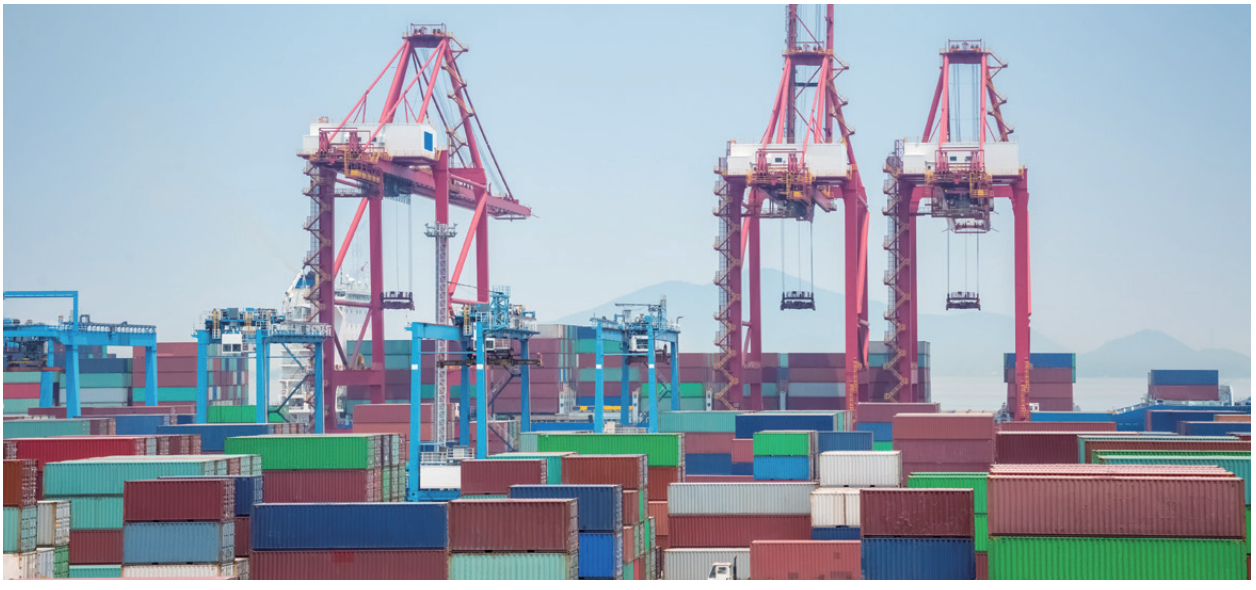
Operators have multiple roles to play. If their focus is on connectivity, there's certainly demand for connections. Some might also consider developing cloud capabilities on top of that, and provide a combination of connectivity and cloud-based services. Or even become a system integration provider and provide a combination of connectivity, cloud capabilities, and integration services. These all require a different set of core competencies, and Huawei is more than happy to work with them to bridge any capability gaps.

5G can and will change everything

We are at the cusp of another golden age for our industry. 5G will generate an immense amount of value for all sectors over the next decade, and opportunity abounds. There will be ups and downs along the way, and every step forward will come with a new set of changes that we need to face.

But I firmly believe that the hardest things are the things worth doing most because when you succeed, the results are incredible.

Huawei is ready and willing to work with operators, our customers, and industry partners to push the boundaries of innovation and build a better future for everyone.



Maximizing wireless network value for a golden decade of 5G

GSMA forecasts that the number of 5G connections is set to reach 1.1 billion by 2025 and that 5G networks will connect one third of the world's population. This will have a profound impact on users and the mobile communications industry as a whole.

By Ryan Ding, Executive Director and President of the Carrier BG, Huawei

The 5G industry is developing much faster than expected, and China has become a leading 5G market worldwide. As 5G brings both new challenges and new opportunities, how can we maximize wireless network value to usher in a golden decade of 5G? This is a common goal that Huawei shares with its partners and customers.

The 5G ecosystem is ready

The 5G ecosystem is already mature. There are more than 110 commercial 5G networks worldwide, and the areas they cover account for more than 70 percent of global GDP. 5G devices are also developing much faster than expected. In China, more than 10 million 5G smartphones are sold every month, and models that cost about 1,000 yuan were already available in the market in 2020. This is much earlier than we expected and we believe that there will be another surge in the number of 5G users.

Leading carriers are already benefiting from 5G. They're seeing an increase in the ARPU of 5G users, thanks to multi-metric service plans and upgraded services like 5G messaging and enriched calling.

As data plans become more generous, users no longer have to be careful about how much data they use. This is redefining traditional telecom services. SMS services,

> Leading carriers are already benefiting from 5G. They're seeing an increase in the ARPU of 5G users, thanks to multi-metric service plans and upgraded services like 5G messaging and enriched calling.

for example, will be upgraded to 5G messaging. Huawei estimates that by 2025, there will be hundreds of millions of 5G messaging users in China alone, which means hundreds of billions of RMB in revenue for carriers. In addition, traditional voice services will be upgraded to enriched calling. This supports video ring back tone services before a call gets through, and visualized customer services during a call. According to public statistics, the enriched calling service has attracted more than 120 million users in China, and video ring back tones are played 4.5 billion times every month.

Building the best 5G networks for individual users

To maximize network value and accelerate the commercial success of 5G, carriers need to build the best possible 5G networks to attract more users. We believe that wireless networks can realize their full value when network coverage is wide, user experience is good, and network TCO is low.

With wide network coverage, mobile phone users can access 5G networks anytime, anywhere. Superior experience means users can instantly download data and watch videos without any jitter. An optimal network TCO means lower OPEX. This is what the best 5G networks will deliver.

Specifically, three things need to be done:

First, all-scenario 5G coverage solutions are needed to give users stable access to 5G networks anytime and anywhere. In outdoor scenarios, carriers can use both TDD and FDD to build networks. TDD's large bandwidth means that it's a perfect choice for providing continuous coverage in urban areas. FDD working in low frequency bands can provide wide coverage in suburbs. In densely populated urban areas, carriers can build both macro and micro sites for fast and low-cost 5G coverage in hot spots and blind spots. To provide deep indoor coverage, like in stadiums, office buildings, and shopping malls, both indoor and outdoor base stations can be deployed.

Second, after users migrate to 5G, carriers need to improve connectivity and make sure that users enjoy a consistently superior experience. Carriers can do this by evolving their full-band multi-antenna equipment and coordinating deployment of 4G and

5G. In Argentina, Huawei worked with a local carrier to reconstruct its networks using our 4T4R solutions operating on the 700 MHz band. This has helped double network speeds and increase the capacity per cell by 40 percent. In China, we worked with carriers to deploy 64T64R on C-band and 2.6 GHz. Multi-user tests showed that the maximum capacity of a single cell reached 5.7 Gbit/s.

In the early stage of 5G rollout, LTE serves as the anchor of non-standalone (NSA) 5G networks and provides VoLTE services. That's why LTE networks will be the foundational network in the 5G era and coexist with 5G New Radio (NR) for a long time to come. In one province in southwest China, improved LTE coverage in the 1800 MHz band has increased 5G coverage from 80 percent to 99 percent. Thanks to the high-quality 4G and 5G network experience, the average download speed available to 5G users has reached 800 Mbps and the average upload speed is 100 Mbps.

The third important thing is to cut network TCO. Huawei was the first company in the industry to propose the idea of simplified sites. The idea here is that all network equipment is deployed outdoors, which reduces carriers' expenditure on rent for rooftops, sites, and equipment rooms. This in turn translates into lower network TCO.

In Russia, we worked with local carriers to build SuperBlade simplified sites, reducing the number of modules required at each site from 25 to 13. That means a 50-percent reduction in TCO. The SuperBlade solution has been put into commercial use in more than 5,000 base stations in Russia, saving carriers US$100 million.

To further lower network TCO, Huawei also provides a layered energy-saving solution that can cut the energy consumption of wireless networks without compromising network performance. The solution has been deployed in more than 200,000 base stations in China. It saves 1.5 kWh of electricity per site each day, which means that a total of 100 million kWh of electricity is saved every year.

5GtoB: A blue ocean for carriers

The industrial market is set to become a new revenue stream for carriers. It has been more than a year since the earliest deployment of 5G, and in that time 5G has been applied in more and more sectors. 5GtoB represents a new blue ocean for carriers.

Many industrial applications have become increasingly commoditized and can be replicated on a larger scale. In China alone, more than 5,000 commercial 5G projects are underway.

In Yangquan Coal Mine in Shanxi Province, a 5G network deployed 534 meters underground is used to remotely control mining machines. With this solution, only half as many workers need to actually go into the mines, because many can now do their work from a control room. In Ningbo Port of Zhejiang, 5G allows gantry cranes to be remotely controlled, and productivity is now four times higher. On Midea's production lines for microwave ovens, 5G networks allow for centralized deployment of programmable logic controllers (PLCs) on the cloud, reducing production costs by 15 percent.

Carriers are also exploring how 5G can empower other industries. The BAF business model, which stands for Basic, Advanced, and Flexible, has been proposed by a Chinese carrier. They offer a menu of services that industrial users can choose as needed. Users can choose different types of basic network architecture to

Carriers need to provide better network connectivity, forge more partnerships with other industries, and push for a more mature industry ecosystem.

meet their basic needs. Building on that, they can then flexibly select advanced functions like uplink speeds, location, and network optimization to meet industry-specific needs. In other words, networks can be built based on service requirements.

Incubating new capabilities for enterprise users

The needs of enterprise customers are diverse, so it's crucial that carriers incubate new capabilities.

Carriers need to provide better network connectivity, forge more partnerships with other industries, and push for a more mature industry ecosystem. They also need to build platforms to cut application deployment costs and make O&M faster. This is the only way to maximize the value of networks in the industrial market.

To make that happen, carriers need to do three things: First, they need to develop the basic network capabilities necessary to support industrial 5G applications. Many industry applications require real-time video upload, which means higher uplink rates are needed. Huawei has developed the Super Uplink solution, delivering a fourfold increase in uplink rates. Highly reliable network services are also very important. Huawei offers a multi-link backup solution for factories, which ensures uninterrupted connections and production and delivers five-nines or even six-nines reliability.

Flexible networking solutions are also necessary to support different industrial 5G applications. For example, carriers can adjust the priority settings of public networks to meet high-priority needs like road and bridge inspections. They can use hybrid 5G network architecture built on network slicing to meet industry needs like live streaming. They can also deploy multi-access edge computing (MEC) and dedicated 5G sites to provide dedicated public network services for industry users.

The second important point is to involve everyone across the whole value chain.

Developing industrial 5G applications is an industry-wide effort, rather than being solely the responsibility of carriers. This development will only accelerate when

> The next decade will be the golden age of 5G. We need to continue to build the best networks possible for consumers, and incubate new capabilities for industry customers.

telecommunications integrates with other industries. Many industries are embracing 5G by actively implementing 3GPP standards.

Release 16 and Release 17 have added improved standards for broadcasting services. Release 18 will define the architecture for 5G smart grids and how 5G will support services like remote control and protection. 5G is now being integrated into industry standards. Recently, Huawei has begun researching standards for 5G in healthcare. This will help define how 5G will be applied in healthcare, and create more innovative 5G applications in the sector.

Third, carriers need to make end-to-end improvements specifically for industries, ranging from network planning and construction to maintenance, optimization, and operations.

In the past, carriers tended to provide O&M services for industry users on a best-effort basis. In the future, O&M needs to be tied to SLAs. SLA-based intelligent planning, on-demand service provisioning, and proactive O&M based on fault forecasts will become a reality. This will make network O&M more efficient.

Carriers also need to provide a unified service operations platform. They need to define their capability boundaries based on which role they play. If they position themselves as a network carrier, they need to integrate 5G capabilities into a cloud platform through APIs. This will make it easier for industry customers to use 5G networks. If they position themselves as a cloud service provider, they need to provide an application enablement center for application developers and an industry application market for industry users. If they position themselves as a systems integrator, they need to integrate resources so that they can provide consulting, design, delivery, and integration test services, maximizing the value of their industry solutions.

The next decade will be the golden age of 5G. We need to continue to build the best networks possible for consumers, and incubate new capabilities for industry customers. We will work more closely with all players across the value chain to maximize network value and embrace the new era of 5G.

Defining 5.5G for a better, intelligent world

Drawing on years of experience in the wireless communications industry, Huawei has proposed its vision for 5.5G to shape the development and evolution of the 5G industry and create new value for social development and industry upgrades. Huawei looks forward to working with industry partners to define 5.5G.

By David Wang, Executive Director, Huawei

4G has changed our lives. 5G will change the world. As more and more customers choose Huawei's 5G solutions, Huawei has created value for the sustainable development of society and the economy. How can we make 5G a reality? How should we continue driving the 5G industry forward?

5G is developing at an unrivaled pace, bringing real changes

5G is developing much faster than 3G and 4G. Currently, there are more than 110 commercial 5G networks worldwide, as well as over 800,000 5G sites. Globally, more than 60 percent of phones shipped are 5G smartphones. In just one year, 5G has reached over 200 million people. In contrast, in the same timeframe, 3G and 4G reached just 320,000 and 400,000 people, respectively.

“In wireless communications, each generation of technology lasts about 10 years. 5G will play a major role in the mobile communications industry in 2030, and will still be in use in 2040.”

5G is dramatically changing the way we live and work. 5G mobile networks promise better coverage, faster speeds, and lower latency, offering simpler and faster access to information. 5G will also provide each user with a more personalized experience.

5G networks will also greatly increase the efficiency of enterprise production. 5G can support unmanned mines, keep track of HD weather maps anytime anywhere, and monitor river pollution in real time. 5G is reshaping our production models and improving productivity.

Looking ahead to 2030, we must continue pushing 5G forward

In wireless communications, each generation of technology lasts about 10 years. 5G will play a major role in the mobile communications industry in 2030, and will still be in use in 2040.

Over the past 30 years, the development of 2G, 3G, and 4G has shown that each generation required continuous evolution to unleash the full potential of the technology and advance the development of the industry.

We’re moving towards an intelligent world where all things sense, all things are connected, and all things are intelligent. 5G will play a key role in this journey. As we look towards 2030, consumers will continue pursuing the ultimate service experience, and more diversified scenarios will emerge for industrial IoT. These developments will bring new challenges to 5G connectivity.

Challenge 1: Enhancing connectivity experiences between people and enabling real-time interaction with the virtual world.

Connecting people is the basic function of 5G. Mobile networks were initially created to keep people connected, anytime and anywhere. Between now and 2030, 5G will increasingly help people interact with the virtual world in real time and deliver a truly immersive experience.

5G-empowered VR/AR has made interactions between the physical and virtual worlds a reality. However, to deliver an XR Pro and holographic experience, cellular communication must deliver higher speeds. The average access speed will need to increase from the current 120 Mbps that supports today's 4K video streaming to the 2 Gbps necessary for 16K video. In

> Huawei's vision and mission is to bring digital to every person, home, and organization for a fully connected, intelligent world.

addition, lower interaction latency will be needed; the current 20 ms will need to be brought down to 5 ms. And to meet all of these requirements, 5G must keep evolving.

Challenge 2: Enabling more connections between things, as 5G will be the cornerstone of 100 billion connections

Connecting things is a major extension of 5G. Huawei's vision and mission is to bring digital to every person, home, and organization for a fully connected, intelligent world. Connectivity and computing will be the building blocks of this intelligent world, while 5G will be its most critical connectivity technology.

Looking ahead to 2030, cellular networks are expected to carry more than 100 billion connections, most of which will be carried by 5G. This amount is orders of magnitude higher than the 1.3 billion IoT connections we have today. Therefore, 5G must constantly evolve to meet the increasingly diverse and complex needs of IoT across all scenarios.

Looking ahead, it's vital that we take 5G to the next level. We need to enhance connectivity experiences between people and explore more scenarios for connectivity between things. 5G has the potential to support 100 billion connections, as well as business development over the next 10 or even 20 years. To realize this potential, it's imperative that we define a level that's higher than 5G.

Proposing 5.5G to create new value for social development and industry upgrades

Drawing on years of experience in the wireless communications industry, Huawei has proposed its vision for 5.5G. With 5.5G, Huawei aims to shape the development and evolution of the 5G industry, inject more vitality into 5G, and create new value for social development and industry upgrades.

5.5G is our vision for the industry. It is an enhancement and extension of the three standard 5G scenarios defined by the ITU – eMBB, mMTC, and URLLC. The introduction of REDCAP means that more device types will become available, providing the diverse range of devices needed by broadband IoT in the mTRC scenario. Optimizations to latency, with a certain level of reliability, allow for smart manufacturing like remote motion control in the URLLC scenario.

> 5.5G will cover three more scenarios than 5G: UCBC, RTBC, and HCS, taking us beyond the Internet of Everything and enabling the intelligent Internet of Everything.

5.5G aims to address the growing number of new applications. The three use cases currently defined by 5G can no longer support more diverse IoT scenarios. For example, industrial IoT applications require both massive connections and large uplink bandwidth. This is why Huawei has proposed UCBC – a scenario that falls between eMBB and mMTC and focuses on uplink speeds. For other types of applications, which need ultra-broadband, low latency, and high reliability, Huawei has proposed RTBC. The RTBC scenario falls between eMBB and URLLC, and focuses on real-time broadband communication. There are also many scenarios that require multiple capabilities. For example, vehicle-road collaboration for connected vehicles requires both communication and sensing capabilities. Therefore, we have proposed our final new scenario, HCS, which focuses on building harmonized communication and sensing capabilities.

Therefore, 5.5G will cover three more scenarios than 5G: UCBC, RTBC, and HCS, taking us beyond the Internet of Everything and enabling the intelligent Internet of Everything.

5.5G will create new value for social development and industry upgrades in numerous ways.

UCBC will accelerate the intelligent upgrade of industries. Built on 5G capabilities, UCBC will enable a tenfold increase in uplink bandwidth, which is perfect for manufacturers who need to upload videos through machine vision and massive broadband IoT. With multi-band uplink aggregation and uplink massive array technology, UCBC can also greatly improve user experience with mobile phones in indoor scenarios, with its deeper coverage and larger uplink bandwidth.

RTBC will deliver an immersive, true-to-life experience. RTBC supports large bandwidth and low interaction latency, aiming to deliver a 10-fold increase in bandwidth with a given latency. These advancements will provide users with an immersive experience during interactions with the virtual world, such as the X Pro and holography applications. Larger capacity pipes built on generic carrier technology coupled with an end-to-end, cross-layer XR experience assurance mechanism can provide the large bandwidth necessary for real-time communication.

HCS enables autonomous driving. HCS is designed to enable connected cars and connected drones, scenarios in which autonomous driving is the key requirement. Both of these scenarios require the communication and sensing capabilities of wireless cellular networks. By applying Massive MIMO beam

> The development of 5.5G requires collaboration between all parties, both up and down the value chain.

scanning technology to the sensing domain, HCS can offer both communication and sensing functions. In addition, HCS is capable of providing location services in indoor scenarios.

To maximize the value of spectrum, we need to restructure the sub-100 GHz usage pattern. Spectrum is the most valuable resource in the wireless industry. To realize the industry's vision, 5.5G requires more sub-100 GHz spectrum. Different types of spectrum have different characteristics. For example, FDD symmetric spectrum features low latency, TDD spectrum offers high bandwidth, and millimeter wave boasts both low latency and high bandwidth. The way that we utilize the strengths of these different frequency bands will be key to the overall development of 5.5G. Our goal is to maximize the value of spectrum through full-band uplink and downlink decoupling and full-band carrier aggregation on-demand, as well as through the restructuring of the sub-100 GHz usage pattern.

With AI, 5G networks have limitless intelligence. The 5G era will see more frequency bands, and more types of devices, services, and customers than any previous generation. 5.5G needs to fully integrate with AI to address all these complexities and push autonomous driving wireless networks towards Level 4 or 5.

Defining 5.5G for a better, intelligent world

Over the past 30 years, unified standards and industry collaboration have been the core DNA that shaped the robust and rapid development of the global wireless communications industry. The development of 5.5G requires collaboration between all parties, both up and down the value chain. To this end, Huawei offers three key proposals:

First, all industry stakeholders should start defining 5.5G within the 3GPP framework as soon as possible. 5.5G is the next step in 5G evolution and must be compatible with all 5G devices.

Second, the industry should work together to develop a thriving 5.5G industry ecosystem by making the most of the sub-100 GHz spectrum to provide diversified network capabilities and devices.

Third, the industry as a whole needs to integrate cloud and AI applications into verticals and create more use cases to accelerate the intelligent upgrade of industries.

Huawei looks forward to working with industry partners to define 5.5G and build a better, intelligent world.

Tunisie Telecom: Tailoring digital transformation to customer experience

Against the backdrop of the pandemic, Mohammed Wassel Belhadj, CIO of Tunisie Telecom, explored the role of the CIO in a telco that's transforming, 5G, data center trends, storage solutions, and the telco's long-term partnership with Huawei.

By Gary Maidment, Huawei

As a CIO, what major trends and challenges are you considering with regard to 5G?

Mohammed Wassel Belhadj: Any CIO should balance vision and reality when undertaking any type of transformation, so that the adoption of new technologies becomes a business enabler for carrying out sustainable investments.

5G shouldn't be regarded as a new generation of communication. The increasing bandwidth it brings alongside low latency and enhanced security are triggers of technological and cultural disruption. Industries will be borderless in a way that will let telcos orchestrate value-added services with partners from across the market. This will ultimately benefit the customer, who sits at the heart of the new era.

And to cope with this new paradigm, CIOs should work on achieving disruptive digitalization, agile time-to-market, and standardized openness. They should also

seek to maximize automation and ensure effective collaboration, rational convergence, and the secure elasticity of innovative services.

Of course, the COVID-19 pandemic has added more stringent challenges such as remote work as well as tough budgetary constraints. Amazingly, the major challenge facing CIOs isn't technological or financial – it's mainly about the cultural shift of operations at a team level.

What do you see as the future of IT services and infrastructure development trends in the telecoms industry?

Wassel Belhadj: 5G is a central topic for carriers, including IT service pervasiveness across the edge and core, as well as IoT systems. People will move from traditional human-to-human connectivity to the human-to-machine and machine-to-machine digital realm.

AI and big data will be the cornerstones of the shift that we're already seeing in many countries, including China, Japan, Korea, and also in the EU. This shift is also underway in Tunisia. To protect existing investments, the impact of 5G on architectures must be fully considered before we decide on acquiring new information systems and infrastructures.

5G is a world where everything is connected and where data is proliferating. Information systems need to process huge amounts of data faster than ever before, so we need scalable data center architecture to cope with sudden service surges.

In my opinion, cloudification and layered decoupling are the future trends we'll see in data centers.

- Cloudification allows carriers to deploy hardware and software resources in shared, scalable, autonomous, and secure pools. Cloud computing promotes resource optimization and operational efficiency while reducing TCO.

- Layered decoupling enables resources to be used on demand. When computing resources are required, a limited number of infrastructure components will be called on.

This will help carriers quickly respond to market demands, achieve on-demand resource allocation, cut TTM, optimize TCO, and boost infrastructure and data-center scalability and efficiency. In the digital era, data is at the beating heart of transformation. Carrier data infrastructure requires 24/7 resilience and unpredictable elasticity.

The COVID 19 pandemic has highlighted our reliance on digital services. In turn, that means that data needs to be hosted and processed by leading high-performance solutions for consolidated storage infrastructure.

How does the solution satisfy your storage consolidation requirements?

Huawei has the advantage of built-in AI in almost all its hardware and software components. That put us in an advantageous competitive position while protecting our investment. Huawei's all-flash high-

end storage is a great choice for critical business in the carrier industry, but it can also be deployed in other fields with high requirements on data such as financial services, education, and the retail sector.

Actually, Tunisie Telecom has been working with Huawei for several years as a strategic partner. Through our collaboration, we identified Huawei as a company that not only delivers equipment, but – thanks to its strong R&D capabilities – also provisions advanced solutions that satisfy our requirements.

The knowledge transfer between TT staff and Huawei experts during project and support execution has also proven to be invaluable.

We're moving fast on the digitalization track. And we need strong partnerships based on a win-win strategy that can accelerate the digital transformation of Tunisie Telecom and our beloved Tunisia.

What are the most important requirements that made you opt for storage consolidation?

The force majeure nature of the pandemic has triggered greater urgency for digital transformation and highlighted the importance of a consolidated data infrastructure for supporting information systems.

Data infrastructure supports interoperability between systems such as online Point of Sale, online marketing, video conferencing, customer management, and remote support. This can reduce data silos under a blended data infrastructure, one that features elasticity, scalability, cloud-enablement, high availability, and security, so as to cope with all these challenges.

Additionally, a self-service approach will drastically reshape businesses by placing the customer experience as the basis of all decision-making. Underpinned by convergence, automation, and security, cloud, AI, 5G, and IoT will catalyze this approach.

Interruptions to critical business systems, such as billing, CRM, or portals, can cause operators huge losses on revenue and brand image. Therefore, an optimal active-active highly available infrastructure is required to ensure data reliability and load-balancing. High performance and low latency are a must for a comprehensive customer experience. In addition, I believe AI capabilities can improve O&M efficiency and analytics to deliver high-value automated assistance and simplified operational support. Finally,

> We're determined to take the lead in Tunisia's ICT market and contribute to developing the digital economy.

data infrastructure should support smooth scalability and easy upgrades to protect investment and optimize ROI.

What's your strategy in regard to data platforms?

Tunisie Telecom has already embraced digital transformation. We're determined to take the lead in Tunisia's ICT market and contribute to developing the digital economy. The core of the digital economy is obtaining value from data, which in turn drives enterprise decision-making and innovation. In fact, a large volume of data scattered in siloed systems is of low value – only after massive data is aggregated and key information is extracted can the value of data be realized. Therefore, building a complete data value chain of collection, storage, analysis, and digital intelligence is a prerequisite for obtaining digital dividends.

The best-in-class infrastructure for storing our data securely and efficiently is the foundation of the data value chain system. While Tunisie Telecom is used to dealing with the leading storage players in the market, we were still hosting our data in scattered architecture, leading to limitations in terms of performance and scalability amid an unpredictable boom in data proliferation.

So, we decided to go for centralized consolidated high-end storage arrays.

To do that, we challenged different vendors based on Gartner Leaders' Quadrant. The solution we selected was a high-end all flash storage aligned with the critical services inherited from our carrier industry. The solution has unique advantages in reliability, elasticity, security, and AI.

Beyond outstanding technical attributes, we were looking for a partner rather than just a vendor. The difference lies in a long-term, win-win collaborative approach, knowledge transfer, a commitment to our stringent SLA, and a clear product roadmap.

That partner was Huawei.

Insights from 5G industry pioneers

During the 2020 Global MBB Forum, I sat down with leaders in the 5G field to explore the latest developments in the 5G arena. Each of their companies received a Contribution Award at the forum for their part in building a healthy, open, and mutually beneficial 5G ecosystem.

By Peng Zhao, IoT Think Tank

> 5.5G expands 5G's three scenarios to six and marks an evolution from the connectivity of everything to the intelligent connectivity of everything.

"5.5G" and "1+N", as explained at the 2020 Global MBB Forum, define how 5G will be integrated into numerous industries in 2021.

5.5G

5.5G expands 5G's three scenarios to six and marks an evolution from the connectivity of everything to the intelligent connectivity of everything.

5G's three original use cases are:

- Enhanced Mobile Broadband (eMBB)
- Massive Machine-Type Communications (mMTC)
- Ultra-reliable Low-latency Communication (URLLC)

5.5G's three expanded use cases are:

- Uplink Centric Broadband Communication (UCBC) for accelerating the intelligent transformation of industries
- Real-Time Broadband Communication (RTBC) for enabling immersive experiences
- Harmonized Communication and Sensing (HCS) for boosting autonomous driving

1+N

"1+N" refers to full-spectrum evolution to 5G and has two targets: 1) Build "1" broadband infrastructure network with universal coverage and large intermediate-frequency bandwidth. 2) Build differentiated advantages with other frequency bands to enable a simplified target network that provides "N" capabilities on demand.

2021 will see more applications of 5G private networks in industries. It's estimated that by 2030, cellular networks will need to be able to convey hundreds of billions of connections. This will be largely made possible with 5G, and most connections will be industry-oriented digital applications. In just a year, the number of 5G users worldwide grew to over 200 million, compared with 320,000 for 3G and 400,000 for 4G over the same timeframe. While 5G brings about emerging use cases, massive connections, and ultra-fast speeds, industries still have doubts: Can conventional 5G address unique industry requirements? What can we do when new business models enabled by 5G are still unproven? Even with all the pilots, how can we convince users to switch to 5G?

No matter how quickly 5G concepts evolve, we eventually measure them by their ability to solve real problems.

How can the high costs of 5G modules and limited value of 5G applications be addressed?

Feng Xiang,
GM, IoT Product Line, TD Tech

While early adopters have invested a lot of time and effort in exploring how to integrate 5G into their industries, integration will go through a period of uncertainty because new applications take time to make headway.

TD Tech produces and researches wireless communications technologies. We have embraced 5G technology, and we promote industrial 5G modules and develop industrial-grade 5G CPE and 5G AI gateway products. Our products have been used in various scenarios, including by Xianggang Iron & Steel and the Port of Ningbo, and also in a live broadcast on Mount Qomolangma.

Currently, 5G modules can be easily integrated into small devices such as live broadcast backpacks, industrial gateways, robotic arms, and machine-vision cameras. But using 5G for large equipment and projects isn't easy because it's expensive and takes a long time. Therefore, trials are necessary in the initial stages of 5G adoption.

With more 5G applications, use cases, and partners, as well as maturing technologies, the price of 5G modules will drop by, I believe, 20 to 30 percent in 2021. This will encourage more companies to deploy 5G, creating a virtuous circle and further driving down module prices.

Recently, the 5G Applications Industry Array (5GAIA) recognized us as an Innovation Center for 5G Industry Devices and Applications. We will set up a testing platform for 5G devices at this innovation center, which provides incubation services for 5G industry device products and partners with customers in research and innovation.

How will companies with strong safety requirements, such as mining companies, approach digital transformation?

Jing Jie,
Chairman, Shanghai Sany Electronics Technology

I've been in coal mining for 30 years, including a decade in the mines. I think the industry desperately needs someone who can provide connections. Coal mining is an old industry: For years, tens of thousands of devices were spread across dozens of kilometers and weren't connected. We're now trying to revolutionize the industry by connecting coal mines with 5G and making them smart.

We use 5G networks and devices to streamline the

workforce, machines, materials, methods, and an environment that's 534 meters underground, and then send data up to the surface. At Sany, we position ourselves as a communications solution integrator in the coal mining industry. We completed the intrinsic-safety and explosion-proof certification of a dozen 5G networking products and devices. We did that in the shortest possible time to support the delivery of a few major 5G smart coal mine projects with Yangquan Coal Industry Group, Yulin of Shaanxi, and Madiliang Coal Mine.

Coal mining is a unique industry. We've had 4G for five years but it's only been adopted in about 100 mines. However, around 100 5G-related projects sprang up in just three months after 5G was launched. 5G can address the most urgent needs of this industry, but it's important to find a way to apply it. Coal mining is an industry with many risks, so few companies want to work with coal mining companies and not many young people are willing to work underground in a coal mine. 5G can play a crucial role in solving these problems.

As a company that has served the coal mining industry for 30 years, we know the industry very well. In the 5G era, things are finally looking up. First of all, we should focus on top-level design, including planning, construction, and operations. Second, we should change our mindset. In the 5G era, coal mining is not just about launching turnkey projects or selling products; it's about continuously providing services and operating capabilities. We need to build a healthy ecosystem with pipes and devices, to create a virtuous cycle.

The coal mining industry exists within what has been called "the energy sector" and in the future will be called "smart energy". 5G can make coal mining part of the smart energy industry, so why don't we call it "smart mining"?

In the past, it was hard to identify where coal was used and measure efficiency. Now, the entire supply chain, from production to sales, is traceable, including the various uses of coal in the chemical industry. Coal accounts for 60 percent of China's primary energy supply. With 5G networks, the coal mining industry will be integrated into the smart energy system and used in various industries.

Some in the industry are cautioning against blindly jumping on the 5G bandwagon, others are rushing to get a seat. How can companies find the right market position during 5G development?

Chen Kai,
President, Lierda Science & Technology Group

As an IoT solution provider, we tried to identify our market position when 5G made its debut. We found that in the early stages of 5G development, most equipment used for 5G connections was heavy and complex, and deploying the 5G modules available at the time was time-consuming and costly. It was clear that the way forward was to make these modules smaller.

We developed a miniaturized 5G DTU and

corresponding connection software and equipment management platform. We've also conducted docking tests with programmable logic controllers (PLCs), automated guided vehicles (AGVs), and cameras to make 5G connections easier and more efficient for all our customers.

In the space of half a year, we organized 500 downstream IoT customers to promote 5G products and helped more than 200 customers develop 5G products. Lierda's 5G DTU products have supported various domestic and overseas projects involving, for example, Yangquan Coal Industry Group, Shandong Gold Group, Huawei Dongguan South Factory, Midea, BMW, Audi, and Daimler. We've also been involved in standards development in healthcare, machine vision, and other industries.

Some projects didn't go well at first, because it took time to show the return and value of 5G applications. But customers gradually began to realize that 5G helped them solve many problems, like disconnection and latency. We also found that different industries have different requirements for 5G networks. Some rely on uplink communication, others need intrinsic safety, and some don't have common standards, so we have to identify requirements company by company.

There are still many problems to overcome in the field of 5G industry applications, but this brings opportunities for companies like us. All the low-hanging fruit has been picked, and now no one quite knows where the next opportunities will be found. The best thing to do is to participate in 5G construction and find our place in the market.

According to the latest data, 4,289 projects participated in the third "Zhanfang Cup" 5G application contest in 2020, 27% of which were Industrial Internet projects – the highest proportion. What are the benefits and challenges of 5G Industrial Internet?

Tan Kai,
Executive Vice President, Beijing Microview Science and Technology

For a long time, manufacturing and mobile communications weren't compatible because manufacturing has very high requirements for latency, reliability, bandwidth, and security, which traditional mobile communications couldn't meet. With its low latency, high bandwidth, and high reliability, 5G has changed the game.

To apply machine vision to production lines in manufacturing plants via 5G networks, we've developed the industry's first 5G smart camera. By using 5G, AI, and MEC technologies, our solution can accurately detect common defects in items on production lines. Traditional solutions for defect detection have many drawbacks, including cabling, maintenance, and poor accuracy. However, the 5G solution solves these issues, slashing deployment costs

and making operations smart.

During the application process, we faced many challenges.

- The first was insufficient upstream bandwidth. The bandwidth required by industrial machine vision can reach 40 Gbps, which is higher than the uplink bandwidth of 5G networks.
- The second challenge was data interface mismatch. In many industrial scenarios, machine vision products are already deployed, so it's necessary to upgrade the products to connect to wireless networks, so that they're compatible with the industrial data interface.
- The third challenge we faced was the international business environment. Due to international trade issues, certain components were in short supply.

We've developed solutions to address these challenges. We're using smart cameras for pre-processing to reduce the required bandwidth, improving the adaptation of different industrial data interfaces. We're looking at the possibility of developing certain core components in-house or procuring them from domestic suppliers. There are many mature manufacturing scenarios where 5G applications are difficult to deploy, and scenarios where requirements are not fully met are more likely to foster innovation. 5G is particularly suited to the Industrial Internet, and 5G applications in the manufacturing industry show a lot of promise.

How can we solve the last-mile problem of 5G applications?

Li Mian,
General Manager, Industrial Connectivity Department, Beijing Aumiwalker Technology

Many entrepreneurs have already realized that 5G will usher in a new era of technological development, and no one wants to risk being left behind. However, 5G applications also depend on other conditions and 5G devices will be key to driving the digital transformation of various industries.

Lightweight, low cost, and portability are preconditions of inclusive 5G – all of which are met by Aumiwalker's latest industrial 5G wireless data transmission terminal. It is small enough to fit in the palm of your hand, but capable of high-performance edge computing.

Within two months, we developed six 5G dongle products in various sizes and with different protection levels for different diverse installation and operating scenarios. So far, we've delivered 2,000 terminals for use in Huawei and CRRC's smart factory projects.

We also provide personalized solutions for industries, as many customers require custom-made 5G terminals. So we work with customers from the beginning on 5G products to better apply 5G to smart factories, smart transportation, and smart healthcare. The fast deployment of 5G requires the cooperation of the entire value chain.

We often talk about how traditional industries should go digital, but how should companies at the digital vanguard go about adopting 5G?

Liu Changjie,
Director of Drone Industry Research,
Chief System Architect, China Mobile
(Chengdu) Industrial Research Institute

Our goal is to figure out how intelligently networked 5G drones will transform industries. Usually a drone's communication range is about 2 to 3 kilometers, but this isn't adequate in scenarios like security patrols. However, in a pilot project with the Shenzhen Public Security Bureau, we were able to extend the patrol range to 20 kilometers using 5G base stations. With 5G, drones can be applied in many more scenarios such as security at major events. We've also enabled solutions using 5G drones for river inspections in Fujian province, transporting blood for emergency transfusions, and emergency communication in Sichuan.

We've been testing 5G drone applications, such as low-altitude coverage and high-altitude base stations, for use in emergencies. The application of 5G drones will gradually give rise to a "low-altitude economy", which could possibly become the next engine of GDP growth. I'm very proud to be a part of promoting the development of the low-altitude economy, as 5G drones will enable the transition to three-dimensional smart city management.

We've seen the launch of the first wave of killer 5G applications, including experience-oriented applications like Ultra HD videos and VR/AR. Cogent has developed the world's first 4K live streaming encoder powered by a 5G module. What breakthroughs led to this?

Geng Liang,
CEO, Cogent Technologies

Our 5G-powered 4K live streaming encoder has supported over 10 major events, including a live broadcast from Mount Qomolangma. Our encoder addresses two major challenges – mobility and the backhaul of Ultra HD videos – and our breakthroughs were built upon increased bandwidth and lower latency brought by 5G.

Previous generations of mobile networks couldn't offer enough bandwidth to transfer 4K signals compressed to an ultra-low bitrate. A major milestone for us was China's 70th National Day Parade, where we successfully filmed on mobile 4K cameras and transferred the feed over 5G using multiple SIM cards for each camera.

In late 2020, we worked with Huawei to launch a

5G SRT multi-link aggregation gateway for general wide-area video transmission services that can be applied in areas like public transport, law enforcement, and education. This new gateway allows us to offer customers in all industries the kind of Ultra HD live streaming services that we've long offered customers in the media industry.

5G network deployment is taking place worldwide. We've helped live stream events in Germany, Norway, and the Czech Republic, and achieved very satisfying results. The wide rollout of 5G networks has allowed our products to enter markets worldwide.

How can companies keep up with the constant rollout of new technologies without getting swept away?

Ding Jing,
Product Director, Shenzhen Hongdian Technologies Corporation

We develop 5G terminals like industrial gateways, CPEs, industrial routers, and automotive gateways. Our first industrial gateway was launched in December last year and it was our first product to receive Huawei's 5G certification for businesses. Our products have been used in nearly 400 pilot projects both domestically and abroad, in various scenarios such as smart factories, Internet of Vehicles, smart healthcare, and smart ports.

5G is applied in different ways in each of these industries to meet different needs. Certain technologies can command a premium when they first appear on the market, but they will eventually drop in price as they become more mainstream.

Shi Weinian, one of Hongdian's founders, believes that while IoT appeared in tech circles with much fanfare, it will eventually just quietly be integrated into daily life. To answer your question about not getting swept away, we've defined a formula for evaluating the survival and development of an enterprise:

Survival and development = Technological innovation × Contribution to the entire value chain.

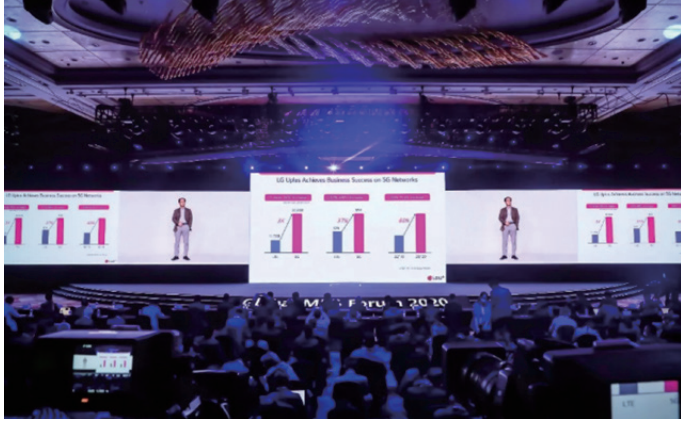
At Hongdian, we've invested in both 5G mobile communications and building the basic elements of IoT. Customers have many suggestions and requirements on the performance, latency, and power consumption of 5G applications. This variety puts us in a difficult position, because the demand for 5G terminals is so fragmented. We aim to empower customers from end to end with our products and services, so we should not only focus on costs, but also on the entire ecosystem and value. We believe that to solve problems is to create value.

LG Uplus

Building 5G success with smart & powerful networks

High-quality 5G services are the key to 5G commercial success, with a superior 5G network experience the cornerstone of business growth. As a long-term partner, Huawei has played a key role in helping LG Uplus deliver leading 5G networks and superior network experience.

By Zhufei, FromGeek.com



The Q3 2020 financial results of three major South Korean operators show that SKT and LG Uplus performed beyond market expectations. In particular, at LG Uplus, Q3 sales were up 5.9 percent year-on-year and operating profits were up 60.6 percent year-on-year.

How did these operators manage to increase revenue and profits in the highly developed South Korean telecommunications market? The answer lies in the commercial success of 5G.

Strong growth in DOU and ARPU are driving up profit

South Korea launched commercial 5G services back in April 2019, making it one of the first countries to do so. Since then, the number of 5G users in the country has continued to rise. By Q3 2020, the number of 5G subscribers in the country totaled 9.25 million, of which more than 2.2 million were LG Uplus customers. LG Uplus was occupying 24 percent of the local 5G market, which was 3 percentage points more than its market share in LTE (21 percent).

Compared with LTE networks, 5G networks' stronger performance in terms of DOU (dataflow of usage) and ARPU (average revenue per user) have contributed to LG Uplus's growing operating profit, says Kim.

The DOU of LG Uplus's LTE networks is 11.7 GB, while that of its 5G networks is 30.6 GB, representing an increase of 300 percent. The ARPU of LG Uplus's LTE and 5G networks stands at US$35 and US$50 respectively, meaning 5G ARPU is 37-percent higher.

The surge in 5G traffic and the value brought by 5G users have contributed to LG Uplus's growing operating profits, which have grown by more than 50 percent for two consecutive quarters.

These achievements are the result of LG Uplus's unique 5G services and superior experience. Kim Dae Hee believes that VR/AR-powered

> LG Uplus has applied various technologies and solutions like Massive MIMO, LampSite + distributed Massive MIMO, and 5G AI+ to build the most powerful and intelligent 5G networks both outdoors and indoors.

5G services and ultimate indoor and outdoor 5G network experience have not just helped operators achieve 5G commercial success, but also promoted the development of companies up and down the value chain and led to the success of South Korea's 5G industry.

In South Korea, the penetration rate of 5G has exceeded 16 percent, with 5G accounting for one-third of total mobile traffic. The success of South Korea's 5G industry is giving users the world's best 5G experience.

Full coverage, superior experience, and intelligent O&M

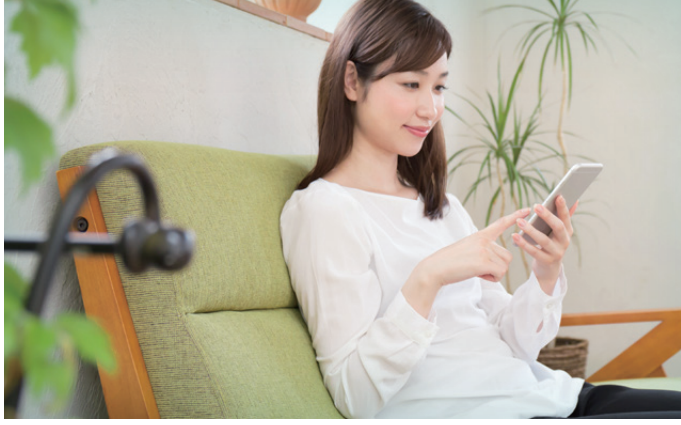
According to Kim, a powerful and intelligent 5G network is the cornerstone of 5G success. LG Uplus has applied various technologies and solutions like Massive MIMO, LampSite + distributed Massive MIMO, and 5G AI+ to build the most powerful and intelligent 5G networks both outdoors and indoors.

LG Uplus aims to achieve a speed of "400 Mbps outdoors and 100 Mbps indoors anytime," with a focus on delivering the ultimate experience for new services like VR/AR-enabled videos.

For outdoor coverage scenarios, LG Uplus has adopted Huawei's third-generation 64T64R Massive MIMO antenna. Weighing just 25 kg and easy to deploy, the solution has greatly improved network performance while extending coverage. At the same time, the adoption of technologies like SRS antenna selection and all-channel beamforming, as well as Huawei's leading software and algorithms, have helped LG Uplus drive up network capacity, speed, and coverage.

Test data from Seoul shows that compared with 32T32R + PMI, 64T64R + SRS technologies helped LG Uplus increase UE speed by 38 percent, reference signal received power (RSRP) by 5 dB, and the performance of 5G networks (including Outdoor-to-Indoor coverage).

COVID-19 has led to a rapid growth in indoor



traffic in South Korea, said Kim Dae Hee. In 2020, LG Uplus deployed Huawei's 5G LampSite Digital Indoor System (DIS). According to testing data from Seoul, the 5G Indoor Distributed Massive MIMO solution helped achieve an indoor throughput of up to 1 Gbps and increased cell capacity threefold.

LG Uplus aims to deliver Gbps-level indoor coverage and continue expanding 5G indoor coverage in 2021 to create a high-quality indoor 5G experience and achieve seamless handover when users move between indoor and outdoor spaces.

Kim states that LG Uplus is committed to building the most powerful and intelligent 5G networks by greatly improving the performance and coverage of both indoor and outdoor 5G networks. Leveraging the 5G AI+ intelligent system, LG Uplus will gradually make "Smart Network" a reality, initiating the transition to an intelligent autonomous network with AI at its core.

The 5G AI+ system allows for collaboration between LG Uplus's upper-layer system - ESS – and Huawei's iMaster MAE, delivering the ability to handle complex 5G network O&M. According to Drive Test and OTT data, the solution achieves automatic neighborhood cell planning and the adaptive adjustment of Massive MIMO SSB beam patterns, improving the efficiency of initial 5G network deployment and basic network quality. In the testing area, low-quality grids were reduced by 30 percent. In addition, AI parameter optimization can be used to adaptively select the most suitable parameter combination for the current scenario, based on the training and modeling of historical data. AI parameter optimization can help increase traffic throughput, a key KPI, by 10 percent. The automatic tuning of parameters has increased engineering accuracy by 80 percent, and the introduction of 5G AI+ has significantly boosted LG Uplus's 5G network O&M efficiency and network experience.

3P verification

The test reports of global mobile network

> The test reports of global mobile network research platform Opensignal indicate that LG Uplus's 5G network performance is "the best of the best" in South Korea.

research platform Opensignal indicate that LG Uplus's 5G network performance is "the best of the best" in South Korea.

In June 2020, Opensignal published a report showing that the average download speed of LG Uplus's 5G networks was 237.2 Mbps, faster than SKT's 220.4 Mbps and KT's 214.8 Mbps. Their report in October showed that the average 5G download speed of the three major operators in South Korea exceeded 300 Mbps. LG Uplus performed better in two major cities: In Seoul, LG Uplus's average 5G download speed was 363.7 Mbps, faster than SKT's 347.8 Mbps and KT's 329.3 Mbps. In Incheon, LG Uplus's average 5G download speed was 351.7 Mbps, ahead of SKT (311.9 Mbps) and KT (329.5 Mbps).

Notably, Opensignal conducted these real-world tests when users were accessing various applications, such as watching videos, playing games, and browsing web pages. So, unlike packet injection tests, the speeds in the test may have been held back by the limitations of the application servers and may not have in fact reflected the full potential of the networks tested.

Huawei's role

According to the test results from Opensignal, the 5G network performance of the three major operators in South Korea has improved over time, with LG Uplus performing particularly well. Huawei and LG Uplus collaborated on testing new applications ahead of deployment, and Kim states that Huawei – a major supplier to LG Uplus – has provided leading 5G technologies, simplified and converged 5G construction solutions, rapid 5G network deployment, and optimization capabilities.

At the beginning of 5G rollout in South Korea, LG Uplus quickly deployed more than 10,000 5G base stations with the support of Huawei's simplified and converged 5G construction solutions. Less than two years later, when LG Uplus beefed up coverage in Seoul and the Seoul Capital Area, the operator again used simplified 5G base stations, allowing it to quickly deploy and optimize 5G networks and set a world record by building 1,367 5G base stations in just 19 days. With Huawei's simplified and converged 5G solutions offering advantages in uplink/downlink speed, network coverage,

> With Huawei's simplified and converged 5G solutions offering advantages in uplink/downlink speed, network coverage, and device energy consumption, LG Uplus's 5G users have enjoyed a better network experience right from the start.

and device energy consumption, LG Uplus's 5G users have enjoyed a better network experience right from the start. In the subsequent network deployment and optimization process, the two parties closely collaborated and continuously improved 5G technical capabilities to maintain a leading position.

For example, in the early stage of 5G deployment, massive MIMO required lightweight 5G AAUs due to engineering constraints. This meant that at most sites, 32T32R units were the largest that could be deployed, resulting in insufficient indoor coverage and poor performance. After adopting Huawei's third-generation Massive MIMO unit, which delivered greatly enhanced performance and weighed just 25 kg, LG Uplus not only achieved simplified deployment of 64T64R units, but also improved network performance by over 20 percent in indoor areas close to windows (shallow indoor coverage), by more than 30 percent in indoor central areas (deep indoor coverage), and RSRP by over 5 dB through Huawei's Outdoor-to-Indoor coverage solution.

On the device side, Huawei has boosted user-perceived speed by using SRS antenna selection technology. Tests show that the average speed of a LG V50S, which uses SRS antenna selection, is 850 Mbps, while the average speed of a Samsung Note 10, which uses PMI, is 678 Mbps. The speed of the LG V50S is 25-percent higher than that of the Samsung Note 10.

In the initial stages of 5G commercialization, LG Uplus faced problems such as the lack of mature devices, an underdeveloped ecosystem, insufficient experience in network maintenance and optimization, and slow performance convergence. After Huawei's iMaster MAE (MBB Automation Engine) was introduced and the planning, development, maintenance, and optimization phases of network construction were completed, new solutions were implemented. These included neighboring cell planning, AI-based massive MIMO pattern optimization, and the automatic tuning of parameters. These addressed LG Uplus's demands for 5G construction efficiency and infrastructure network quality improvements in the initial stages of network rollout, greatly improved its network planning and optimization efficiency, and ensured network experience for

> LG Uplus has not only increased its DOU and ARPU, but it has also created a new revenue stream by expanding its business model to include VR/AR content.

users.

More than 70 percent of traffic is generated indoors, which means it is particularly important to create a superior indoor 5G experience. To address this, LG Uplus partnered with Huawei, deploying the 5G Indoor Distributed Massive MIMO solution to introduce macro site massive MIMO technology from outdoors to indoors. The RF headend coverage and hardware networking remained unchanged, while beamforming and MU-MIMO space division technologies were used to eliminate indoor interference, elevating cell capacity and the average experience of users. According to Kim, distributed massive MIMO technology was put into large-scale commercial use on LG Uplus networks. In actual tests, the average experience of users increased by 25 percent, and cell capacity increased threefold. LG Uplus has fewer 5G spectrum resources than either of the other two operators, but with distributed massive MIMO technology, it was possible to greatly improve LG Uplus users' indoor 5G experience.

In addition to network experience, attractive 5G services are a must. In this regard, Huawei has been working with LG Uplus for a long time in preparation for the race in the 5G fast lane. Both have performed application tests on 360-degree VR live streaming, 5G FWA IPTV, intelligent connected drones, and autonomous driving. Huawei has also been working with local 5G value chain participants in South Korea to build open labs, helping operators develop a healthy 5G ecosystem at multiple levels.

Data shows that, since putting 5G into commercial use, LG Uplus has continuously increased its investment in AR/VR. The operator has progressed from Uplus 5G 1.0, through Uplus 5G 2.0, and now into Uplus 5G 3.0, with each new phase bringing an expansion of its content services. This expansion of content has driven consumption, with users flocking to online video and game services. LG Uplus has not only increased its DOU and ARPU, but it has also created a new revenue stream by expanding its business model to include VR/AR content. In addition to consumer-facing 5G content, LG Uplus also innovates with Huawei and industry partners, expanding and incubating 5GtoB services, such as private networks and smart port, and smart factory solutions, to drive the adoption of 5G in all industries.

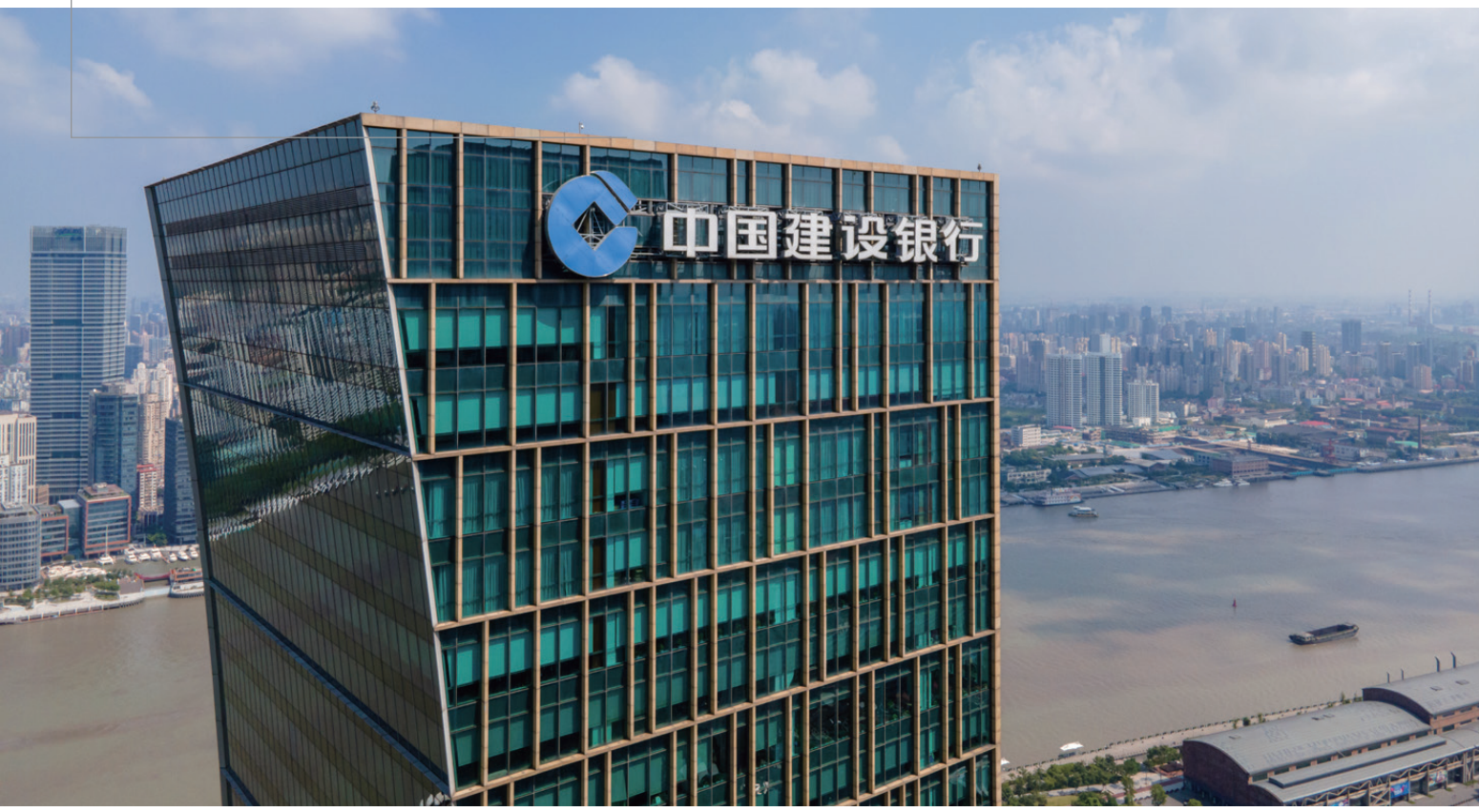
The performance of the 5G market in South Korea and the innovative practices of LG Uplus shows that business success has led to the overall success of the country's 5G industry – a success that will continue to grow.

CCB

Building a 5G-powered intelligent bank of the future

China Construction Bank (CCB) and Huawei have created the world's first 5G-powered intelligent bank with a 5G+SD-WAN solution, transforming branches into marketing and services centers.

By Shang Jiantao



> CCB is applying technologies, such as financial cloud, 5G, IoT, and AI, to accelerate its switch to smart branches and focus on marketing and services rather than transactions. The bank's goal is to build a future-proof 5G-powered intelligent bank that's the first of its kind.

More people than ever are using mobile banking services, and brick-and-mortar branches are facing unprecedented challenges in how they operate. Which direction should these branches go as they look to evolve?

5G & intelligent

"Stepping into this branch, I'm really impressed by how high-tech it is. Flashy robots, a personalized display of a customer's journey, a Smart Teller Machine (STM) with remote expert support, a Financial Capsule, and an automated financial services experience...just about all you could imagine. It's completely different from conventional branches."

"On entering the Financial Capsule, I'm immersed in a futuristic financial service space. A robot recommends the latest wealth management products and shows me their yields. I really love it."

These are observations about the 5G-powered intelligent CCB Qinghuayuan branch. CCB is applying technologies, such as financial cloud, 5G, IoT, and AI, to accelerate its switch to smart branches and focus on marketing and services rather than transactions. The bank's goal is to build a future-proof 5G-powered intelligent bank that's the first of its kind.

CCB's 5G-powered intelligent bank includes applications such as Financial Capsule, Smart Teller Machines (STMs), and robots. It provides 327 functions for common financial services, reshaping the service process from the perspective of the entire customer journey. This intelligent bank integrates online and offline mobile banking services and offers interactive games for customers who visit its branches. The result is more efficient transactions, minimized wait times, and more interesting financial service transactions. These features make the 5G-powered intelligent bank an ideal space for marketing and services.

As the bank continuously optimizes the financial services experience, data traffic is increasing exponentially. Therefore, bank branches need real-time data transmission and larger bandwidth. The MSTP private lines use in traditional branches usually have a bandwidth of only 2 to 4 Mbps, which isn't nearly enough

for a wide range of smart applications, given that intelligent branches have much stricter requirements on mobility and provisioning speed. With more than 10,000 branches across the globe, CCB also needs to improve the O&M efficiency of its numerous, complex WANs.

5G+SD-WAN for smart connections

As a fintech pioneer, CCB is the first bank to integrate Huawei's SD-WAN and 5G technologies into its intelligent bank. The 5G network functions as an underlay network, providing an infrastructure with ultra-high bandwidth and ultra-low latency. The SD-WAN is used as an overlay network on top of the 5G network and legacy MSTP private lines. This approach provides high-speed interconnection channels between CCB's branches and the financial cloud. The cloud-based iMaster NCE, a network management and control system, enables smooth operations for dozens of applications and automated configurations for complex branches. The combination of 5G and SD-WAN brings WANs to banking, extending the reach of CCB's services and allowing more customers to benefit from 5G-powered intelligent banks.

Cloud & 5G: 100x bandwidth, ms-level latency & plug-and-play

5G's high bandwidth, low latency, and cable-free deployment make it ideal for banking. By deploying NetEngine AR – Huawei's first enterprise-grade 5G router – CCB builds dual service channels (5G and MSTP private lines), resulting in a hundredfold increase in bandwidth for smart branches. The tested rate of 5G-powered intelligent banks can reach 2 Gbps, supporting the exponential growth of data traffic. With facial recognition, intelligent voice, virtual reality, augmented reality, and Wi-Fi 6, customers will enjoy faster banking services and consultations as well as enjoying personalized and dedicated services. 5G-powered intelligent banks can provide a full-journey, immersive, and personalized financial services experience.

Other benefits of 5G are fast deployment and high mobility. This means that intelligent banks can launch mobile services without having to wait for carriers to install private lines. With 5G/LTE and the Internet, it's much easier to connect community banks and call centers or to set up temporary financial service branches at large venues.

Application-based intelligent traffic routing ensures an optimal financial services experience

SD-WAN creates an end-to-end overlay network to logically combine intermediate network nodes, and 5G enables one-hop access to the cloud for intelligent banks, greatly simplifying network topology.

Intelligent banks often have dozens of applications. These applications can be monitored and identified in real time using SD-WAN, which connects to the cloud through 5G and MSTP private lines. SD-WAN can precisely

> With 5G/LTE and the Internet, it's much easier to connect community banks and call centers or to set up temporary financial service branches at large venues.

identify key applications and dynamically optimize their paths based on Service Level Agreements (SLAs), application priority, and bandwidth usage. This means that key financial applications are always running on optimal paths while ensuring the best experience.

Smart O&M and centralized cloud management

SD-WAN orchestrates and schedules links and bandwidth across an entire network based on applications. It also intelligently and quickly identifies key financial applications, IoT applications, and Internet applications, and displays their key indicators in real time, including status and bandwidth usage, links, branches, and devices. This optimizes network investment and planning by informing decisions on application and link adjustments, capacity expansions, and branch adjustments.

Moreover, SD-WAN provides centralized network O&M and management tools, as well as comprehensive network policy configuration tools to centrally manage LANs, WANs, and security networks. It also automates the entire process from network provisioning, service deployment, and fault location, all the way to routine inspection.

In addition, Geographic Information System (GIS)-based network topology information and visualized, multi-dimensional reports on links, applications, users, sites, and devices can help quickly locate network faults while optimizing network policies. This allows financial services to be carried out over an easily managed and reliable network.

Security is the lifeline of financial services

Network security is crucial for fintech. Based on Huawei's NetEngine and iMaster NCE, CCB can provide all-around security protection at the device, link, and policy levels. For CCB's 5G-powered VPN, Huawei's SD-WAN solution orchestrates security service chains based on policies for end-to-end encrypted transmission of service data.

The combination of 5G and SD-WAN will offer diversified and flexible access for intelligent banks, and better meet security and flexibility requirements of financial services. Because of these advantages, 5G-powered intelligent banks will make financial services more inclusive and cover all scenarios for a better banking experience.

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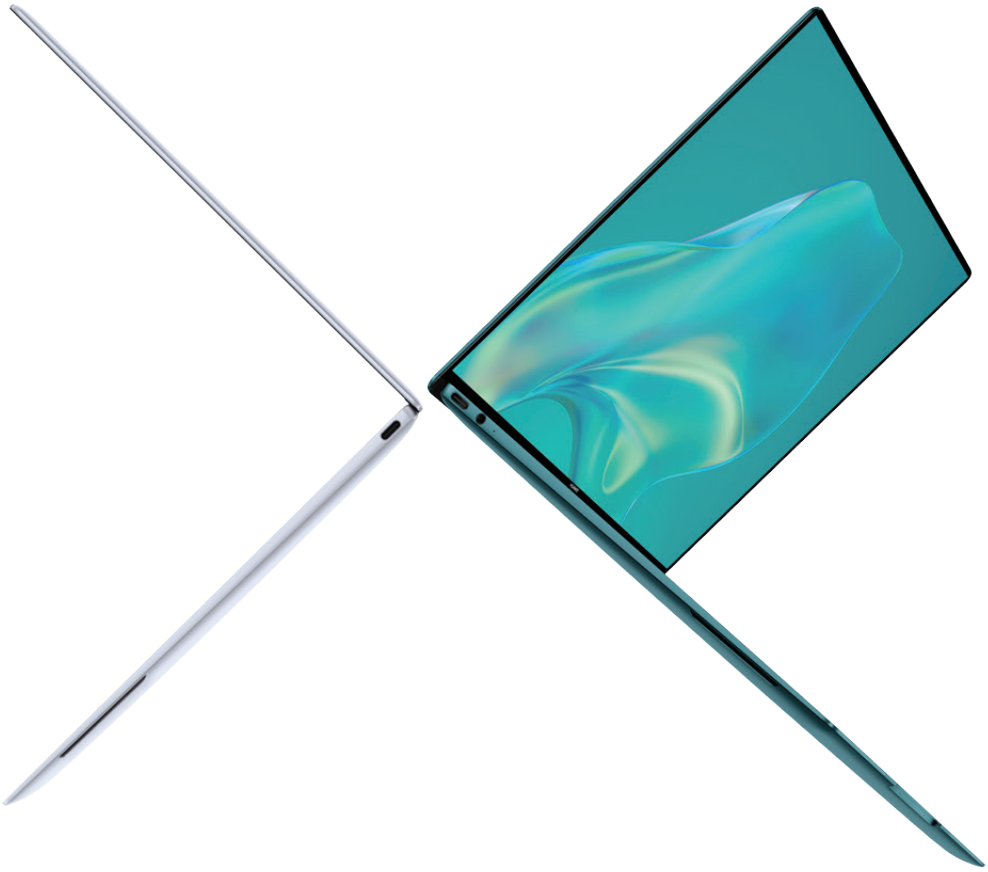

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