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Transforming
healthcare
with 5G

Moving towards
the era of Intelligent
Connectivity

Shifting paradigms
for greater value

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Provide fast and easy access to essential healthcare services, enabling effective early detection of diseases, while also providing medical research support for health professionals.

Building a Fully Connected, Intelligent World

HUAWEI

Value creation: The essence of industrial digital transformation

In his book *Value*, Zhang Lei, the CEO of Hillhouse Capital, states, "There is one and only one criterion for investment in the true sense, and that is creating real value to benefit society. Those who adhere to this criterion will benefit over time – in a way that is sustainable and immense in most cases."

The same applies to the digitalization of industries that's taking place today – creating value is at the heart of digital transformation. Technologies such as 5G, cloud, and AI have demonstrated their value during the pandemic; for example, in prevention and control in healthcare scenarios, and in helping businesses set out on the road to recovery by enabling digital operations and capabilities such as process automation.

Over the past five years, the benefits of new technologies have shifted from the consumer Internet to the industrial Internet. And with that we've seen connectivity expand from between people to between people and things and between people and services. At the same time, economic development is shifting from a reliance on demographic dividends to technological and digital dividends powered by the digital economy and industry digitalization. For example, the economic value added by China's digital economy accounted for about one third of its GDP in 2020 and two thirds of its GDP growth.

Today's digital transformation is not just poised to greatly boost productivity, cut costs, and increase efficiency, it will also redefine how humans and machines work together to create new value and innovate new business models.

Digital transformation means enterprises have to change to better serve customers and create value in new ways. However, the path to doing so isn't without challenges. Organizations need to deep dive into data-driven analytics to understand the digital transformation needs of key service scenarios. They require technological applications that can develop industry-specific, scenario-based solutions that create real value.

Huawei is committed to working with partners in all industries to provide scenario-based solutions that integrate ICT and industry know-how to help governments and enterprises move forward in the digital age.

Layla Zhang

Layla Zhang, Editor-in-Chief

WHAT'S INSIDE

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Voices from Industry

Lu Qingjun, Director of Development at the China-Japan Friendship Hospital and Director of the National Telemedicine and Connected Health Center in China, explores current 5G medical applications, future trends, and the impact of COVID-19.

Perspectives

The intelligent era is approaching, and individuals, homes, and enterprises require more from connectivity. The fifth generation of connectivity technologies bridges the virtual and physical worlds, enabling an intelligent world.

COVID-19 has accelerated the digital transformation of all industries. We provide the know-how for that to happen, helping customers create greater value and bringing stakeholders together to build a digital ecosystem where we can co-create and share value.

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5G networks are poised to transform all critical components of healthcare, a transformation that's especially meaningful today.

Lu Qingjun, Director of Development at the China-Japan Friendship Hospital and Director of the National Telemedicine and Connected Health Center, China

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Transforming healthcare with 5G

At Huawei's Global Mobile Broadband Forum 2020, Lu Qingjun, Director of Development at the China-Japan Friendship Hospital and Director of the National Telemedicine and Connected Health Center in China, explored the 5G medical applications available today, future trends, and how COVID-19 has changed attitudes towards remote medicine.

By Xu Shenglan

5G promises a new health ecosystem, one that can meet patient and healthcare provider needs accurately, efficiently, conveniently, cost-effectively, and at scale. 5G networks are poised to transform all critical components of healthcare, a transformation that's especially meaningful today given how the pandemic has placed tremendous stress on healthcare systems around the world.

A shot in the arm for healthcare

Since the early days of 5G trials, the technology's
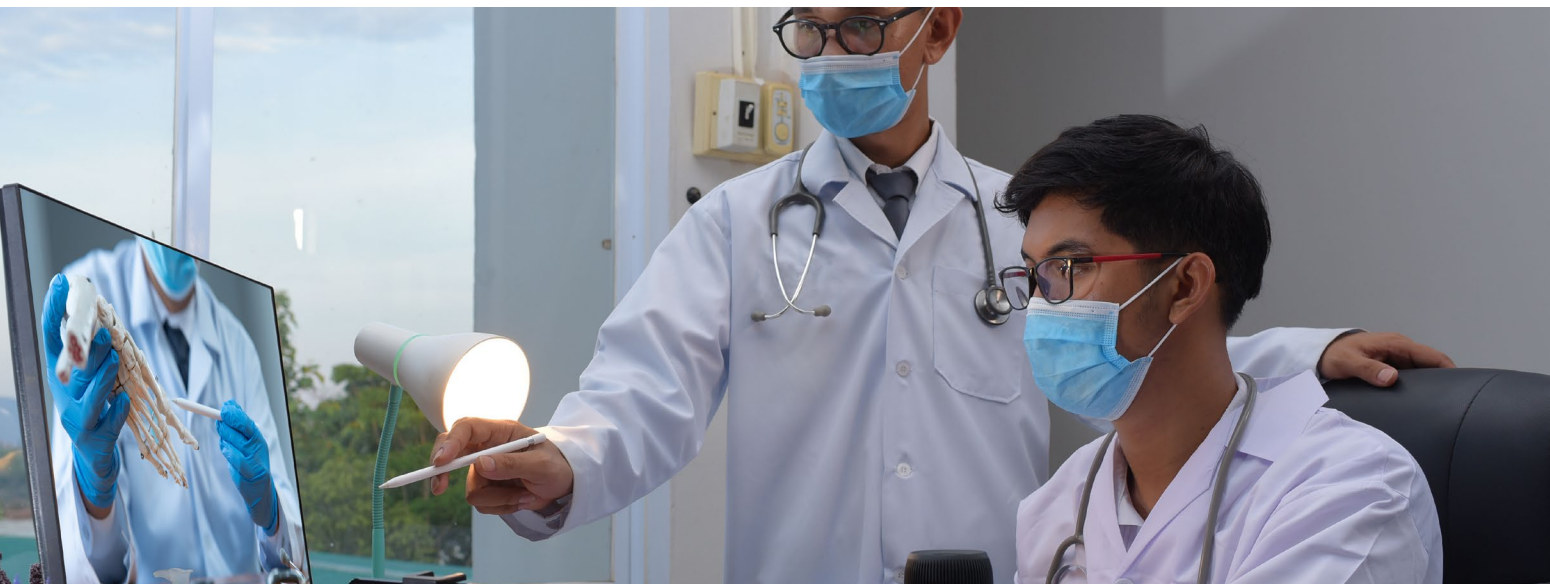
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> We can use telemedicine to get help from skilled specialists to local hospitals. Patients can stay at home and get prescriptions through the Internet. Medicine can be delivered to their front door.
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potential to transform the medical sector has been frequently cited in scenarios ranging from remote diagnosis to remote surgery. In a GSMA Intelligence survey of mobile operators in early 2020, 62 percent of respondents cited telehealth and telemedicine as sectors offering long-term business opportunities, 12 percentage points higher than security and almost as high as data analytics systems.

Although surgical procedures performed remotely over mobile networks are still likely many years away, plenty of applications using modern network technology, and systems are being rolled out globally, alongside many other trial projects.

Lu believes that 5G has the power to solve many of the problems that have prevented the wider uptake of telemedicine, "In China telemedicine has been studied for 20 years, but communications technology has remained a big problem. However, 5G will solve a lot of the legacy connectivity problems," he says. Potentially game-changing use cases for 5G-based applications tend to involve AI and big data; for example, the way professionals and patients will be able to access vital pieces of medical information like

the results of CT and MRI scans. In the aftermath of the coronavirus pandemic, 5G eMBB technology will enable remote healthcare support and reduce patient exposure to contagions by minimizing in-person visits to doctors or healthcare facilities. For patients who can't easily travel to healthcare providers, 5G will allow the provider to visit them via immersive telepresence systems.

High-quality 5G connectivity systems can boost collaboration between medical professionals, allowing them to collaborate on things like scans to improve diagnosis and patient care. "5G technology will support terminal-to-terminal communications, making communications easier and real-time," Lu says. "It will make telemedicine accepted by both the doctors and patients."

According to Lu, the COVID-19 pandemic has made people realize the advantages of telemedicine and of reducing the risk of spreading the virus by traveling to hospitals. "We can use telemedicine to get help from skilled specialists to local hospitals. Patients can stay at home and get prescriptions through the Internet. Medicine can be delivered to

their front door."

In a project supported by Huawei at the National Telemedicine Center, a remote diagnosis system designed for fighting COVID-19 was set up earlier this year. It connected 147 hospitals covering 108 counties and 18 cities, aiding collaboration between professionals, allowing better resource allocation, and providing treatment guidance by experts. The system made high-quality medical resources available to remote areas, facilitated remote checks on patients in isolation wards, and powered online workshops with coronavirus experts. Patients and medical centers in towns and counties could get help from large hospitals, boosting response capabilities and

decreasing the risk of cross infections due to patient transfer.

The rise of AI

Alongside the advancement of health IoT networks and devices, the possibility of smart, data-driven algorithms in healthcare will also increase. 5G infrastructure will make it much easier and more reliable to use AI software to analyze real-time patient data sent to cloud platforms. In fact, AI will truly arrive with the advent of 5G technology.

AI allows doctors to analyze individual patient statuses in real-time, offering improved diagnosis and healthcare delivery regardless of where the patient is

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> Recent advances in machine learning systems have demonstrated that AI can extract more information from images with higher reliability and accuracy, and identify features that are not be easily detectable by the human eye.
> **"**

located. This provides cost savings, reduces the time taken to access care, and provides flexibility for the end user.

Analyzing medical images is a daunting task due to the high volume of data. Clinicians have to interpret their complexity and dynamic changes, which can be time-consuming and prone to errors due to visual fatigue. Recent advances in machine learning systems have demonstrated that AI can extract more information from images with higher reliability and accuracy, and identify features that are not be easily detectable by the human eye. Applications range from analyzing large numbers of images from screening programs to the enhanced diagnosis of specific problems such as fractures.

The large amounts of data used in real-time machine learning require ultra-reliable high-bandwidth networks, particularly if clinicians wish to access data from mobile devices. By switching to high-capacity 5G networks, healthcare organizations can use machine learning systems to provide the best care possible from wherever they are in the hospital or clinic.

"5G networks can support the precise real-time transmission of massive data, guaranteeing the accuracy and reliability of medical data through AI systems," says Lu. 5G and AI will remove obstacles for hospitals to interconnect and enable advanced diagnosis and treatment experiences to be shared between large and small hospitals, which will benefit underserved rural areas. It's often difficult for medical facilities in rural areas to install and use AI applications due to financial and technical limitations, but 5G will enable them to connect with bigger hospitals to make use of their AI applications.

Roadblocks in healthcare

Although the advantages are clear, many barriers remain. Lu is currently involved in a national study project in China, which seeks to address these concerns and define how to help care providers use 5G to deliver medical applications. "On the hospital side we have a big problem with connecting the old equipment to the 5G network," Lu says, highlighting the need to add 5G communication modules into existing equipment used to perform procedures such as CT and MRI scans.

> The family doctor can connect with specialists in real time and the patient can have access to the family doctor in real time. Communication about treatment will be easier and family doctors can get help much easier. This will benefit the whole medical system.

ICT platforms could allow easy access to real-time information by doctors, managers, and patients, and save time and money due to better collaboration and efficiency.

One of the current challenges in 5G is the lack of concrete specifications. It isn't just a faster and bigger version of previous generations; instead, 5G will present as a set of services that can integrate M2M, audio and video services, and other services spread over a much larger spectrum range than any previous network generation.

 "In the future, most treatment systems will be connected to 5G as the network connection becomes real time," says Lu. "The family doctor can connect with specialists in real-time and the patient can have access to the family doctor in real time. Communication about treatment will be easier and family doctors can get help much easier. This will benefit the whole medical system."

For the patient, benefits will include reduced traveling time, lower costs, and fewer missed work days.

According to Lu, telemedicine has government support and policies have been introduced to encourage its use. While China is beginning to embrace 5G in medical settings, low-latency, high-bandwidth connectivity technology is underpinning advanced telehealth and aiding hospital logistics worldwide.

5G is also providing the basis for experimentation into advanced uses such as surgery performed remotely by experts using robotic arms connected through communications networks. These applications can also form new revenue streams for operators, which play a central role in enabling this exciting use of modern network technology.

5G has generated a buzz due to the capabilities of the technology itself, potential use cases, and its ability to catalyze a chain reaction of digital transformation. Those within the healthcare industry feel that 5G and the hype around it will help drive the innovation, adoption, and implementation of new technologies and solutions. WIN

Moving towards the era of intelligent connectivity

The intelligent era is approaching, and individuals, homes, and enterprises require more from connectivity. The fifth generation of connectivity technologies bridges the virtual and physical worlds, enabling an intelligent world.

By David Wang, Executive Director of the Board, Huawei

In 2020, telecom operators around the world played an important role during the pandemic and the value of networks has never been more evident.

Looking back, every upgrade in connectivity has driven social development. In agrarian societies, "post stations" connected remote cities. The Silk Road, a connection built on the post station system, promoted the exchange of goods and information between East and West. During the industrial era, telegraphs and telephones transformed long-distance communication. In the information era, mobile, fiber, and data communications have supported the explosive growth of the Internet and rapid development of the global economy.

Now, we're entering the intelligent era. Individuals, homes, and enterprises require more from connectivity, which is increasingly embedded with new technologies such as cloud and AI.

The connectivity industry is experiencing 5 exciting changes

Change 1: From IoT and intelligent IoT to connected Intelligent Twins

> Compared with 4G networks, 5G networks increase connection density by more than 100 times and the number of network configuration parameters by more than 10,000.

In an era where people and homes are the focus, connectivity is the main goal – specifically, the connectivity of everything. As the integration of intelligence in our lives and enterprises accelerates, we need to connect more things, more intelligently. The goal of this phase is to connect everything intelligently. At HUAWEI CONNECT 2020, the entire industry reached a consensus that it requires industry-specific intelligent twins to make enterprises intelligent.

Change 2: From office to office + production

Home networks are expanding from simply providing information and entertainment services to supporting online education and telecommuting, and enterprise networks are extending from offices to production environments. Third-party data shows that 18 million enterprises in China allow telecommuting and 420 million users are taking online classes. According to Huawei's report on digital transformation, the focus of digital transformation has shifted from digital office to digital production, transactions, and operations.

Change 3: From best effort to differentiated deterministic services

Connectivity requirements vary with industries and service scenarios. For example, smart city services require massive connections, while smart factory services require deterministic latency. Providing differentiated services is fundamental, and deterministic assurance is mandatory. Only after operators develop these two capabilities can they gain a foothold in vertical markets.

Change 4: From Mbps to Gbps via any medium

There are many connectivity technologies, including cellular, Wi-Fi, and fiber technologies, which will coexist for the long term since service scenarios are diverse. No single technology can do it all. The good news is that all of them now support gigabit connectivity.

Change 5: From manual O&M to hyper-automation

New technologies such as 5G, AI, and cloud enhance network capabilities, but also bring challenges to network O&M. Compared with 4G networks, 5G networks increase connection density by more than 100 times and the number of network configuration parameters by more than 10,000. As networks increase in complexity, manual O&M is no longer sufficient. Big data and AI must be integrated to simplify decision-making, implement hyper-automation, and free people from complexity.

The five changes above show that the value of connections depends not only on the number of connections, but also on the quality, bandwidth, latency, and network slicing of these connections. For financial transactions, a reduction of 1 ms latency can increase revenue by US$1 million. According to the test data of an OTT cloud data center, a 0.1 percent network packet loss will cause a 50-percent loss in computing power. In the era of traditional connections, Metcalfe's law interprets the value of connections, which is directly proportional to the number of connections squared.

For new connections, several variables need to be incorporated into Metcalfe's law, including bandwidth, latency, and slicing. These redefine the value of connections to form the "new Metcalfe's law".

where
- k: value coefficient

$$V = \sum_{slice=1} \left(\frac{k \times Bw \times N^2}{T} \right)$$

- Bw: bandwidth
- T: latency and jitter
- N: number of connections
- $slice$ (ranging from 1 to N): number of network slices

The new Metcalfe's law redefines the relationship between connectivity and productivity in the era of intelligent connectivity.

Moving towards intelligent connectivity with AI

To address these five changes and increase productivity, connectivity needs to be upgraded. First, bandwidth is the bedrock of connectivity. In home and enterprise scenarios, the widespread use of ultra-HD video, VR/AR applications, AI cameras, and drones requires ubiquitous gigabit-level connections. Second, networks must provide a deterministic experience to ensure smooth telecommuting and online classes at home and secure and reliable production in enterprises. Third, as the scale and complexity of networks increase exponentially, big data and AI must be introduced to implement hyper-automation. Therefore, connectivity in the new era needs to offer ubiquitous gigabit connectivity, deterministic experiences, and hyper-automation. That is intelligent connectivity.

What does intelligent connectivity mean for operators? Huawei proposes two propositions for home broadband and enterprise services.

Proposition 1: Powered by intelligent connectivity, realizing the value of home broadband experience with "1 + 3 + X"

"1 + 3 + X" enables smart connectivity to transfer home broadband from demographic dividends to experience dividends.

"1" refers to the "one" fiber that will provide gigabit-level broadband access, and "3" refers to the three measures over the fiber: full gigabit-level Wi-Fi coverage, optimized experience, and precise operation planning. This "1 + 3" initiative enables the development of more innovative broadband services such as office broadband, education broadband, eSports broadband, live streamer broadband, and smart homes. This is the "X".

Proposition 2: Powered by intelligent connectivity, inspiring new growth in enterprise business

Deeper: Intelligent connectivity extends LAN services to WAN services. Enterprise digital transformation must be based on high-quality and high-reliability enterprise campus networks. By leveraging the advantages of WAN networks and hyper-automation technologies,

> By leveraging the advantages of WAN networks and hyper-automation technologies, operators can extend their services to enterprise LAN networks to open up new market space.

operators can extend their services to enterprise LAN networks to open up new market space.

Better: Intelligent connectivity refines the quality of interconnections between enterprise branches. As an increasing number of enterprise applications are deployed, branch interconnections need to meet diverse service requirements and ensure deterministic experience. Operators need to provide high-quality private lines by utilizing their advantages in network coverage and diverse connection capabilities.

Wider: Intelligent connectivity builds more extensive cloud connections. Enterprise cloudification is a huge opportunity. Operators can leverage their advantages in network coverage and integration to provide agile and secure cloud access for enterprise customers, and achieve strategic cloud-and-network synergy.

Huawei's all-scenario intelligent connectivity solutions

For home broadband scenarios, Huawei's intelligent distributed access solution upgrades home terminals, CO devices, and NMS systems. Fiber to the room (FTTR) builds an all-optical home network, providing gigabit-level Wi-Fi for each room. AI is integrated into home terminals to intelligently identify service types and ensure high-quality service experience. Second-level data sampling and intelligent analysis capabilities monitor user experience in real time and accurately identify users suffering a poor network experience.

For SME campuses, Huawei's intelligent campus network solution extends operator services to the campus, and implements unified LAN and WAN management and control, Gbps-level all-wireless access, and AI-powered intelligent O&M.

Based on the successful practices of the OTN premium private line in the financial, government, electric power, and OTT industries, Huawei has upgraded its intelligent premium private-line solution. The latency is decreased with all-optical switching to 1 ms. In addition, Liquid OTN technology is used to implement flexible bandwidth increments ranging from 2 Mbps to 100 Gbps to make premium private lines more affordable. Moreover, by binding the channel resources of wavelengths or sub-wavelengths, wavelength-level private networks are provided for enterprise customers.

To support cloud migration in different industries, Huawei has launched the intelligent cloud network solution. Based on the intelligent IP network, this solution builds a high-quality private network to

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> Society is at a critical stage of evolving from an information society to an intelligent society. People will increasingly utilize intelligence to experience the immersive interactive experience of the virtual and physical worlds.
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provide multi-cloud services for enterprises. For the cloud backbone, multiple clouds are pre-connected to access multiple clouds through one private line. For cloud access, network slicing is used to provide differentiated SLAs for different industries. Finally, for cloud private lines, the wide coverage of the mobile transport network is leveraged so that 90 percent of enterprises in urban areas can connect to the cloud within one day.

Key strategic moves

To support and promote the development of the intelligent connectivity industry, Huawei is implementing three key measures. First, we continuously invest in basic research and system engineering capabilities to develop leading products and solutions. Second, we're working with the entire industry to overcome the challenges of deglobalization and maintain a unified global standard for the connectivity industry. Third, Huawei is working with ecosystem partners to continuously improve solutions based on industry scenarios, the IPv6 expert committee to promote network capability openness, and alliances such as NGOF and ONA to jointly develop scenario-based F5G solutions.

Society is at a critical stage of evolving from an

information society to an intelligent society. People will increasingly utilize intelligence to experience the immersive interactive experience of the virtual and physical worlds, strengthen collaboration, and break limits. The fifth generation of connectivity technologies, such as 5G, F5G, IPv6+, and Wi-Fi 6, provide ubiquitous gigabit connectivity, deterministic experience, and hyper-automation, bridging the virtual and physical worlds and enabling the intelligent world.

In the future, the sixth generation of connectivity technologies will continue to develop in multiple aspects such as space, time, and scale. They will provide 100-fold bandwidth improvements, lower latency, and widen coverage to evolve an intelligent society into a futuristic society. Huawei will explore the sixth generation of connectivity technologies such as 6G, F6G, next-generation IP, Wi-Fi 7, and Wi-Fi 8, continuously make breakthroughs to achieve optimal network performance, and provide the best connections for the world.

Any assumptions about the future of connectivity may be underestimates. The best way to predict the future is to create the future. Let's advance towards the intelligent connectivity era together. ▮▮▮

Shifting paradigms for greater value

COVID-19 has accelerated the digital transformation of all industries. We provide the know-how for that to happen, helping customers create greater value and bringing stakeholders together to build a digital ecosystem where we can co-create and share value.

By Peng Zhongyang, Board Member, President of Enterprise BG, Huawei

2020 was an unusual year, with COVID-19 generating enormous uncertainty for both individuals and organizations. But we've managed to make positive changes in many different industries and create new value. A new digital paradigm is taking shape.

Industries innovate while digitalization advances

Since early 2020, the COVID-19 pandemic has changed the way we work, live, and learn. Many things have moved online, with distance education, telemedicine,

and livestream marketing by influencers continuing to flourish. Even here at Huawei, we've shifted to connecting with customers online and signed contracts over the cloud. Industries are displaying an incredible will to survive, explore, and develop in the digital world, with technologies like AI, IoT, and cloud computing developing rapidly to facilitate this process.

Exploring the potential value of each business scenario

To achieve industry digitalization, we should determine business scenarios based on customer strategies and business pain points. There are three key factors to digitalization: First, technology. We need to integrate multiple technologies with core businesses. Second, industry know-how. We need to fully understand different industries. Third, practice. We need to explore and create a better future through hands-on application.

Synergy across five tech domains drives customized innovation

In the new digital age, we will see synergy between five major tech domains: connectivity, cloud, computing, AI, and applications. These will enable people, things, and information to be connected at all levels. Huawei needs to connect the business scenarios of diverse industries to broaden the boundaries of traditional industries, and offer more flexible scenarios.

Huawei's synergy across these five tech domains has already created a solid foundation for digitalizing the coal mining industry. Huawei has turned coal mines into digital structures in more than 10 unique business scenarios, including five flows (power supply, ventilation, drainage, main transportation, auxiliary transportation) and two

planes (tunneling and mining). By digitalizing mine infrastructure, Huawei has created digital twins that make the whole mining business digital and intelligent. Thanks to these massive data flows, workers no longer have to climb up and down mines. AI-powered machines can now dig more intelligently. Remote control is now possible on the ground, leading to great gains in efficiency and enhanced security. And more miners can now come to work in suits and ties and do their job while enjoying a cup of coffee.

Gathering industry insights and maximizing potential

Industry digitalization isn't about disrupting industries; it's about helping them to do better. This requires deep insights into how each industry works and an understanding of industry know-how. We seek out experts who truly understand a given industry and put them in the driver's seat. By integrating and innovating technologies and services, we can maximize the core competencies of our enterprise customers, allowing them to go from strength to strength in new dimensions.

For example, technology has changed how TV programs are produced. In the past, artists used single-person editing, manual copying, and serial production. Now, more than 150 cameras are used onsite for program production and the volume of data generated for a single episode can reach 150 TB, 15 times that of a traditional program. Producers desperately want to see change.

To address this issue, Huawei has collaborated with its partners to establish a cloud platform for the filming process, streamlining the entire video production process from shooting, editing, and streaming to storage and backhaul, moving the entire process to cloud. This has shortened production cycles by 30 percent and cut costs by 20 percent.

> Customers have insights into the needs and direction of their own industries. Huawei has the technical expertise and ability to drive customers to develop more rapidly and embrace a better future.

Customers have insights into the needs and direction of their own industries. Huawei has the technical expertise and ability to drive customers to develop more rapidly and embrace a better future.

Learn from practice and innovate for a better future

The idea behind digital transformation is easy to understand but difficult to implement. Huawei has encountered many challenges on its own digitalization journey, but has learned valuable lessons during the process. In the past, our logistics campus in China's Dongguan had warehouse overstock issues during peak periods in June and December. Finding the right goods was very challenging, inefficient, and error-prone, so Huawei started developing automated equipment and intelligent algorithms in 2018. By synchronizing sensors on equipment, applications, and people, Huawei was able to move from manual to automated intelligent operations. As a result, delivery efficiency (volume of goods delivered per capita) has increased by 67 percent and delivery cycles were cut by over 50 percent.

Over the course of Huawei's 30-year globalization journey, we've identified 68 digital scenarios within our own business, including in R&D, manufacturing, global marketing, and finance.

Huawei has been deeply involved in many customers' digital journeys. We've helped build more than 700 smart cities around the world, including Smart Shenzhen, Digital Fuzhou, and Smart Dunhuang.

Creating and sharing value together

To build a digital future, we need to first build a digital ecosystem where we can co-create and share value. In the age of excess demand, the ecosystem model we used mainly focused on selling products, which meets rigid demands through the principle of equivalent exchange.

This is a positive-sum game, not zero-sum. And it's one for which we've identified three dimensions:

The first dimension targets the future of digitalization and gains insights into the unsatisfied demand in segmented scenarios in multiple industries. The second dimension requires aggregating the different capabilities of industry partners and maximizing their strengths. The final

14

Create value together for industries

First principles

Open up a world of possibilities

Unleash greater potential
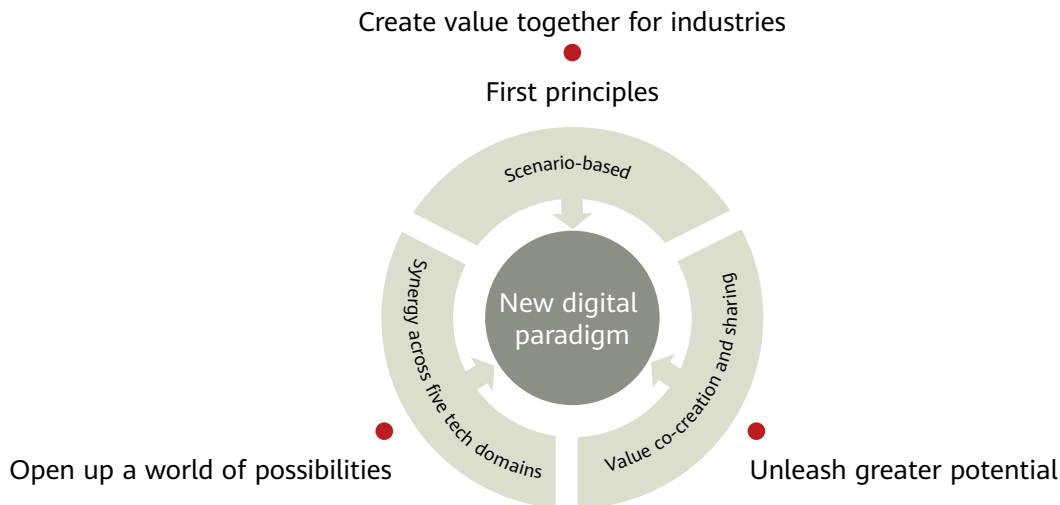
dimension involves developing multiple approaches to collaboration and new business models that create and share value together.

Shenzhen's Airport of the Future exemplifies how we used these three dimensions to co-create value. In this project, Huawei and its partners developed diverse scenario-based solutions such as flight scheduling, stand allocation, and ground support. Huawei also aggregated its partners' software development and data governance capabilities and guided its partners throughout the entire project cycle. In 2019, we managed to reduce the number of passengers who took shuttle buses by 2.6 million, boosting the efficiency of security checks by 60 percent.

Paradigm shift for a brighter future

Humanity will enter the intelligent world era over the next twenty to thirty years. The depth and breadth of this change will be beyond anything we can imagine. Traditional development paradigms will no longer meet social demand and that's why we urgently need to re-orchestrate all related elements and build a new paradigm, to generate new productivity.

The new digital paradigm has three features:

First, Aristotle's first principles define the nature and starting point of things. The first principle of the new digital paradigm is to center on customers' requirements, pain points, and aspirations, and to create value in each scenario.

Second, digitalization will rely increasingly on collaboration between different tech domains. The synergy between the five major tech domains we've identified will digitalize industry infrastructure and business processes to create digital twins, opening up a world of possibilities for diverse industries.

Lastly, the digital ecosystem will evolve into one that encourages co-creation and value-sharing. We will work with our partners to create synergies and share success. Gary Hamel once said, "You can't use an old map to see a new land." We are now in a world full of uncertainty, which is accompanied by unlimited opportunities. We hope to work with our customers, partners, and friends to embrace these changes, build a new paradigm for industry digitalization, and create a great future. Let's work together to scale new heights.
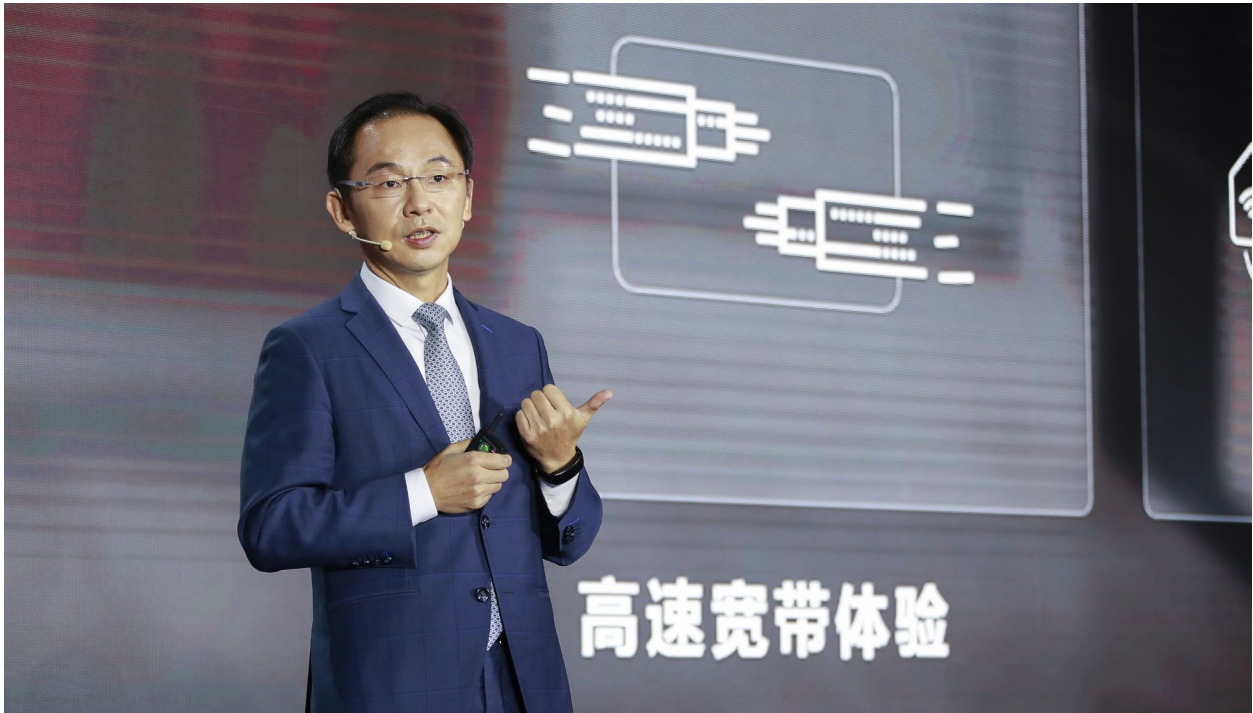
Intelligent experiences unlock new value

The world is entering an age of intelligent connectivity. In response, Huawei and carriers are deploying intelligent connectivity with deterministic experience, ubiquitous gigabit speed, and hyper-automation, bringing full connectivity to homes and enterprises.

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

Today, many countries and regions are implementing ultra-broadband connectivity strategies such as EU's Gigabit Society 2025, South Korea's 10GiGA plan, and Malaysia's National Fiberisation and Connectivity Plan. A Huawei survey reveals that there are over 24 million gigabit broadband users worldwide, so carriers are racing to release gigabit broadband services. 10G home broadband packages have already been released in France, Japan, and Singapore, and full-coverage Wi-Fi packages are now available in Thailand and Saudi Arabia. The world is entering the age of intelligent connectivity.

Home+: Better experiences and more diversified services

As online connectivity becomes increasingly important, homes are developing into multi-purpose platforms. More people are working, studying, and doing business

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> Carriers need to deploy FTTH and ensure fast broadband connectivity, so that a single investment can lead to returns for 30 years. With fiber infrastructure in place, users will enjoy faster speeds, from 100 Mbps and 1,000 Mbps right up to 10 Gbps in the future.
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from home, and international conferences and key business decisions are currently taking place online. This requires networks that are stable and secure, with a guaranteed level of user experience. In the first half of 2020, 800 million students worldwide studied online. Universities were running online classrooms, including the University of Cambridge in the UK. And in South Africa, Rhodes University streamed its graduation ceremony online.

Live streaming platforms are giving consumers a true-to-life shopping experience. During the pandemic, many small business owners in Africa have been selling products through live streaming. Their businesses haven't been affected – in fact, many vendors have expanded their reach thanks to stable and smooth live streaming.

From 128 Kbps bandwidth to gigabit broadband to intelligent connectivity, connecting homes is a never-ending journey. Providing an intelligent experience for diverse home services is where our value lies. We define this as follows:

Home digital value = Broadband Speed + Home Network + Diversified Services

First, carriers need to deploy FTTH and ensure fast broadband connectivity, so that a single investment can lead to returns for 30 years. With fiber infrastructure in place, users will enjoy faster speeds, from 100 Mbps and 1,000 Mbps right up to 10 Gbps in the future.

Second, carriers need to build networks that can cover an entire household. They should not simply connect homes, but every user in every home. Minor home network upgrades will result in major user experience improvements.

Third, carriers need to provide guaranteed levels of user experience for diverse services. This will grow the entire smart home ecosystem and further unlock digital value.

Connecting the unconnected

At the end of 2019, 1 billion households were still unconnected and 500 million households only had access to low-speed Internet. Being able to quickly provide broadband access at home is a major obstacle we must overcome.

In the Philippines, Globe used Huawei's AirPON solution to build FTTH. They used AI-powered building scanning technology to accurately identify where high-value users were located. In addition, lighter, easier-to-deploy products increased construction speeds by 90 percent and cut TTM from 180 days to 7 days. In Peru, Claro and Huawei developed a digital ODN solution, making plug-and-play for optical fibers a reality and eliminating the need for fiber splicing and making fiber deployment much faster. Second, home networks are key for carriers to improve user experience. Many carriers have launched related services.

In the UK, BT has launched its Complete Wi-Fi value-added service. Users can install the AP themselves and test the Wi-Fi. If necessary, BT will provide home-visit services and if stated data rates are not realized, BT will return £100 to their users. In Anhui Province, China Telecom uses its network O&M platform to offer users services such as custom networking, self-service management, monthly quality reports, auto network optimization, and online expert services. By upgrading its basic services to professional services, the carrier has seen a rapid growth in sales.

Home network development does not stop with Wi-Fi coverage. We're working with carriers to promote a Fiber-to-the-Room (FTTR) solution. Once fiber is available in every room, we will see an explosion in intelligent services. The ability to intelligently identify priority services has also become increasingly important. We can provide differentiated services with guaranteed experience levels across multiple scenarios. For example, VIPKid needed to guarantee a high-quality online learning experience when the number of users quickly rose as the pandemic hit. So they worked with China Unicom and used Huawei's eAI technology to increase network speeds specifically for VIPKid services. In Thailand, 3BB used Huawei's eAI technology to identify popular games and provide

gaming broadband packages for end users, attracting a large number of gamers. The carrier has since seen an increase of 10,000 new users every month.

Unlocking the digital value of homes depends on intelligent connectivity and guaranteed experience levels. As homes become multi-purpose platforms, we will work with carriers to explore and incubate new services and offer end users an intelligent experience at home. This will help carriers unlock new value while monetizing differentiated services.

Enterprise+: Maximizing digital value with better experiences

For enterprises, digitalization is about connecting the flows of capital, human resources, assets, and information. After all, connectivity is the lifeblood of digital enterprises. Zhang Qingxian, a professor at China's First Affiliated Hospital of Zhengzhou University, has seen the value of the remote consultation system. He said that a doctor can provide remote consultations for 81 cases each day. If cloud and private lines become available earlier, more patients can be treated.

At the Hong Kong Stock Exchange, the average daily turnover has exceeded 100 billion Hong Kong dollars, with their network handling 300 transactions every millisecond. When a private line with guaranteed ultra-low latency is in place, the stock exchange can quickly handle more transactions, giving it a head start in the volatile financial market.

In the automotive industry, a key approach to ensuring driving safety is to use the cloud to simulate collisions in all scenarios. At FAW Group, the model used for the collision simulation of a single car generates hundreds of gigabytes, if not terabytes, of data. A high-

> Many issues are affecting connection experiences for enterprises. Provisioning of services takes a long time. Pricing options are limited. And SLAs are invisible.

bandwidth private line is needed to instantly upload the model data to the cloud. Bandwidth demand during off-peak hours is 100 times less than demand during peak hours. Therefore, bandwidth flexibility is crucial.

Many issues are affecting connection experiences for enterprises. Provisioning of services takes a long time. Pricing options are limited. And SLAs are invisible. So, we came up with a formula to address these issues and help enterprises create greater digital value.

Enterprise digital value = Coverage (C) x Architecture (A) x Fusion (F)

First is coverage. This is about achieving seamless coverage through comprehensive service area planning and intelligent network construction.

Second is architecture. This is about adopting flexible, intelligent architecture to deliver deterministic SLAs.

Third is fusion. This is about integrating the cloud and networks to achieve one-hop access to the cloud

and deliver user-defined experiences.

The value of connections is maximized when we multiply C, A, and F together. But if we miss any one of these dimensions, the overall value of the network suffers. First, let's look at the coverage dimension. To ensure agile access for enterprise users, carriers must plan their infrastructure networks and make resources rapidly available. China Telecom Shanghai has realized wide coverage with its all-optical city plan, deploying one private line for each SME and providing five types of services. This reduces the need for SMEs to deploy ICT solutions and cuts maintenance costs. The carrier can then deliver more compelling services and generate higher revenue.

The second dimension is architecture. Carriers need an elastic and intelligent architecture that's congestion-free, always-on, scalable, and simplified. This type of architecture is the precondition for providing deterministic experiences. For example, a carrier in western Europe built a country-wide private line specifically for the local media industry, employing a transparent transmission solution that dynamically adjusts bandwidth. China Telecom

> Business development and tech advancements cannot happen independently. To constantly grow, an industry needs both the technologies and the business applications to monetize these technologies.

Shanghai rapidly upgraded its services by optimizing optical cable routes, reducing network latency at the local stock exchange from 4.6 milliseconds to 0.63 milliseconds. BRI is one of the largest banks in Indonesia. It requires highly reliable interconnections between data centers to guarantee business development and security. The Indonesian carrier Indosat has rolled out a private line for the bank, improving network reliability from 99.9 percent to 99.999 percent, which represents a 50-percent increase in service prices. China Telecom Ningxia enables network sharing through slicing, and provides dedicated services for different tenants. It has deployed private lines in multiple industries, including 3,000 medical institutions and 2,000 educational institutions.

To more easily monetize their networks, carriers must optimize network architecture for agility, so networks can adapt to the needs of enterprise customers.

As AI technologies mature, the demand for computing power from enterprises is growing rapidly. How can we increase network bandwidth to make the most of computing power and accelerate digitalization across industries? We believe network capabilities should gradually become the foundation, so that carriers can provide cloud, network integration, and one hop to cloud with guaranteed SLAs and differentiated cloud and network services.

Business development and tech advancements cannot happen independently. To constantly grow, an industry needs both the technologies and the business applications to monetize these technologies.

Huawei is ready to work with carriers. Together, we achieve innovations in intelligent connectivity and provide hyper-automation, ubiquitous gigabit, and deterministic experiences. We will apply the two monetization formulas to generate greater value from homes and enterprises and deliver intelligent experiences based on ubiquitous connectivity. We will enable digital transformation based on the two drivers, and tap into industries worth trillions of dollars.

We believe that demand can always be created and experiences will never stop evolving. Intelligence shapes experience, connectivity creates the future. ▥

5 key enablers of smart banking

Powered by our open technology architecture, continued R&D investment, and proactive collaboration model, Huawei helps financial companies transform digitally and embrace the digital age in five ways: vision, insights, solutions, ecosystem, and experts.

By Cao Chong, President of Global Financial Services Business Department, Huawei Enterprise BG

mature banks in risk resilience and the ability to deliver both normal and tailored services to customers.

The digital transformation of financial enterprises starts with digital channels, such as mobile banking, and gradually extends to the company-wide digitalization of employee working models, branch resource management, data management methods, and risk control strategies.

The requirements of digital transformation

Redesigning the customer service journey: Although online banking has become more widespread, customers still need to visit their local bank branch for certain financial services. With branches closed during the pandemic, banks have begun to focus on redesigning their customer service journey with mobile banking.

Fintech can be used to make more services available online and reconstruct existing services around customers' online and mobile habits. Online appointments and pre-filled forms can be seamlessly integrated with offline processes such as QR codes, one-click interconnection services, and cross-selling, which makes the in-branch customer service journey

A new era for finance

During the pandemic, banks with leading digital capabilities could continue offering digital and contactless services for customers, out-performing less digitally

> Leading banks worldwide have adopted mobile-first strategies that increase service agility and better meet customer requirements. We predict that the main competitive arena for banks in the future will be mobile apps and digital customer acquisition, services, and operations.

more organized, efficient, and reassuring.

Business agility and mobility: 5G, AI, cloud, and the Internet have shifted customer behavior towards mobile, personalized, and cashless and cardless services. Leading banks worldwide have adopted mobile-first strategies that increase service agility and better meet customer requirements. We predict that the main competitive arena for banks in the future will be mobile apps and digital customer acquisition, services, and operations.

A mobile-first strategy, however, requires full-service partners to transform all banking processes with advanced IT capabilities and collaboration platforms.

Smart branches: Technologies like 5G, Wi-Fi 6, and IoT combined with devices such as AI-powered smart cameras and smart terminal machines (STM) will make bank branch operations lightweight and intelligent. Smart tellers can guide customer interactions and services, while smart temperature control, cameras, and smart experiences can make branches safer and more comfortable and boost management and operational efficiency. Regional hubs will be able to optimize branch distribution and resource allocation.

Digital payments: Internet giants have made mobile payments a must-have service in the online ecosystem. Research by IDC reveals that mobile payments increased by 60 percent in some Asia-Pacific markets in the first quarter of 2020. Banks are facing the challenge of how to support mobile payments, make them more convenient, integrate them with banking services, and open up capabilities to more Internet players.

Digital customer acquisition and digital operations: The Internet is now a key channel for banks to acquire customers. Financial institutions need to develop online customer acquisition capabilities alongside big data, AI, and fintech (such as eKYC - electronic Know Your Customer) to better understand customers, mitigate risks, and improve the precision of customer services.

Customer communication: Internet companies can easily communicate with customers, send personalized notifications, and quickly respond to customer needs 24/7 using their own platforms. Replicating this poses

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> Hybrid cloud is the foundation of bank digital transformation. It's scalable, improves resource utilization, and provides on-demand microservices and development tools.
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a big challenge for banks' siloed multi-channel service approach. They need interactive platforms that enable direct communication with customers, push services in real time, and respond to customers any time.

Cloud architecture: Hybrid cloud is the foundation of bank digital transformation. It's scalable, improves resource utilization, and provides on-demand microservices and development tools. And banks can quickly launch and iterate new services and products online.

The 5G+ trend: 5G and IoT can connect mass devices, with 5G's high bandwidth allowing customers to use video, VR, and AR to interact with banks. 5G's low latency and high reliability will enable banks to migrate more services online and seamlessly connect with billions of consumers and enterprise customers.

Edge computing and AI can bring personalized service capabilities closer to customers by, for example, automatically identifying customers in service centers and understanding their needs.

5G+ will make virtual lending services, investment, and wealth management services available on smart devices. The loan process for companies will be simpler

and more transparent, with technologies like big data analytics able to analyze business performance. Overall, services will cost less to implement as they become flatter with fewer steps.

Empowering digitalization

Over several decades, Huawei has served over 1,600 financial customers in more than 60 countries, including 45 of the world's top 100 banks. Huawei believes that the financial services industry must focus on three things:

Connectivity: Without fast, reliable, and high-quality network connections, mobile devices can't provide rich interactive experiences, financial services can't rapidly respond to every customer, and business models will stagnate.

Digitalization: Ubiquitous connectivity allows all services to be digitalized and offered online, so that financial companies can shift away from traditional models to online digital service models.

Business agility: COVID-19 has shown that financial companies must be able to respond quickly to uncertainty and use digital technologies to adjust business models, resource capabilities, and risk control

> Huawei provides intelligent marketing, connectivity, management, and security solutions for bank branches that boost the customer experience and slash OPEX.

measures.

The ABCDE of finance

Huawei's ABCDE strategy covers five key enablers for financial customers.

Architecture: New architecture can enable intelligent finance transformation. Huawei offers hybrid cloud, data centers, and business cloudification to support business continuity; high-availability disaster tolerance; and internal networks based on software-defined networks (SDNs), in addition to active-active and all-flash storage systems. Financial cloud architecture integrates data centers into hybrid cloud for the secure and efficient use of public cloud resources.

For example, Bank of China's new Huawei-provided architecture supports 1 billion users and 100,000 transactions per second, including more than 10 million online users of the bank's Make it Easy e-commerce platform. It's open-access platform for third-party services supports more than 5 million transactions per day, and the cost of the new architecture is significantly lower than the host architecture.

Huawei's full-lifecycle intelligent storage solution has also helped Singapore's DBS Bank boost the efficiency

of its service data access, providing the required infrastructure for collecting, storing, and processing massive amounts of data – mass data is key for new data platforms.

Branches: Physical bank branches need to evolve into smart and digital service centers. Based on 5G, AI, and cloud, their new role will be to enrich the customer journey with a high-end, convenient, and comprehensive financial service experience.

Huawei provides intelligent marketing, connectivity, management, and security solutions for bank branches that boost the customer experience and slash OPEX. At China Merchants Bank (CMB), for example, customers can book services on CMB's app, so a branch can plan resources in advance. Smart cameras can identify customers as they arrive for appointments, notify customer managers, direct customers to the correct customer service area, and – during the pandemic – take temperatures. Customers can also access services easily through QR codes. Edge computing and IoT lets staff manage branch security, devices, and resources on mobile devices. Interactive displays in waiting areas can push targeted financial services.

Digital core: Most commercial banks' core systems still run on a central architecture, leading to low scalability, high costs, long service provisioning periods, and complex O&M.

Banks need to maintain the stability of their basic services in the traditional core, but also quickly build new digital banking cores to achieve service agility. The digital core needs open and distributed technologies that support the rapid development and rollout of next-gen applications, accelerate customer acquisition, enhance the customer experience, and lower IT costs. It must also support next-gen data platforms, so that banks can quickly reconstruct the data plane, including the data lake and data factory.

Huawei and each of its leading partners, including Sunline Technology, Forms Syntron, and Temenos, have brought their respective strengths into play to develop digital banking core solutions for a range of scenarios. Our open banking core system solution uses distributed architecture at the IaaS, PaaS, and SaaS layers. It adopts a microservice concept, supports modular deployment, and can be used as a new digital service platform that will help banks to develop super apps and over time migrate traditional core systems to the new digital one.

The traditional core system in one major bank in Thailand, for example, was struggling to support the rapid growth in users. Huawei and its partners developed a new digital banking core solution for the bank, helping it quickly deliver services to tens of millions of users through a digital wallet feature. In the future, the new digital banking core will carry new services for different ecosystems and gradually take

> *In the finance domain, Huawei has more than 200 solution partners worldwide, with solutions ranging from core banking systems, AI chatbots, and intelligent networks to mobile office apps, business intelligence, and intelligent data pools.*

over the bank's traditional services.

New data platform: Traditional databases can't support the big data that banks need for digital transformation. Huawei has been working with its partners to build a new data platform with functions like targeted customer acquisition, real-time risk control, and lean operations. The solution architecture consists of an innovation application layer, integration platform layer, and intelligent infrastructure layer, covering areas such as marketing, operations, and risk control.

To serve its 500 million customers, Industrial and Commercial Bank of China (ICBC) has adopted the solution to replace its traditional data warehouse platform. Over the last three years, it's migrated and expanded its data marts to accommodate over 2 PB of data, including marketing, mobile banking, the financial market, and risk prevention and control.

The new data platform has slashed TCO and driven up scalability and system performance, including query and analysis capabilities. It analyzes in real time how customers use the app, enabling ICBC to improve customer experience.

Open ecosystem: In the finance domain, Huawei has more than 200 solution partners worldwide, with solutions ranging from core banking systems, AI chatbots, and intelligent networks to mobile office apps, business intelligence, and intelligent data pools.

We've worked with partners on successful cases from around the world, including new distributed core systems for multiple Chinese BFSI companies, an inclusive financial credit platform for a leading Kenyan bank, a new digital core system for leading regional banks in Southeast Asia, and a payment ecosystem with Indonesian banks for cardless users to use financial services.

5G, AI, and cloud will have a profound impact on the financial industry – technological fields in which we've invested heavily and become a global leader.

For the financial industry in the era of mobile intelligence, Huawei offers vision, insights, solutions, partners, and industry experts. We've become a strategic digital transformation partner for financial institutions across the world thanks to our technical expertise and strategic investments in the BFSI sector. ▟▙▟

Pioneering a new financial service model with intelligent connected things

Shanghai Pudong Development Bank (SPD Bank) is a pioneer in fintech and has embraced new technologies to digitalize its full stack, from basic technologies to the entire service ecosystem. For SPD Bank, technology is redefining how the physical world connects and interacts with the digital world and creating a new financial service model.

By Pan Weidong, Vice Chairman and President, SPD Bank

To scale up the digital innovation ecosystem and give new momentum to fintech, financial professionals must figure out how to integrate technology with finance. SPD Bank's journey to a digital world is a great example of this.

SPD Bank's digital transformation practices

SPD Bank is a national joint-stock commercial bank headquartered in Shanghai, China. Over the years, Huawei has referenced the world's top banks in terms of their digital transformation and explored cutting-edge technologies to help SPD Bank achieve full-stack digitalization, from basic technologies to the entire service ecosystem.

SPD Bank believes that technology is the primary force behind productivity and that innovation is the main driver of development. With this in mind, the bank has

> New technologies like 5G, cloud, big data, and AI are leading humanity into a new era – from connecting people to connecting things to building a fully connected, intelligent world.

transformed its business models through technology, so as to realize its strategic goal of building a leading joint-stock commercial bank with international competitiveness. SPD Bank hopes to become a pacesetter and pioneer of high-quality development in the financial sector in the new era. Driven by a better customer experience and digital technology, SPD Bank promotes open banking and innovative connectivity through technology.

In 2018, SPD Bank launched the industry's first API Bank, leading to a wave of open banking in China that brings banking services into customers' lives.

The following year, SPD Bank teamed up with Huawei and China Mobile to launch China's first 5G+ smart branch in Shanghai. The first bank account was opened over a 5G network in the smart branch, which offered HD remote customer services with mixed reality, and an innovative customer experience.

That same year, SPD Bank unveiled its first digital assistant Xiaopu to provide customers with smart, personalized services based on humanized user interfaces (HUIs). Xiaopu has created a new financial service model by redefining how the physical world connects and interacts with the digital world.

From the API Bank and 5G+ smart branch to virtual assistants, SPD Bank has continuously invested in new technology to create new service models and find new touch points, channels, and ways for banks to interact with customers and partners.

Fully connected, intelligent banking

New technologies like 5G, cloud, big data, and AI are leading humanity into a new era – from connecting people to connecting things to building a fully connected, intelligent world. Intelligent vehicles, smart homes, and delivery robots are just a few examples of how intelligent things with intelligent computing and automation capabilities have become a new component of the new era.

Huawei Global Industry Vision (GIV) predicts that by 2025, there will be 100 billion connections in domains like personal devices, public utilities, manufacturing, healthcare, and agriculture. All intelligent things will be connected to become Intelligent Twins, which will make up smart cities, intelligent transportation systems, and more. This intelligent space will create huge network value and unleash unlimited potential for innovation. To make this a reality, banks will

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> Intelligent things have changed the way banks engage customers and provided new ways to interact with the digital world, so that banks can get closer to customers and offer services whenever they're needed.
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embrace a fully connected, intelligent world, and move from connecting intelligence and service scenarios to connecting the ecosystem.

Connecting intelligence: Unleashing productivity through digitalization

In the future, the volume of data and AI capabilities will become a new factor of production, especially for enterprises. Therefore, strong intelligent connectivity is vital for banks to build core competitiveness and take the lead again.

Intelligent networks can connect computing nodes and data centers and fully unleash the computing power of the cloud. They can also seamlessly connect cloud, edge, and device for smoother data flows and power closed-loop intelligent service flows from sensing, analysis, and decision-making to response. With intelligent networks, banks can overhaul customer experience and services, while enhancing operating efficiency and lean management.

Connecting scenarios: Creating a new service model

SPD Bank is customer-centric and strives to integrate financial services into its customers' lives. Intelligent things emerging in banking scenarios have brought new opportunities for SPD Bank's innovation in services, technologies, and business models. And intelligent things have changed the way banks engage customers and provided new ways to interact with the digital world, so that banks can get closer to customers and offer services whenever they're needed. Intelligent things can build an intelligent space around people based on the situations and provide integrated services.

A lack of connection and coordination of intelligent things means that scenario-based finance cannot connect all customer touch points and only offer limited service models. By contrast, integrated services provide an intelligent service experience for customers based on time, space, and context. For example, vehicle-to-everything (V2X) networks make interactions easier by connecting people to roads, navigation systems, service areas, and charging stations through intelligent vehicles.

Connecting the ecosystem: Driving cross-industry

> Financial services should focus on customers and rely on the ecosystem to interlink businesses, consumers, and governments based on service scenarios – with the ultimate goal of serving the physical economy.

collaboration

Intelligent space is a thriving ecosystem. V2X enables intelligent vehicles, roads, traffic lights, and parking lots to be supported by various companies, regulators, and intelligent technology platforms. All of these make up a diverse ecosystem of people, things, and enterprises.

Technologies, such as IoT, blockchain, big data, and AI, will build a bottom-up technology stack for an intelligent, open, and coordinated ecosystem platform. Financial services should focus on customers and rely on the ecosystem to interlink businesses, consumers, and governments based on service scenarios – with the ultimate goal of serving the physical economy.

On the platform, all stakeholders can share information about the industry and ecosystem, customers and service scenarios, and technology and finance. This helps address information asymmetries, reduce the cost of trust, and provide comprehensive services for all enterprises across the industry ecosystem to achieve shared success.

Moving towards a fully connected, intelligent world, SPD Bank proposed the concept of "the bank of things", extending the focus of banks from people to intelligent things to create new financial service infrastructure for the digital world. This marks the bank's cutting-edge exploration into digital innovation, as well as a new financial service model that's borderless, touchless, and seamless.

SPD Bank has collaborated with leading global tech companies on future-oriented research to give new momentum to fintech. In 2018, SPD Bank and Huawei had many positive outcomes from their innovation lab, and in August 2020, they strengthened their ties through a comprehensive strategic cooperation agreement.

As a result of their partnership, SPD Bank and Huawei jointly released the *Bank of Things White Paper*. This white paper represents the beginning of a new financial service model focusing on intelligent things and innovations for integrating financial services into retail, transportation, healthcare, and other industries. 〰

Sailing to blue B2B oceans with 5G

Synergy between connectivity, cloud, AI, computing, and industry applications will create new opportunities for all industries. 5G B2B service development must start with looking at typical scenarios, streamlining the upstream and downstream of the supply chain, and working with partners to provide customers with a complete set of solutions.

By Sun Pengfei, 5GtoB Solutions, ICT Strategy & Marketing, Huawei

Synergizing five tech domains

5G's convergence with cloud, AI, computing, and industry applications will accelerate the digitalization of all industries and pave the way to a digital society. Without this convergence, 5G B2B cannot be achieved.

In remote control scenarios, for example, the integrated application of multiple technologies is required to reduce customer costs, increase revenue, and improve problem-solving efficiency. The technologies involved include HD camera recording, 5G

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With 5G applications now widely used in enterprise production systems, some 5G features have been widely applied in certain key scenarios.

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backhaul, the video analysis platform, the PLC control platform, and remote control applications. After they are integrated and coordinated, these technologies need to be iterated and widely applied in key scenarios such as mines, ports, factories, and campuses. Without any one of the five tech domains, synergy cannot exist.

As this synergy presents opportunities for all industries, Huawei is committed to working with partners to create new industry value worth trillions of dollars through industry digital transformation.

5G B2B: Typical applications

With 5G applications now widely used in enterprise production systems, some 5G features, like large uplink bandwidth, low latency, multi-connection, high-precision positioning, and MEC, have been widely applied in certain key scenarios.

Wire removal: The removal of wires is essential in scenarios that involve large amounts of mobile equipment where fixed networks cannot be used, such as when equipment and tools used for scanning, collection, and detection (that is, mobile equipment on tracks in factories and warehouses, robots in production lines, and mobile consoles) are used in an enterprise's production system.

Wireless broadband: The models and standards of traditional enterprise private networks aren't unified, which creates many challenges using and maintaining networks. Enterprises face high costs to deploy and operate multiple independent private networks, complex last-mile transmission scenarios involving high demand and frequent updates, and other challenging scenarios that aren't suitable for wired networks. Therefore, enterprises need 5G private networks to address these pain points.

High-density IoT: An enterprise's production system requires high numbers of devices, materials, vehicles, and personnel to be connected, which in turn needs many different types of sensors that can be used in challenging environments. 5G networks can support access to high-density IoT and data collection on personnel, machines, objects, and the environment.

Remote PLC control: Many industries have challenging operating environments that need to be improved.

Video surveillance upgrades: Currently, the resolution of surveillance cameras in many enterprise campuses and factories is 480p or 720p, which is insufficient for precise recognition.

Mobile high-risk inspections: Challenging inspection

scenarios in many industries must be improved to help both inspectors and enterprises. Mobile inspections conducted by robots will need to replace manual inspections around the clock to eliminate safety risks in factories.

High-precision positioning: Many enterprise campuses and factories need AGVs, intelligent tallying, and personnel and equipment monitoring that require high-precision positioning.

5G B2B must thus be deployed in selected industries based on regional characteristics and key scenarios that can create commercial value.

Streamlining for 5G B2B rollout

To achieve business success in 5G B2B, we must fully understand industries, starting with the application of 5G B2B services in digital transformation scenarios. Based on industry development and the industry ecosystem, as well as network capabilities, Huawei will work with carriers, equipment vendors, integrators, ISVs, and developers to provide services for end enterprise customers.

First, understanding is the cornerstone for 5G to penetrate industries. Each industry has its own scenarios and is at a different stage of digitalization. The ICT industry should collaborate with leading enterprises and industry experts in traditional industries to combine 5G technologies with industry ecosystems and develop corresponding solutions based on detailed analyses of industry conditions and requirements, solving enterprises' problems.

Second, we should build a prosperous industry ecosystem. 5G industry applications need to integrate CT/IT/OT technologies and converge with 5G, cloud,

AI, smart devices, and industry applications. With immature value chain development and complex business models, the cultivation of a long-term ecosystem is a must.

The 5G B2B industry value chain stretches far and involves many players. To empower various industries, it's essential to integrate numerous applications, aggregate ecosystems, and build a platform shared by ecosystems. This will make products easier to purchase, activate, operate, maintain, and apply during secondary development. This model can be easily replicated by businesses.

The cloud-edge ecosystem is hugely important. Industry applications deployed in campuses or factories must align with the application ecosystem built around the central cloud to achieve sharing among ecosystems and flexible deployment.

Third, we must design a mature business model that fairly distributes value and benefits. The 5G B2B industry value chain, which adopts a multi-party transaction model, is complex, making the business cycle extremely long. Therefore, there is a need to simplify the business model by integrating cloud services, application ecosystems, and 5G networks to improve efficiency. At the same time, efforts should be made to ensure benefits are fairly distributed across the value chain. Those who shoulder greater responsibility should receive greater rewards.

A reasonable "value-based pricing" mechanism must be established to drive innovation. The pricing of 5G services must be set based on the value they bring to customers as 5G works to establish its presence in businesses' production systems. This will contribute to positive business growth and attract more players to the 5G market.

> Measures such as establishing 5G industry funds, adopting intellectual property protection policies, and building a compound talent cultivation system will go a long way towards helping the 5G B2B industry to achieve scale development.

Fourth, technical and industry standards are required. The standardization of 5G B2B services, including R16, R17, and 5.5G, should be promoted.

It is necessary to develop industry specifications to open up 5G B2B network capabilities, such as 5G Network-as-a-Service (NaaS), slicing, MEC, and network function architecture and specifications. These include CSMF/NSMF, NEF, open northbound interface, and the interface that enables industry applications to call network-wide capabilities.

Standards for regulating the operations of 5G B2B industry solutions must be developed to facilitate sales, covering on-shelf 5G networks, cloud services, and industry applications. The GSMA Operator Platform is one example.

Fifth, the implementation of industry policies should be advanced. Industry policies must be up to date and strategic arrangements must be made in advance – a favorable regulatory and policy environment is key to the healthy growth of the 5G B2B industry.

Measures such as establishing 5G industry funds, adopting intellectual property protection policies, and building a compound talent cultivation system will go a long way towards helping the 5G B2B industry to achieve scale development.

Sixth, we must strive to meet the key technical requirements of industries. We should focus on the network capabilities required to support business functions, including high-quality performance, business isolation, security, and reliability. This includes remote control for ports, large bandwidth with a latency of 10 to 20 ms for ensuring security in campuses, high upload speeds for AI-based quality inspections in manufacturing, network slicing to achieve business isolation in factories, highly reliable private wireless and transmission networks, and MEC for factories and campuses. Specific technical requirements include:

- Demand for cloud services such as AI-powered learning and analytical capabilities, and on-premise cloud.
- Demand for industry applications, including remote control for functions such as wheel cranes and overhead cranes, campus solutions, and AR remote assistance.
- SLAs for enterprises, which covers the division of responsibilities between network, cloud, and industry application providers and E2E SLAs.
- Demand for the self-service and self-management

of network services such as slice management, MEC management, and not transferring data off campus.

Using existing advantages in partnerships

Based on our expertise in connectivity, computing, and digital transformation, Huawei joined forces with players along the industry value chain to build a B2B business model comprising sales, marketing, and services; a solutions platform; and converged device, network, cloud, and edge solutions. This collaboration can increase the deep integration of 5G within various industries and promote the development of commercial 5G B2B services.

Faced with a fragmented market, we must develop unified business architecture. We believe that there are six key roles in the future 5G B2B business cycle: network operators, cloud service providers, service integrators, application developers, and enterprise customers.

Network operators: provide 5G network services; explore the applications of 5G, fixed networks, and IoT across wider areas; provide industry-specific cloud service providers with private lines, private networks, and edge capabilities to develop B2B services; standardize network capabilities; and provide interfaces that industry partners can integrate with and utilize.

Industry-specific cloud service providers: empower application developers with 5G capabilities by establishing industry application enablement centers; accelerate the development of 5G applications; build an inclusive 5G application ecosystem; and build a 5G B2B market to aggregate industry applications and 5G B2B products, simplify the transaction model, and enable large-scale replication of 5G B2B solutions. It's worth noting that an industry-specific cloud service provider may be a network operator, public cloud service provider, or service integrator.

System integrators: integrate various resources; design, deliver, and offer advice on solutions for industries; and aggregate ecosystems and provide integration verification services. This role is key to the success of any industry digitalization project and requires comprehensive industry understanding. Currently, operators in China have built their own system integration teams and cultivated corresponding capabilities by working on DICT (Department of the Information and Communications Technology) projects. Operators now offer 5G networks and cloud services, as well as integrated services for industries. While evolving leading roles in helping industries go digital, operators have maximized their value.

Industry application developers (ISVs/IHVs): provide applications that can be sold in various industries or integrated as part of system integrators' industry solutions.

Enterprise customers: procure industry solutions either independently or via a system integrator. As end users, enterprises will be able to access a self-service portal through which they can self-manage daily operations and identify problems.

Industry-specific customers: digitalize their industry as end users and project owners. Currently, 5G B2B is mainly applied in the manufacturing, mining, ports, construction, education, healthcare, campus, and public security industries.

The commercial success of 5G B2B depends on large-scale user groups (industry leaders), the participation of the world's top operators and communication vendors, leading IT infrastructure, robust innovation ecosystems, and strong support by national policies. Together, these factors will create an environment that enables synergy between the five tech domains.

How 5G will revolutionize manufacturing

Nations rely on manufacturing to grow and thus intelligent upgrades are crucial for the sector to develop. Wireless connectivity will take over from wired networks to power this growth with smart and flexible technologies that take productivity to the next level.

By Xiang Ling

5G solves connectivity issues and creates more scenarios where cloud computing and artificial intelligence can be applied to manufacturing, bringing new possibilities to the industry.

Smart manufacturing today and in the future

Global manufacturing has entered the Fourth Industrial Revolution. Digital, network, and intelligent technologies will revolutionize production equipment and processes as well as product supply. To become part of this revolution, manufacturing powerhouses have launched plans to upgrade the manufacturing industry. Some examples are the US's Strategy for American Leadership in Advanced Manufacturing, Germany's Industry 4.0 strategy, and China's Made in China 2025 plan. All aim to use advanced ICT to empower manufacturing and enhance the industry's

core capabilities. China, for example, has deployed the world's largest 5G network and developed more than 100 5G-enabled manufacturing benchmark applications, which the nation is starting to commercialize.

The application of 5G to R&D and design systems, production control systems, and service management systems will revolutionize the production processes of vertical industries covering R&D and design, production, and management services. This will transform manufacturing into a more intelligent, flexible, service-oriented, and premium industry.

Since 2016, countries worldwide have been promoting the development of 5G-enabled manufacturing by developing policies, incentivizing industries, and establishing alliances. In China, the US, the EU, Japan, and South Korea, we've seen governments, industry alliances, manufacturers, and carriers leading efforts to implement 5G-enabled manufacturing applications. A number of countries, including Canada, Australia, Singapore, Saudi Arabia, India, Brazil, and Russia, have stated in their digital strategies that they will adopt 5G, showing direct or indirect national strategic support for 5G application in manufacturing.

5G in smart manufacturing

Considering the speed at which 5G is developing, the general industry consensus is that 5G should be introduced to manufacturing in three stages.

Informatization: Network infrastructure optimization began in 2018. In 2020, 5G's enhanced Mobile Broadband (eMBB) capabilities started to be adopted. Thanks to unprecedented large upstream and downstream bandwidth and low latency, 5G is finding its way into non-crucial elements of manufacturing processes. This is enabling digital transformation in manufacturing and benefits enterprises by offering

lower costs, higher quality, and higher efficiency.

Digitalization: 5G is expected to integrate with IT and operational technology (OT) between 2021 and 2023. During this stage, 5G will be introduced into the very core of manufacturing thanks to the development of industrial modules, multi-access edge computing (MEC), network slicing, and ultra-reliable low-latency communication (URLLC). 5G will adapt to use cases that require real-time control and high reliability and integrate with IT and OT in manufacturing.

Intelligence: 5G is expected to fully integrate connectivity and intelligence after 2023. As the digital transformation and flexible evolution of manufacturing develop, and the low latency, high reliability, mass connectivity, and wide coverage of 5G further improve, 5G will empower fully wireless smart factories. This full connectivity will enable a wide range of services, from connecting basic equipment and meeting office needs, to ultra-low-latency precision control and manufacturing.

China has deployed the world's largest 5G network and developed more than 100 5G-enabled manufacturing benchmark applications, including 5G + Industrial Internet, in numerous manufacturing sectors including ports, iron and steel, cement, aircraft, home appliance, electronics, and semiconductors.

Based on experience from actual projects, industrial connectivity will place the following three requirements on wireless networks:

Solid network performance: The core 5G features of high bandwidth, low latency, and massive connectivity will be required. Currently, 5G is going through the preliminary stages of commercialization and meets the basic needs of connectivity for manufacturing. With the freezing of Release 16 and progression of Release

> As mobile communications technology has shifted from consumer-oriented to business-oriented, reliability requirements have changed dramatically.

17, 5G is set to be applied in even more use cases.

High reliability: Wireless networks must have stable connections and latencies. As mobile communications technology has shifted from consumer-oriented to business-oriented, reliability requirements have changed dramatically. Actual 5G projects for business have been examined to develop a preliminary reliability requirement model, and 5G equipment is becoming increasingly capable of meeting the high reliability requirements of manufacturing.

Onsite adjustment: Wireless networks should be easy to deploy, maintain, and expand. As a wireless communications technology, 5G cannot be compared to optical fiber in terms of absolute performance indicators. However, mobility and flexibility are two key reasons for manufacturers to choose 5G as their connectivity solution. In addition, the ease of planning, construction, O&M, and optimization that 5G can offer is beyond even what manufacturing industries need.

The general industry consensus is that the earliest 5G applications for smart manufacturing have preliminarily matured and are ready for massive commercial use.

Connecting equipment: This is the most common application of 5G in smart manufacturing. Li Peigen, academician from the Chinese Academy of Engineering (CAE), believes that because a high-precision manufacturing process can entail accessing tens of thousands of sensors and actuators, it's vital that wireless communications technology features high reliability, massive connectivity, and ultra-low latency, all of which 5G does. Currently, most smart factories rely on wired connections. However, deploying the hardware needed for wired connections is complex and time-consuming. Hardware also deteriorates over time, and troubleshooting, maintenance, and replacing equipment is difficult. Moreover, wired connections don't enable adjustments to the production line. As manufacturing becomes more intelligent and flexible, wired connections cannot keep up. That's why more smart factories are connecting their systems and equipment using 5G, which promises communications capabilities almost equal to wired connections, but with greater flexibility.

AI-based detection: For scenarios in which defects are difficult to detect and manual inspection is required, the best approach is a long-term process of photographs plus computing to find the pattern and perform an

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>
> 5G technology, with its large bandwidth and low latency,
> fully meets the transmission requirements of automatic detection
> in smart manufacturing.
>
> 99

informed analysis. Wang Guodong, another CAE academician, believes that real-time image transmission will generate huge demand for 5G. Traditionally, photography and detection functions are incorporated in manufacturing equipment, but that is costly and relies on dated detection algorithms backed by insufficient computing power. It's also hard to upgrade detection algorithms. Now, however, more manufacturers are adopting automatic detection through cloud AI, which imposes new requirements on the network given the volume of data transferred to cloud – mainly images and videos for training and data for real-time detection. 5G technology, with its large bandwidth and low latency, fully meets the transmission requirements of automatic detection in smart manufacturing.

Real-time control: According to Wang, 5G networks are the best way to achieve fast, real-time communications between physical entities and their digital twins in manufacturing process control. Digital twin technology has not yet been widely adopted. Currently, real-time remote control and automatic operations are mainly used for equipment; for example, bridge cranes, gantry cranes, and manufacturing robots require extremely low latency, below 20 ms, which 5G can deliver. Currently, 5G is seeing broad adoption in steel mills, ports, and manufacturing plants.

Synergy across five tech domains is the key to success

"In digital transformation, manufacturers should focus on extended reality, digital twins, multi-domain physical modeling, Internet of Vehicles, digital supply chain, and cloud robotics applications," Li Peigen told *WinWin*. "These applications are very demanding in terms of connectivity and computing capabilities. Therefore, technologies such as 5G, cloud, and AI should act as a digital foundation for driving the adoption and development of these applications in the manufacturing industry."

As the most advanced mobile communications technology standard, 5G will greatly boost the connectivity experience and act as an important part of future-oriented digital infrastructure, bringing opportunities to smart manufacturing through the synergy across five tech domains: connectivity, AI, cloud, computing, and industry applications.

The explosive growth of data is placing new demands on the computing industry, with 5G set to take cloud computing to the next level. In the 5G era, computing is evolving towards a new paradigm of cloud-edge-

> With the evolution of 5G standards and protocols and the improvement of the modular device industry, 5G will become the engine that drives the digital transformation of all industries.

device synergy and diversified computing, addressing the varied computing requirements that come with massive numbers of devices and smart application scenarios.

Right now, we're seeing the rapid proliferation of 5G industry applications. For example, in smart manufacturing, remote control enabled by 5G and cloud has changed how people work. Valin Xiangtan Iron & Steel, a factory in China's Hunan Province, has used 5G and cloud computing to enable remote-controlled bridge cranes. In the past, operators had to control equipment while sitting inside the small control room, a dangerous and unappealing job that made recruitment difficult. With 5G and cloud computing, operators can control equipment in the comfort of an air-conditioned room. One operator can control several bridge cranes, watching them via HD video and greatly reducing the manufacturer's labor costs.

Wang is enthusiastic about the potential of 5G and cloud computing to accelerate AI applications, "Cloud and AI are vital to many aspects of the process industry, including data processing, AI applications, algorithms, and programming methods," he said. "The edge cloud is especially important, because digital twins will provide the best real-time feedback through

direct interaction between the edge and physical entities. The combination of cloud, AI, and the large bandwidth and low latency of 5G can fully address the requirements of industrial manufacturing."

With 5G, the driving force of services will shift from the human brain to cloud. For example, Valin Xiangtan Iron & Steel is now using 5G, cloud, and AI technologies for detecting defects on steel surfaces. Photos taken by industrial cameras are sent to the cloud via the 5G network, and defects are automatically identified through AI-based machine vision. Unlike manual detection, automatic detection can accurately identify subtle defects and objects in motion, and can be used during the hot rolling process. This will help improve product quality and reduce workload.

Chinese companies have taken the lead in applying 5G in manufacturing. Throughout the country, 5G is seeing wider adoption in manufacturing, logistics, and other scenarios. With the evolution of 5G standards and protocols and the improvement of the modular device industry, 5G will become the engine that drives the digital transformation of all industries and the development of the digital economy. ▬▬▬
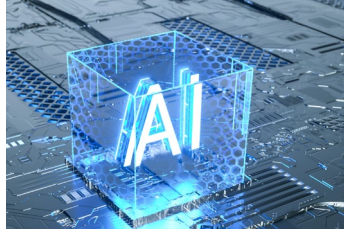
Shenzhen
is getting smarter

Life for Shenzhen residents is changing as the South China economic giant transitions into a smart city with improved public services, urban governance, and increasingly widespread digital technologies.

By People's Daily

I n the Shenzhen Government Management and Service Command Center, an HD LED screen displays a constant scroll of updates on 14 smart city projects that are reshaping various aspects of city life, including economic development, environmental management, government services, and urban governance.

Fine-grained management: Building a digital foundation for the smart city

Shenzhen is one of the first pilot smart cities of China. In 2018, the city issued the New-Style Smart City Development Plan, laying out a coordinated approach for its transition into a smart city.

"At the Shenzhen Government Management and Service Command Center, we're building a proactive, precise, comprehensive, and intelligent government management and service system, and using data to drive fine-grained, scientific, and intelligent city management services," said Chen Chaoxiang, Deputy Inspector of Government Services and Data Management Bureau of Shenzhen Municipality.

Established by Shenzhen municipal government and Huawei, this center is a smart city operation command hub that's able to see, use, think, and coordinate. To date, the center has accessed 82 systems across the city and converged 100 types of service data and over 380,000 surveillance videos from various government departments. This has helped the center build more than 200 level-1 indicators for monitoring the vital signs of the city, transforming experience-based urban governance into scientific governance.

A 360-degree view

An employee presses a button and brings up the transparent kitchen surveillance system on the screen. A warning message flashes up, informing center staff that at 14:55 in a restaurant of Luohu District, a cook wasn't wearing work

"Shenzhen citizens can access most government departments from one device and handle over 7,700 different types of approval and public service transactions using the mobile government service platform, iShenzhen.

clothes and a dustbin was missing a lid. This system uses computer vision for the remote, real-time monitoring of restaurant kitchens, guaranteeing food safety for consumers. The employee proceeds to toggle through some other systems: We see images of Shenzhen's roads, beaches, and ports, all displayed in real time.

"The center can offer a 360-degree view of Shenzhen," says Yang Feng, head of Government Service Data Management Division of Shenzhen Government Services and Data Management Bureau. "By visualizing key indicators of the city's operations, the center provides insights into city operations from the macro, mid-scale, and micro perspectives, and promptly detects risks to support the local government's decision-making with data."

The center is a command center that assigns incident-handling tasks. In the first half of this year, the government held several pandemic prevention and control meetings and assigned tasks in the center.

According to Chen, the large screen is supported by small and medium-sized screens so that staff

can check the city's operation status anytime, anywhere. The smart government service system makes public services more efficient. Thanks to HUAWEI CLOUD solutions, Shenzhen citizens can access most government departments from one device and handle over 7,700 different types of approval and public service transactions using the mobile government service platform, iShenzhen.

More convenient transportation: Creating an intelligent and comprehensive transportation system

Shenzhen resident Li Bin finds that travel is now much easier than before, citing the facial recognition system deployed at Shenzhen International Airport last year. Made possible by Huawei's digital transformation solutions, the airport provides scenario-specific solutions for operations control, security, and services. The airport needs only one map for operations and one network for security. From check-in to boarding, passengers need to present their passports only once.

The airport uses Huawei's AI platforms to collect, analyze, and measure massive amounts of data, increasing the ratio of on-time departures of flights to 88 percent. With intelligent gate assignment powered by algorithms, 4 million fewer passengers per year have to take a shuttle bus to board a flight, guaranteeing a better travel experience.

On trips within the city, the intelligent transportation system also saves Li time. During peak hours, the traffic management department uses the command platform to monitor roads in real time, and remotely controls traffic lights based on traffic conditions. Shenzhen Traffic Police worked with Huawei to launch the AI-assisted off-site law enforcement solution, which uses AI image analysis to identify traffic violations.

Shenzhen's recently-opened metro Line 6 and Line 10 became the city's first metro lines with 5G coverage. The 5G networks provide technical support for the operation management of the metro system and at the same time create a new travel experience for citizens.

Shenzhen is advancing a range of major projects

that are vital to a comprehensive transportation system, covering both intercity transportation, such as roads, railways, airports, and ports, and intracity transportation, including buses and subways. Built on Huawei's technology, Shenzhen's smart transportation project is taking a top-down approach to establishing an intelligent, effective transportation system that utilizes video cloud, big data, and AI.

Smarter campus: Rolling out Wi-Fi 6 campus networks

The University Town of Shenzhen (UTSZ) teamed up with Huawei to launch Wi-Fi 6 wireless campus networks. As part of their partnership, Huawei provided an industry-leading one-stop management center, which uses AC controllers, CampusInsight, CIS, and other core components for automated network deployment across UTSZ.

"Having Wi-Fi 6 technology across the university town has greatly benefited the work, study, and lives of everyone here, teachers and students alike," said Liu Ying, Director of UTSZ's

> With Wi-Fi 6, 1,000-seat auditoriums can provide network coverage and mobile data, even when filled to capacity, and support high-quality video streaming and Internet access.

Management Office.

With Wi-Fi 6, 1,000-seat auditoriums can provide network coverage and mobile data, even when filled to capacity, and support high-quality video streaming and Internet access. In classrooms, teachers can interact remotely with students through video or appear in class virtually using VR technology. Wi-Fi 6 also helps locate valuable assets in labs to ensure equipment security, and works with intelligent trolleys in the library to automatically keep track of books.

In addition to upgrading its wireless campus networks, UTSZ has increased the bandwidth of wired campus networks to 10 Gbps and backbone networks to 100 Gbps. That means UTSZ has established a high-performance physical network for several dedicated virtual networks covering dorm life, teaching, scientific research, safety protection, and the Internet of Things. According to Liu, digital technology has increased teacher-student interaction by 40 percent and research simulation efficiency by 30 percent. At the same time, 60 percent fewer O&M staff are required and energy consumption has been cut by 30 percent.

Using Huawei's safe campus solutions, data from 139 kindergartens and over 5,000 cameras in Luohu District is sent to Shenzhen Municipal Education Bureau. To ensure the safety of children, these cameras are connected to the smart campus safety operations and control platform and the district education bureau platform.

Easier healthcare services: Improving quality of life

Shenzhen Third People's Hospital was the designated referral hospital for COVID-19 patients in the city. Liu Lei, the head of the hospital, says that Zhong Nanshan, academician from the Chinese Academy of Engineering, visited the hospital while he was researching the virus after the outbreak of the epidemic. Since then, Liu has been in numerous meetings with Zhong and many other experts to discuss the latest developments and explore possible response plans using a Huawei teleconference system.

Shenzhen actively promoted Internet+ healthcare services in the fight against COVID-19, said Luo Lexuan, Director of Shenzhen Municipal Health Commission. Many hospitals in Shenzhen can now provide online consulting services and 22 have obtained an Internet hospital license to provide further consultation services for common and chronic diseases. The Shenzhen government also encourages the development of personalized services like online drug deliveries, Internet+ medical care, and online home doctors, giving citizens faster and easier access to medical services without leaving their homes.

Shenzhen Municipal Health Commission has worked to optimize both medical hardware and software over recent years. In addition to building an information-based healthcare system and Internet hospitals, the Commission also provided smart healthcare services to residents and promoted the application of health QR codes in medical institutions across the city. These efforts significantly reduce the time it takes residents to see a doctor.

Different hospitals and community health service centers share medical examination and imaging results, so that residents don't need to go back and forth between different institutions.

Huazhong University of Science and Technology Union Shenzhen Hospital launched a 3D medical imaging system powered by Huawei's ICT infrastructure, helping doctors to clearly explain health status to patients.

A total of 89 community health service centers and five hospitals in Shenzhen's Nanshan district can now share data about doctors and patients, make referrals, share test results, and conduct remote expert consultations.

Despite being a young city, Shenzhen is a pioneer in building smart cities. "Huawei is based in Shenzhen and will continue to move forward with the city in building a smart Shenzhen with a digital government, economy, and society," said Peng Zhongyang, Huawei Director and President of Enterprise BG. "Huawei aims to help Shenzhen become a model of new-style smart cities, and a benchmark for modern cities."

Digital FIRST for health & education in
Ningxia

China Telecom Ningxia and Huawei have integrated industry applications, cloud, and network resources in "FIRST" private networks for governments and enterprises, providing richer, more personalized digital services.

By Qian Bin and Tian Hui

n July 2018, China's National Health Commission officially approved Ningxia's plan for building an inclusive Internet + Healthcare demo zone by 2020. To improve healthcare experiences and home health management services, the aim was to unify private information networks and build a telemedicine network from the village level right up to the regional level. To do so, the project included consolidating connections, building a big data center and regional medical center, and constructing the following five platforms:

- National health information
- Online medical platform
- Online diagnosis
- Online pharma platform
- Online operations oversight

Also in July 2018, Ningxia got the green light to build the first Internet + Education demo zone in China. Scheduled for 2022, the project will make the region a leader in areas like sharing education resources, creating a model that can be replicated nationwide.

The principle for these FIRST networks are Fast delivery, Intelligent bandwidth, Reliability, Security, and Time latency.

Healthcare needs interconnectivity and education needs bandwidth

Healthcare and education are the dual pillars of a prosperous, well-functioning society. In both sectors, digitalization is now in full swing. These are also two areas that carriers are prioritizing for B2B, which in turn require new interconnection models to ensure a smooth user experience.

Interconnectivity for health

To enable information exchanges between the urban medical alliances and county medical communities in Ningxia, hospitals need to migrate to cloud and interconnections must be established between different medical institutions. A county-level medical community is led by a tier-one county-level hospital, which links with township health centers and village clinics in a hub-and-spoke network.

Urban medical alliances are led by a leading public hospital, which connects with county hospitals also in a hub-and-spoke network. County and city hospitals may also need to connect with each other via a mesh network to support the telemedicine needs of different urban medical alliances.

However, county and city hospitals under an urban medical alliance are still independent entities for which linked IP addresses may not fall within the same network segment. As the weakest link in the entire medical system, primary care hospitals need remote robots, digital ICUs, managed care services

> " The healthcare sector won't benefit from a host of independent private networks – it needs an interconnected private network. The education sector needs a large WAN egress bandwidth where 1 Gbps is a common standard. "

in wards, bedside consultation services, and remote managed care services. However, interconnections between township health centers and village clinics are poor and cannot support such services. If they moved to the cloud or networked via a passive optical network (PON), congestion on an Internet egress could easily occur. This would slow down service provisioning and may create a poor user experience in rural areas where wait times could be as long as 10 seconds.

The healthcare sector won't benefit from a host of independent private networks – it needs an interconnected private network. User experience would benefit greatly if township health centers and village clinics access the Internet and cloud through a wide private network.

Bandwidth for education

Education digitalization in China is heading towards its 2.0 iteration. It aims to make teaching applications available to all teachers, make learning applications available to all school-age children, enable all schools to go digital, boost the digitalization and information literacy of teachers and students, and build up a

broad Internet + Education platform.

The education sector needs a large WAN egress bandwidth where 1 Gbps is a common standard. In the Ningxia education demonstration zone, China Telecom Ningxia has proposed the construction of a 10-Gigabit Ethernet campus network. Considering requirements for high bandwidth, China Telecom Ningxia hopes that traffic can be diverted to the shortest route locally, without going to the provincial core network.

Private school networks are moving from PON with asymmetric bandwidth to STN with symmetric bandwidth. Schools and education bureaus generally agree that the former is a better choice. To make the interactive classrooms in Education Informatization 2.0 reality, schools need to connect with each other. That means each classroom generally needs to have three cameras. Ningxia is also piloting VR classrooms, which require very low latency in network transmission and the diversion of traffic to the shortest route. Schools are expected to connect with each other via both a mesh network and private networks.

As a demo zone for Internet + Healthcare and Internet + Education, Ningxia is committed to intelligent networks, intelligent operations, and a service ecosystem that will provide customers in education with 2,431 cloud access points and healthcare with 2,921 cloud access points. Industry applications like telemedicine, distance education, and video surveillance require carriers to have fast full-mesh connections between different access points and to provide secure, reliable, high-quality private networks.

To connect city hospitals and county hospitals, service channels must be established in a few days. Medical institutions, including small clinics and larger hospitals, need to increase access speed to between 100 Mbps and 1 Gbps. To ensure that bandwidth can handle emergencies, the network latency for migrating the core medical system to the cloud, as well as using services of the Picture Archiving and Communication System (PACS) and Hospital Information System (HIS), must be kept under 10 ms.

Private industry networks for differentiated digital services

Facing the new challenges brought by new services, China Telecom Ningxia launched an integrated ICT solution based on STN networking technology for governments and enterprises in April 2020. This solution has implemented China Telecom Group's concept for FIRST private networks and integrated industry applications, cloud, and network resources. China Telecom Ningxia used Huawei's intelligent private line solution, iMaster network cloud engine (NCE) and end-to-end physical

isolation, to build high-quality FIRST private networks for government and enterprise users. These private networks meet needs for fast service provisioning, rapid service response, security, and reliability.

The FIRST private industry network offers the following three advantages:

Flexible networking and fast interconnection: The private industry network spans the region, cities, counties, townships, and villages, and is also connected to the Ningxia e-government resource pool. Users can quickly access multiple clouds at speeds reaching 10 Gbps in the autonomous region, and have access to fast networking and cloud migration.

Secure service isolation and committed SLAs: This solution has the smallest hard pipe in the industry. Different services can be carried through different pipes. Exclusive pipes are used for critical services with high SLA requirements, such as telemedicine and remote monitoring, whereas common office services, such as Internet browsing and email, share a pipe. Different pipes are physically isolated, so that even when other pipes are congested, services in exclusive pipes aren't affected. This can help

> **FIRST private networks embedded with Huawei's intelligent private line solution can meet industry customers' requirements for high bandwidth, high reliability, and secure isolation.**

ensure stable bandwidth and low latency for critical services, delivering an optimal experience for users.

Automated services and intelligent O&M: NCE is used to automate management throughout the entire network lifecycle. With automatic service provisioning, private line services can be provisioned in minutes and bandwidth can be flexibly adjusted in seconds. With in-situ flow information telemetry (iFIT), customers can monitor service performance in real time and locate faults within minutes. Network availability exceeds 99.99 percent, meeting customer requirements for high reliability.

FIRST private networks embedded with Huawei's intelligent private line solution can meet industry customers' requirements for high bandwidth, high reliability, and secure isolation, in addition to supporting agile service provisioning, automatic speed adjustment via mobile apps, and visualized O&M.

In the traditional private line market, carriers offer similar solutions and mainly provide fixed bandwidth for governments and enterprises. However, FIRST private networks for healthcare and education by China Telecom Ningxia streamline the entire process vertically and provide multiple one-stop services, including service handling, provisioning, charging, and operations. These private networks help strengthen the foundation for the Digital Ningxia portal. Network capabilities are now provided as services, and value-added features, such as self-service provisioning, on-demand bandwidth selection, SLA visualization, and private networks, are provided for end users. This has reshaped the business model of private networks to better meet customer needs for differentiated network services.

Moving forward, China Telecom Ningxia will continue partnering with Huawei to build private lines for governments and enterprises that deliver better quality, faster services, and cloud-network synergy. The two parties will continuously optimize product types and enrich their offerings to provide diversified and differentiated digital services for different scenarios. ▪▪▪

A seismic shift

in the value of Earth data

Precision is everything in oil and gas exploration. However, traditional systems for data processing no longer meet business requirements due to inefficient processing of seismic data. In response, Sinopec Geophysical Research Institute (SGRI) developed a converged and shared seismic data resource pool based on Huawei's OceanStor Mass Storage.

By Wang Yongbo, senior high-performance computing expert, Sinopec Geophysical Research Institute

> The oil and gas industry has found itself at the forefront of high performance computing (HPC) application and innovation, identifying ways HPC can be used to find more oil layers and provide greater accuracy for locating wells.

With the global consumption of oil increasing each year, the oil and gas industry has found itself at the forefront of high performance computing (HPC) application and innovation, identifying ways HPC can be used to find more oil layers and provide greater accuracy for locating wells.

The oil and gas exploration workflow

There are three steps in oil and gas exploration: collecting seismic data in the field, processing that data, and interpreting it.

Field data collection

At this stage, electromagnetic and gravitational technologies are key. Usually, artificial earthquakes – created through manual blasting or seismic vibrators – are used to generate seismic waves. These seismic waves that emanate from underground are then transformed into field data.

Seismic data processing

This process uses HPC for seismic signal processing and generates seismic datasets that reflect underground geological features.

Seismic data interpretation

First, technicians analyze and examine data to find possible oil and gas reservoirs and provide suggestions for well location. After the seismic data is interpreted, geologists can determine the location and size of the oil and gas reservoirs, whether they're worth extracting, and where to drill wells based on the generated geological map.

Bottlenecks in oil and gas exploration

Oil and gas exploration is like performing a CT scan of the Earth. Collecting more data and processing it using more refined techniques provides greater accuracy of the geological structures deep below the Earth's surface. This increases the chance of finding oil.

Oil and gas reservoir exploration data has the following characteristics:

First, the volume of seismic data is huge. A

raw seismic dataset is usually dozens of TB in size and can even reach PBs, there are many intermediate steps during data processing, and a huge amount of temporary files and intermediate data are generated. Therefore, a single processing task takes up 10 times more storage space than raw data alone.

Second, seismic data processing involves multiple processes and frequent I/O operations. Processing seismic data just once involves dozens of steps – ignoring possible iterations – and up to 400 software modules. During operations, these modules must frequently exchange data, which puts great pressure on built-in disks and external storage to perform read and write tasks.

Third, processing seismic data involves immense computation and lengthy processes. In addition to consecutive processing, parallel processing also takes place in many compute-intensive scenarios. A single computing task usually involves weeks of uninterrupted computing, requiring extremely high reliability.

With the higher level of precision in data acquisition in recent years, problems with traditional data processing systems are increasingly obvious. The first is that separate systems create multiple data silos. As data needs to be repeatedly copied between different computing clusters, overall data processing efficiency is negatively affected. Second, resource isolation leads to insufficient data sharing and low resource utilization. In addition, I/O processing capabilities are fast becoming a bottleneck in that CPU waiting times keep increasing and computing power cannot be fully utilized.

Data processing based on distributed architecture

To address the above challenges, SGRI teamed up with Huawei to develop a converged and shared seismic data resource pool based on Huawei's OceanStor Mass Storage solution, resulting in a more efficient and cost-effective data analysis and processing platform.

The storage layer is critical to seismic data processing, because computing speeds are

> SGRI teamed up with Huawei to develop a converged and shared seismic data resource pool based on Huawei's OceanStor Mass Storage solution.

much higher than the read and write speeds of disks. In SGRI's case, data migration and conversion takes up more than 35 percent of the time needed to process seismic data. Therefore, storage solutions that feature high bandwidth and low latency are key to improving exploration efficiency.

Huawei's OceanStor Mass Storage can do just that. Featuring large bandwidth and low latency, OceanStor Mass Storage greatly reduces I/O waiting time and improves the parallel processing efficiency of computing cluster CPUs. With CPU usage holding stable at over 60 percent, data analysis is over 16-percent faster.

Powered by decentralized architecture, OceanStor Mass Storage reduces the number of cabinets by 40 percent and TCO by 30 percent by integrating and sharing storage resources. This allows it to meet data expansion requirements for the next 5 to 10 years.

OceanStor Mass Storage adopts the N + M

elastic EC data protection mode. "N" indicates the number of data fragments and "M" indicates the number of parity fragments. This protects data against simultaneous failures of M storage nodes and supports automatic data-shrinking, boosting data reliability and providing sustained assurance for lengthy periods of seismic data processing.

Oil and gas exploration is now a testing ground for emerging technologies, and seismic exploration data has obvious big data features. As stream and non-stream processing and structured, semi-structured, and unstructured data are used, the oil and gas industry is an ideal field for trialing new technologies.

Moving forward, big data and AI will become more widely used in the energy exploration sector to optimize exploration efficiency. Continuous data refinement and algorithm training can improve forecasts relating to oil layers, well positions, and reserves, catapulting oil and gas exploration into a new era.

IPv6+

Boosting the value of IP network infrastructure

On November 26, 2019, the world's 4.3 billion IPv4 addresses were officially exhausted. Not only has IPv6 solved this problem permanently, but the technologies driving IPv6+ are opening up a whole new panorama of innovation.

Latif Ladid, Founder and President, IPv6 Forum

> When you're on IPv4, you're in economy class. If you're using NAT, then you're in the luggage hold. If you're on IPv6, you're in business class. But when you're on IPv6+, like SRv6, you've been upgraded to first class.

Due to the public health crisis that's spanned 2020, we're becoming accustomed to new application scenarios such as video conferencing, collaborative office, wireless projection, and robot-based services. New infrastructure deployments involving 5G, artificial intelligence, cloud computing, and industrial Internet are also on the rise.

These changes are posing higher requirements on IP networks.

- **Massive connections:** On November 26, 2019, the world's 4.3 billion IPv4 addresses were officially exhausted. However, the booming growth of 5G, cloud, and IoT means that the number of global IoT connections will hit a predicted 27 billion by 2025. In general, the number of communication connections will continue to grow explosively, taking us into the era of massive connections.

- **High-quality connections:** 5G is the starting point for people to shift their focus from personal entertainment to a fully connected society. Emerging services, such as VR education, smart healthcare, smart grids, enterprise cloudification, and autonomous vehicles, require low latency, large bandwidth, high mobility, and high-quality connections.

- **Swift provisioning of connections:** With the increasing adoption of cloud, many types of enterprises will migrate from local platforms to cloud. The service provisioning time ranges from 6 to 12 months to hourly, and so we need to provide a quick deployment method.

With a huge address space of 340 trillion trillion trillion, IPv6 solves the IP address shortage once and for all. In addition, the IPv6 extension headers functionality greatly improves the scalability and flexibility of packets. The industry's collected wisdom is already seeing IPv6 as the future. IETF IAB stated that, "IETF will stop requiring IPv4 compatibility in new or extended protocols. Future IETF protocol work will then optimize for and depend on IPv6".

IPv6 is a basic ingredient to address current evolution trends and solve the problem of insufficient IP addresses. But that's not all: Emerging services require massive, high-quality, and fast connections. These new services pose higher requirements on network automation, intelligence, and user experience. To tackle

those requirements, IPv6 needs to combine with other technologies to generate groundbreaking "IPv6+" based networks.

IPv6+ is IPv6 Enhanced Innovation for the 5G and cloud era. It's characterized by protocol innovations such as SRv6 and BIER6, combined with AI capabilities such as network analytics and intelligent tuning. These functions can meet the requirements of path planning, quick service provisioning, SLA assurance, automatic O&M, quality visualization, and application awareness.

IPv6+ powers innovations in business models, which in turn increases revenues and efficiency. For example, in the financial services industry, if a customer uses the traditional MPLS scheme, every node needs to be configured, just like a bus that stops at every bus stop. Upgrading to IPv6+SRv6 can enable automated service provisioning between, for example, bank branches and HQ in one-hop. Like a taxi, it focuses on the destination. No transfer is required, which reduces service provisioning time by 90 percent.

In the healthcare industry, IPv6+ slicing technology can isolate multiple planes on a physical network to carry different types of services and provide dedicated channels for different scenarios like ambulances, CT scans, and office tasks, greatly improving service experience. Operators can transform from selling bandwidth to selling differentiated services, changing their business models and increasing revenues in the process. Through dedicated healthcare channels, for example, patients can receive medical diagnosis and urgent treatment 15 minutes faster. Medical resources can be better shared to improve medical standards.

In a different class

When you're on IPv4, you're in economy class. If you're using NAT, then you're in the luggage hold. If you're on IPv6, you're in business class. But when you're on IPv6+, like SRv6, you've been upgraded to first class.

IPv6+ has gained traction in the research of international standards organizations. ETSI has released the IPv6 Enhanced Innovation whitepaper, and the IPv6 Forum, Huawei, TLF, CT, KPN, POST, and others are working together to set up a new ISG in ETSI. The new ISG will focus on IPv6 enhanced innovations in the context of things like use cases, reference architecture, and best deployment practices.

IPv6+, combined with innovations in business scenarios, is deepening and developing IPv6 into a key basic technology of IP networks for the 5G and cloud era. The accelerated deployment of IPv6 also provides a broad space for IPv6+ technology, networks, and service innovation.

IPv6+ will undoubtedly boost the value of IP network infrastructure. The future of IP networks requires the efforts of the ecosystem chain and you're welcome to join us! ▭▭

HKT B2B

Network service innovations

The story of today's telco is one of transformation and Hong Kong's HKT is no exception. HKT's Peter Lam explains the carrier's business and technology strategies and approach to lowering CAPEX.

Peter Lam, Managing Director of Engineering, HKT

Most of our B2B customers are currently undergoing digital transformation. The demand for high-quality ICT services is growing, creating an entirely new B2B market that's driving telecom operators towards a new phase of development. In view of this, HKT has implemented continuous network service innovations to maintain market leadership.

The B2B market normally includes governments, MNCs, SMEs, and the carrier business, which is characterized by high growth potential and high profit margins. It remains the most competitive market segment and a new growth engine for many telecom operators.

HKT's B2B market ultra-broadband strategy

HKT's ultra-broadband strategy is to move from access and connectivity to content, applications, and transactions.

On the access network side, we actively rolled out territory-wide fiber coverage, including FTTO to support mission critical applications in the B2B market, to capture business growth opportunities with high-speed broadband.

On the core network side, we've leveraged the tremendous traffic usage stimulated by our extensive fiber coverage in the access network to build a high-capacity core network in a cost-effective way. We provide a full range of cloud-based applications to meet emerging business needs, with a robust SLA that's one of the key differentiations from our competitors.

For our flag-ship Carrier Ethernet data service, HKT is able to commit 100 percent to its SLA thanks to our sophisticated design for network resilience. New applications in cloud are a market trend that's fueling future growth, and we're actively developing new applications to meet emerging B2B market needs.

Extensive fiber coverage and network nodes enable ubiquitous ultra-broadband services

Leveraging our extensive network nodes and territory-wide fiber coverage, HKT can provide ubiquitous ultra-high-speed connectivity with resilience. For some remote areas, it's more

> "We provide a full range of cloud-based applications to meet emerging business needs, with a robust SLA that's one of the key differentiations from our competitors."

economical to serve customers with mobile broadband solutions.

HKT also boasts international network coverage. As a top ten global traffic carrier, we have 125 points of presence across 76 cities utilizing over 60 submarine cable systems.

We're able to provide end-to-end high-bandwidth, low-latency services to local and overseas customers. The high-bandwidth, low-latency services are particularly welcomed by the BFSI customer sectors.

Challenges in the Hong Kong B2B market

Although the penetration of broadband services for individuals and households has hit new levels, we're well aware of the threat posed to traditional broadband services. We predict that the B2B market will be a new growth engine for many telecom operators. Today, typical B2B service requirements cover voice, Internet, data, payments, IoT, video surveillance, Wi-Fi, and securities, and B2B customers' requirements are continually increasing. For ease of operation and cost efficiency, B2B customers normally

require simple connection services to support multiple applications. In addition, they require instant bandwidth upgrades, quick service provisioning, a 100-percent SLA commitment, real-time proactive service performance monitoring, and higher service quality at a lower price point.

Therefore, we need a completely new network design to improve our cost base. And we need our service provisioning and maintenance process review to become more agile, so we can maintain our competitiveness in the market.

A cost effective solution to lower CAPEX

Our analysis shows that for a typical CAPEX investment profile for network infrastructure, core network equipment typically accounts for 7 percent of total CAPEX and that edge network equipment and fiber infrastructure form the bulk of investment in network infrastructure.

Therefore, we've adopted a flexible fiber solution for both B2B and B2C customers to lower CAPEX on fiber infrastructure and access

> *CAPEX for the B2B market can be incremental and we can greatly reduce it by leveraging our large B2C high-speed broadband customer base and Huawei's GPON technology.*

networks. We use direct fiber to serve mission-critical customers such as the police, hospitals, and BFSI customers. CAPEX for the B2B market can be incremental and we can greatly reduce it by leveraging our large B2C high-speed broadband customer base and Huawei's GPON technology.

In April 2020, HKT became the first mobile operator to launch 5G in Hong Kong. Mobile access solutions play an important role in serving the B2B market. For example, it's more cost-effective to deploy a mobile access solution for services that don't use much data.

Mobile access can also be used as an interim solution for voice, data, broadband, and video surveillance when a customer's premises are not yet covered by fiber. Moreover, mobile access is the ideal backup for a fiber solution.

CE 2.0: A multiple services multiple access platform

Our flexible Carrier Ethernet 2.0 network supports multiple services through multiple access platforms to achieve high cost efficiency. It can support all of our B2B services such as

data line, Internet, Wi-Fi, Enterprise Centrex, and 5G mobile backhaul services, whether they're served by direct fiber, PON or DSL. This greatly expands our service coverage and flexibility to better serve our existing B2B customers. More importantly, it's a secret weapon through which we can attack our competitors' customer base.

B2B customers are always looking for dual carrier service diversity. And for good reason – they have a tendency to put some of their connectivity services in the hands of our competitors. In view of this, we've built a twin CE 2.0 network, but with different equipment vendors at different site locations, to simulate a virtual competitor's network environment. This provides a three-level resilience solution. With the virtual carrier network, we can commit a 100-percent SLA for our CE 2.0 service. The virtual carrier network not only helps to protect our customer base, but also attracts customers away from our competitors.

The virtual dual carrier configuration has helped us win many projects in recent years, especially mission-critical applications in the banking and financial sectors, and emergency services from

the police, fire department, and health authority.

Serving B2B customers with emerging technologies

Most B2B customers are undergoing digital transformation to improve efficiency and become more agile at innovating new services. Our reliable connectivity and managed services create a tailor-made platform for supporting B2B customer business transformation.

We provide customized solutions for different B2B sectors such as finance, insurance, retail, manufacturing, construction, and education by integrating connectivity, CPE, cloud, and security solutions. Emerging technologies are increasingly driving the application of innovative solutions that converge AI, IoT, and cybersecurity. HKT is the major service provider of IoT solutions for Smart Workspace, Smart Campus and Smart Shopping Malls, and we widely apply AI in our B2B applications.

AI-powered video analytics

The smart surveillance camera system is one of HKT's AI-powered video analytics solutions that's helping the government to monitor illegal waste disposal by construction companies. To avoid paying waste disposal charges, some companies dispose of their waste in remote areas without permission from the government. We installed the smart surveillance camera system to provide real-time monitoring in such areas. The images captured by 4-megapixel cameras are processed by a sophisticated video analytics system. The government is instantly notified of suspected incidents, creating an effective and cost-efficient solution to an ongoing problem.

On the flip side, the system is also used as part of smart construction sites, with a whole suite of applications available to improve worker safety and work efficiency. These include location-tracking, asset-tracking, mobile attendance, danger zone alerts, and fleet management. The video analytics system also ensures that site workers wear necessary safety protection equipment such as helmets, reporting any violations instantly.

C-V2X application at Hong Kong Airport

HKT has helped Hong Kong International Airport develop an autonomous driving system for their baggage carts. In the past, a driver needed to drive to and from Sky Pier to the Passenger Terminal through a single-lane bi-direction private road inside the airport. The driver turnover rate was very high because of long hours of tedious work. Moreover, the baggage carts move at a maximum speed of 30 km per hour, occupying the road for so long that they block fire engines from passing – a problem that autonomous driving can solve. Our C-V2X RSU and camera solution is installed at both ends of the road and at the fire station entrance. If a fire engine is in transit, the RSU sends information to the OBU in the baggage cart, which then stops to let the fire engine pass.

As emerging technologies are applied, we will continue to provide groundbreaking services and strong SLAs for our B2B customers.
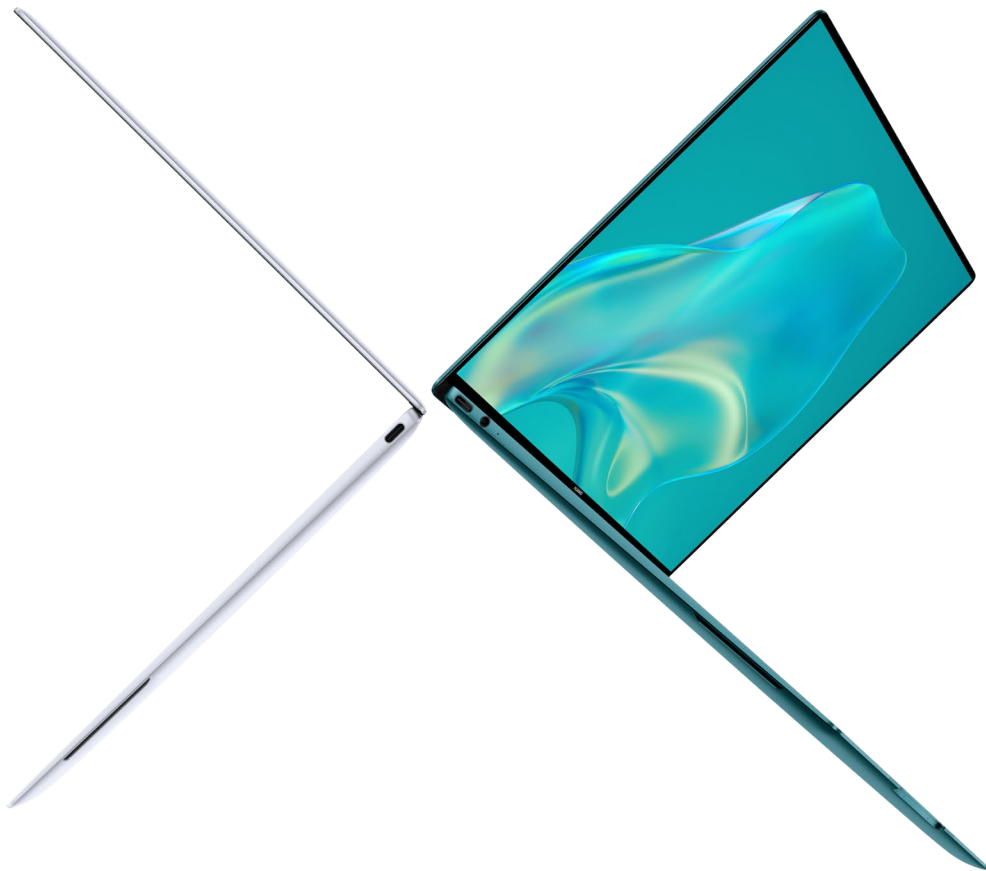
TECH 4 ALL

Let's find new ways to install better education around the world

Make learning more accessible and effective for the disadvantaged – particularly underprivileged children and people living in remote areas – while delivering fundamental ICT skills to potential talents.

Building a Fully Connected, Intelligent World

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