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stc's
Formula for Success: Realising the Potential of 5G Technologies for Enterprises

CSL Mobile's
Unique Strategies to Win Customers

China Unicom's
5G Private Network PLUS Opens Up Blue Ocean for 5G Applications

China Mobile
Enters Golden Period of 5G Industry Applications: 5G Use Cases Grow by Over 100%

APPLICATION ECOSYSTEM CONTACT MANUAL

Global Market | Cooperation Model | Business Development

Boost operators' exploration of new 5G blue ocean
and accelerate 5G business success

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Seize the Moment: Accelerating 5G Prosperity

Since starting its commercial rollout, 5G has experienced tremendous growth. In just three years, it has achieved the progress 4G made in five years, helping carriers enter a positive business cycle.

With Huawei's GUIDE business blueprint, carriers can create their solid foundation for 5G success by focusing on five areas: Gigaverse Initiative, Ultra-automation Speed Up, Intelligent Computing & Network as a Service, Differentiated Experience On-demand, and ESG — More Bits, Less Watts.

5G early movers have already capitalized on the business opportunities of 5G, achieving commercial success by monetizing multiple metrics when connecting people and things, and empowering industrial digitalization.

In terms of connecting people, user experience is becoming a key driver of revenue growth. This is creating new pricing structures based on metrics like speed, latency, and uplink rates. For example, one Thai carrier has designed an experience-centric 5G plan that offers users more service privileges. This has boosted 5G ARPU by over 10%.

Additionally, 5G is driving the rapid development of IoT, creating hundreds of billions of new connections. In addition to connecting people and things, 5G is also empowering industrial digitalization. High-quality connectivity and new services, like leased lines and private networks, are helping carriers expand into the B2B market, giving them a second growth curve.

stc, for example, has worked with industry customers to apply 5G to smart cities, campuses, and ports, offering differentiated experiences. These efforts have transformed stc into a digital service provider with a diversified business portfolio.

Chinese carriers have also offered 5G leased lines and 5G virtual private WANs that are designed for industries requiring wide and high-quality coverage. They also provide local private networks that can guarantee SLAs in scenarios like smart factories, ports, and mines. This has helped Chinese carriers increase 5GtoB revenue by over 200% in 2022.

To achieve commercial success in 5G, carriers will need to grow their 5G user base and increase DoU. A common theme exists among leading carriers: 5G user penetration rate and share of 5G data traffic both exceed 30%.

HKT, for example, offers VR, AR, and 4K content, and 24-bit lossless music services, which increases both their 5G user penetration rate and share of 5G data traffic to 30% in 30 months. These efforts have accelerated their 5G development.

Short-form video apps can also tap into 5G to push videos at higher bit rates and deliver better user experience. For example, China Mobile Hubei optimized network coverage to improve 5G user experience, increasing the proportion of short-form videos at 720p or higher by 6%. This has generated a 5G traffic increase of 12.4%

We can already see three trends clearly unfolding: All connections and services will evolve to 5G, and so will all bands. Huawei is committed to constantly innovating in technology, so that we can help carriers make the most of every band, hertz, and watt. Together with carriers and partners, we've built a prosperous 5G industry. And going forward, we'll keep working hard to help lay the groundwork for 5.5G.

By Li Peng,
Corporate Senior Vice President
President of the Carrier BG
Huawei

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stc's Formula for Success: Realising the Potential of 5G Technologies for Enterprises

By Haithem Alfaraj, Group Chief Technology Officer, stc Group

stc's 5G journey started in 2018, and since then, we have committed to delivering the best experiences in next-generation connectivity to our customers. Powered by a meticulous approach to R&D, strong collaboration with leading vendors, and strategic investment in cutting-edge technologies, we have emerged as a regional and global leader in 5G infrastructure deployment and relevant commercial products.

We pioneered 5G and successfully deployed 5G networks on a larger scale in Saudi Arabia, Bahrain, and Kuwait. As of Q3 2022, we have deployed 7,247 5G towers to serve different gulf communities and support the digital transformation in the region. Our 5G customer base has continued to proliferate in consumer and enterprise segments. Specifically, the consumer business unit has seen a 6.9% growth in revenue as attributed to an 8% increase in mobile revenue and an 18.1% increase in FWA (Fixed Wireless Access) subscribers, demonstrating the overall success of stc's 5G network and supporting technologies and our great value proposition as a network provider.

"By leveraging 5G's speed and latency, as well as the innovative applications empowered by the latest digital technologies, stc enables enterprises to build several use cases to enhance efficiency and security, while reducing the overall costs of running their businesses."

Steering an advanced 5G application strategy

Besides a strong focus on R&D, what makes stc Group the leading network provider in the Kingdom of Saudi Arabia is our dedication to advancing technologies, the focus of our people, and a willingness to learn from different sources. Our team consists of professionals such as academics and engineers who proactively study emerging technologies and incorporate them with industry knowledge and best practices. We also ensure that new solutions, as part of the R&D capabilities, go through a very intensive development process, including field trials, before they are ready.

With an understanding that every new technology capability and service has in the product lifecycle, we engage our partners, study the market, and work closely with customers to identify pain points. Customers view digital transformation or 5G advanced services as a way to solve their business challenges. To facilitate that, we at stc Group need to develop expertise in this domain and maintain a close relationship with them to ensure our solutions meet their needs and expectations. With this customer-centred mindset, we could roll out our access networks based on the latest technologies like massive MIMO on 5G. To promote further research in 5G, AI and beyond, we have researchers specialising in futuristic technologies, including early-stage discussions surrounding 5.5G/6G and how stc Group can contribute to its development.

In addition, we have set up benchmarks being

monitored at the customer level to deliver the expected value. Looking ahead, latency will likely be the future parameter around enabling several advanced use cases of 5G or network services. With that, we have invested heavily in our data centres, especially edge data centres designed to enable several mission-critical applications for our customers to ensure our platforms are capable of superior performance in supporting these applications. We are also committed to building an R&D talent pipeline through stc Academy and strengthening and accelerating our data-driven strategy around AI capabilities to provide best-in-class expertise, services, and solutions to our customers.

Leading strategic partnerships in different industries

stc's vision is to create a reliable platform for the digital economy with leading world-class capabilities to enable and protect critical economic infrastructure in both government and private services. Catering to the growing demand for digital services while fulfilling stc's DARE Strategy, which aims to foster digital transformation, pave new paths for development, and meet the objectives of Saudi Vision 2030, stc's enterprise division has been actively engaged in implementing successful POCs for our customers across multiple verticals, ranging from oil and gas to transportation, ports to logistics, and more.

We were fortunate to launch our service when the Kingdom was preparing for a significant digital transformation and have been working towards developing new subsidiaries and verticals. For example, stc Group initiated several cloud partnerships to boost revenue from enterprise applications. We also formed an IoT subsidiary, "iot squared", and a hosting company. Following a customer-centred strategy, stc Group has evolved from merely a traditional Internet provider to a group of diversified businesses and a full-fledged digital service provider with an extensive service offering.

To better serve our customers and drive industry development, stc Group has collaborated with leading technology vendors to develop different use cases around 5G. Following the footsteps of global operators and industry best practices, we initially started with the non-standalone network. Still, we later took the industry to the next level by moving on to the standalone 5G core, which is crucial for applications like high-speed machines and the ultra-low latency capabilities required in several advanced use cases.

To date, stc Group has developed over 15 advanced services applicable to different industries. We are currently focusing on three major sectors: smart cities, smart campuses, and smart ports. We aim to make smart cities more intelligent and deliver a differentiated experience to our customers. For 5G smart campus networks, we ensure that they are designed for 5G coverage with extremely low latency and the capacity to provide different services on campus. For smart ports, we help to address the unique challenges faced by stakeholders and customers.

Boasting diversified offerings and a strong track record

Our services span many domains, including civilian services, augmented reality-related services, advanced network monitoring, thermal detections, and many more. They are built on the latest technologies like AI, augmented reality, real-time data processing and edge computing. By leveraging 5G's speed and latency and the innovative applications empowered by the latest digital technologies, stc Group enables enterprises to build several use cases to enhance efficiency and security while reducing the overall costs of running their businesses.

The MCIT Smart City Project is a major 5G initiative undertaken by stc Group for the Kingdom. The project aligns with the digital transformation goals of Saudi Vision 2030 and aims to enable smart cities across KSA with 5G applications. It focuses on four key areas of applications: improvement of security, promotion of green environment, enrichment of life through live broadcasting, and enhancement of public service with unmanned vehicles. Leveraging ICT, 5G and AI, as well as massive IoT devices, the project has facilitated use cases, including AI-based CCTV using a 5G camera which has resulted in 50% fewer illegal events as compared to no-camera scenarios; Real-Time Multimedia Communication using 5G embedded body-worn camera which has seen a 40% reduction in use-of-force incidents by police agents; 4K Live Broadcast for cost-effective live broadcasting; remote-controlled smart inspection vehicles accessible via 5G

which necessitates a decreased need for on-site patrols; as well as 5G accessed smart street lamps equipped with lighting management and environment detection to reduce energy consumption by 60% depending on capabilities.

In another major project, stc Group partnered with Huawei to build Dammam's 5G Smart Port. Currently, the project focuses on four use cases: 5G smart CCTV + AI, 5G smart tally, 5G smart RTG crane, and forklift camera. It is built upon stc's smart port integrated management platform with Intelligent Algorithm Service, Video Surveillance, Data Analysis and Security acting as the four pillars. Since enterprise security is a major concern in 5G deployment, this platform provides both application-based encryption and storage security. The Dammam 5G Smart Port has taken the lead in completing several 5G use case verification using the latest technologies, including 5G SA (Stand Alone) and MEC (Multi-access edge computing), demonstrating the value of 5G in meeting the digital requirement of various port business scenarios and changing the game in seaport operations. For example, with the 5G RTG remote control, the overall efficiency of RTG has been improved, and 2 million dollars have been saved for the fully automated port. These 5G applications have enhanced O&M efficiency by 30% and reduced accident risk by 50%.

Safeguarding cyber security on all fronts

Indeed, in light of growing cyber security threats, stc Group believes that security element needs to be addressed on multiple fronts. As digital adoption rises, cloud-based solutions grow, and IoT networks proliferate, the risks are even higher. In response, stc Group established sirar, a subsidiary dedicated to ensuring cyber security for our enterprise customers. We follow a highly robust and mature product life cycle covering all dimensions of cyber security across all levels, whether legacy services, new deployment, cloud or IoT. With 5G networks added to the mix, overall security can be further increased.

As members of multiple standards organisations, we have all the necessary security measures and controls within stc infrastructure to ensure our customers are protected and resilient against threats. Jointly with many enterprises, stc Group has also established a security standard mechanism to ensure network security and enterprise security. We are also continuously developing talent and expertise in different aspects of cyber security, like access control or threat intelligence, constituting a proactive and customer-centred approach towards mitigating attacks.

stc Group is moving steadily to enhance its local and regional leadership and global reputation. In line with its DARE strategy, we aim to realise further growth in digital transformation and other new, unconventional areas. Throughout our 5G journey, we have abided by the principle of always putting our customers' interests first. We believe that this commitment to industry-leading innovation and dedication to our customers will radically transform not only the telecom business but also other industries while driving forward digitisation by enabling automation and smart cities with smart homes, smart parking, AVLs, automatic vehicle locations, and all other applications to bring greater dimension and richness to people's lives – both personally and professionally.

CSL Mobile's Unique Strategies to Win Customers

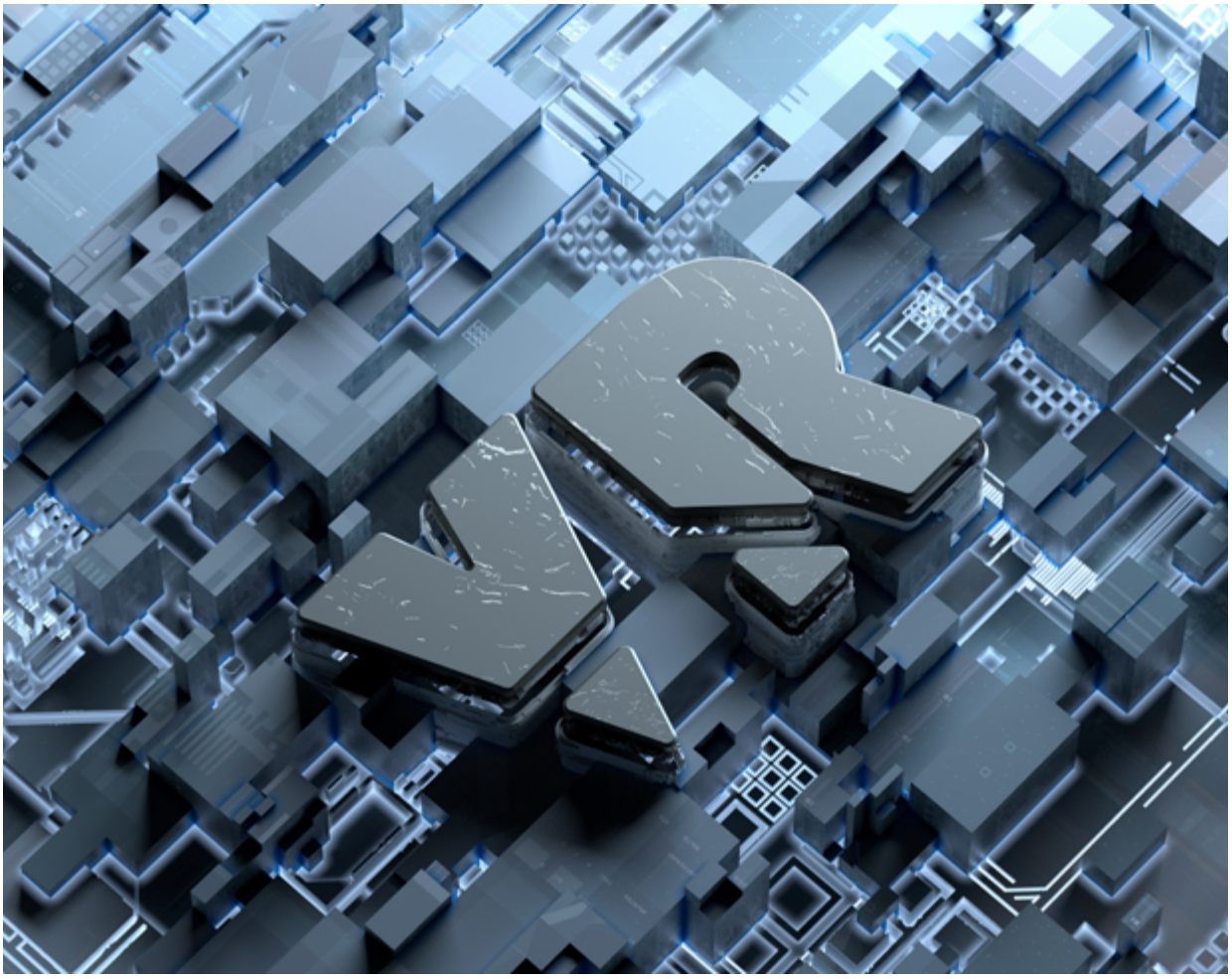
CSL Mobile (CSL), an HKT company, is the first local mobile operator to launch a true 5G network in Hong Kong with differentiated value-added services. With our fast-evolving 5G network backed by extensive spectrum resources across all bands, as well as a robust fiber backhaul infrastructure, CSL strives to offer their customers a competitive 5G portfolio.

By Bruce Lam,
Managing Director, Consumer Mobile, CSL Mobile Limited

CSL has achieved significant commercial success in 5G over the past three years, owing to the growing adoption of 5G services in both the consumer and enterprise segments. As of July 2022, 5G users make up 28% of HKT's total mobile subscribers; the number is expected to grow to 30% by the end of 2022. Moreover, we are leading in terms of 5G traffic, which makes up more than 30% of our total mobile network traffic. This has helped us improve ARPU and drive earlier ROIs from 5G investments, as compared to 4G. Thanks to 5G and fixed broadband, the revenue (excluding mobile handset sales) of our parent company, HKT, grew by 5% to HKD14.87 billion in the first half of 2022.

At the center of this growth is our strong, customer-centric marketing initiatives that focus on building unique brand value and delivering high-quality user experience across all areas, including network and applications. Building on the success of these strategies, HKT's 5G is enabling a positive business cycle across domains. Recently, HKT became the first mobile operator to provide full 5G coverage along all metro lines in Hong Kong.

> At the center of this growth is our strong, customer-centric marketing initiatives that focus on building unique brand value and delivering high-quality user experience across all areas, including network and applications.



CSL's Unique Strategies to Win Customers

CSL adopts a user-driven approach that has taken our customer journey to a new level. For the consumer segment, we leverage our 5G services to deliver a differentiated experience in four focus areas: music, video/TV, VR and AR.

Our music service started in the 3G era and continued to grow during 4G. We have maintained a large number of subscribers who have been with us throughout the journey. With 5G, we aim to elevate their experience. We worked with our music streaming service partner, MOOV, to provide 24-bit FLAC lossless streaming on handsets to offer an excellent music experience on the go. In addition, we have prepared thousands of playlists and invited KOLs and celebrities to share their own to enrich the user journey.

For TV and video, currently we deliver 4K video content, including Netflix, Premier League and all kinds of popular TV and video content from the U.S., China, France, Japan, Korea, Thailand, Taiwan and more. CSL was also the first to launch a 5G multi-angle video concert, delivering a one-of-a-kind perspective for the audience to see their favorite stars.

For VR, we overcame issues with hardware and introduced Pico G2, an ultra-light wireless 4K VR headset. We have on offer some of the most popular VR gaming titles, including Zombie Street, Hostage Rescue, Extreme Challenge, Shooting Range and more. We also provide a range of VR entertainment content such as 4K multi-angle VR sports and K-Pop concerts. We see great potential in our AR/VR apps and will continue to facilitate a 5G ecosystem which will hopefully see further take-up as customers, especially

the younger population, grow more accustomed to 5G.

To continue with the ethos of delivering user-oriented services, CSL wanted to further resonate with consumers. The latest frenzy of Hong Kong boy band MIRROR was just what we needed to bridge this gap. The "csl x MIRROR 5G Campaign" proved to be a popular initiative, designed for more customers to understand and experience AR outside of a one-off event setting. The campaign utilizes the csl. 5G Lens app, which allows CSL to reach customers by having them scan static images printed on campaign cards or outdoor billboards to see the latest videos of MIRROR. Using the app, they can also scan a different image for each calendar month to access secret video messages from different members of the band. In addition, the "csl x MIRROR 5G Campaign" offers collectible cards encrypted with special AR effects, which fans can scan for videos revealing interesting trivia about their favorite MIRROR members. Customers can collect and scan three consecutive AR-enabled cards in a particular order to watch a narrative from MIRROR.

CSL's go-to-market strategy revolves around an understanding of the local market and what customers want. Today, operators work with a zillion bytes of data. The best way to understand what customers really need is by analyzing this data and creating services to match their interests. While adopting new technologies is undoubtedly important, the future hinges on an awareness of what innovations will drive us forward to deliver the right content in a customer-friendly way.

Equally critical to our user-driven approach is our pricing and device strategy. Today, customers are willing to pay for what they want. The upgrade from 4G to 5G has seen users paying HK$70 extra, around 25% more than 4G rates, allowing us to make significant ARPU progress. However, it is important to remember that customers will not pay you more if you cannot provide them with extra value. In terms of device strategy, 5G currently covers most existing devices from different brands, from high-end down to the mid- and low-end; meanwhile, 95% of new phones already support 5G. Terminals are one of the most important factors for 5G success and our device ecosystem is ready.

On the other hand, strengthening the network experience is as crucial as creating the applications. We need to measure network capability in terms of performance and latency to decide whether an application will run smoothly. The thing about networks is that it is a challenge to market their strengths; the marketing of hardware or devices is easier because they are tangible—if we can see the performance, we can sell their features. However, selling the intangible such as spectrum, bandwidth and speed is difficult. People tend to care more about the device they are using than their operator, because the network part is abstract. That is why we need to aspire to continuously improve our network and thus enhance the user experience, so that we can catch users' attention.

The Way Forward

CSL's journey as a digital experience provider has just started. We have diversified our services beyond telecom to serve our customers in more ways than one. For example, we offer premium concierge services, assisting customers in everything from booking golf sessions and tours to making restaurant reservations. Driven by our vision of offering a fully immersive 5G experience, we have established an all-round ecosystem encompassing HKT's enterprise solutions, global interconnectivity, consumer broadband, media & entertainment, and mobile services, integrating several partner ecosystems. We have also incorporated loyalty programs, e-commerce, travel, insurance, big data analytics, FinTech and HealthTech services.

CSL is leveraging emerging technologies such as 5G, cloud computing, Internet of Things (IoT) and Artificial Intelligence (AI) to accelerate the digital transformation of enterprises and contribute to Hong Kong's development into a smart, digital economy. As we move towards the 5.5G era around 2025, we expect more innovations around AI and IoT. We will need to mold our vision to incorporate these trends in our customer strategies, for both consumer and enterprise segments. With a strong foundation integrating primary services such as TV, music, broadband, mobile, fixed line, and enterprise services, we can connect these services using our network, spectrum, fiber and supporting technologies and drive them into the future, as we continue this journey alongside our customers in 5.5G and beyond.

China Unicom's 5G Private Network PLUS Opens Up Blue Ocean for 5G Applications

China Unicom's 5G Private Network PLUS, which is based on the comprehensive 5GtoB network architecture that leverages a centralized cloud and distributed MEC, represents a distinctive path for 5G business growth. To date, China Unicom has delivered 2500 5G private network projects and more than 9000 commercial projects spanning 38 industries, including iron & steel, mining, electric power, education, culture, tourism, and healthcare. Through continuous innovation in 5G applications, the operator has created a virtuous business cycle in 5G private networks.

By Fan Ji'an,
Chief Big Data Scientist, China Unicom

5G Private Network PLUS delivered in more than 9000 commercial projects

Advanced ICT technologies like 5G are propelling us on our journey to the Connectivity of Everything. In China, where the 5G market is maturing rapidly, the Ministry of Industry and Information Technology (MIIT) has even released a "*Set Sail" Action Plan for 5G Applications* to support the development of 5G applications that are poised to unleash further value from 5G networks.

All of this is no surprise given how China's 5GtoB market is already a global leader in four major areas:

1. In terms of applications, China's constantly expanding offerings now range from data collection, AGVs, and AR/VR services to industrial control networks and multi-campus management.

2. In terms of scale, China has now deployed 2.2 million 5G base stations, more than the rest of the world combined. In addition, with the vast number of 5GtoB projects, a broad ecosystem has emerged to support these projects — and countless more.

3. In terms of solutions, the 5G network capabilities offered by Chinese carriers are edging increasingly closer to the proposed targets of 5G-Advanced, including ultra-large uplink bandwidth, ultra-low latency, super-high reliability, and high-precision positioning.

4. In terms of business value, the market created by 5G in China has proven that consumers, industry customers, equipment suppliers, and ecosystem partners all benefit from 5G industry development.

In the local 5GtoB market, a perfect example of the advanced services being offered is China Unicom's 5G Private Network PLUS, which is designed for industrial customers. To date, China Unicom has delivered 5G Private Network PLUS in 2500 5G private network projects and in excess of 9000 commercial projects spanning 38 industries, including iron & steel, mining, electric power, education, culture, tourism, and healthcare. The company has partnered with customers like BMW, Schneider Electric, Midea, State Grid, and Hainan Provincial Health Commission to build even more pioneering 5GtoB applications.

Industrial Internet services based on 5G are rapidly becoming a major driver of China Unicom's revenue growth. In the first half of 2022, China Unicom's

revenue from innovative industry services increased by 22.9%. Meanwhile, government and enterprise services accounted for 72% of the company's revenue growth, and its cloud service revenue doubled.

A network architecture that enables a virtuous business cycle

When China Unicom moved into the 5GtoB market, it decided to focus on industrial digital transformation. This paved the way for the 5G Private Network PLUS solution.

5G Private Network PLUS is designed for industry customers, and has already seen large-scale deployment. Its network architecture uses a dedicated, unified 5G core (5GC) cloud for B2B services and supports unified management, orchestration, and O&M for the entire network. This makes network management much more efficient and agile for customers. The 5G Private Network PLUS solution owes its unique success to the comprehensive 5GtoB network architecture that leverages a centralized cloud and distributed MEC.

The unique value of this architecture lies in its ability to enable quick network deployment and service rollout, while still delivering high levels of security and reliability. This architecture also enables customers to benefit from new features, like 5G positioning, 5G LAN, and VPN roaming, three to six months earlier than the competition.

China Unicom's other offerings include industrial application-based baseline network solutions and network configuration templates that support large-scale delivery of 5G private networks and enable automated network upgrade, slice provisioning in just days, and MEC provisioning in a matter of minutes. The result is agile service rollout.

China Unicom has upgraded its 5G application store and 5G private network operation platform to make all of these services available within China through one-stop service subscriptions.

The multidimensional 5GtoB network architecture of one centralized cloud and one distributed network gives China Unicom's 5G Private Network PLUS differentiated competitive advantages such as quick network deployment and service provisioning, as well as higher security and reliability. It is also the key to 5G applications' quality innovation, efficient expansion nationwide, and realization of business value.

China's first use of URLLC for automotive manufacturing networks

Looking to the future, China Unicom cannot wait to offer customers even more exciting new solutions. As 5G evolves towards 5G-Advanced, it will further support industrial digitalization by offering an even stronger network infrastructure that delivers lower latency, stronger sensing capabilities, and larger uplink capacities. Indeed, 5G-Advanced will deliver 10 times higher uplink capacity than 5G, 4 ms or lower air interface delay, sub-meter-level positioning accuracy, integrated communication and sensing, and intrinsic intelligence.

China Unicom has already begun research into new capabilities for 5G-Advanced and their applications, with a focus on three specific areas: new visual experiences, large uplink capacity, and intelligent sensing. It has incubated new applications — such as smart manufacturing based on flexible production lines and power grid management based on low-altitude drones — to address problems encountered by industry customers.

These innovations can also be seen in 5G Private Network PLUS. After learning about the functionality and performance of 5G applications, many industry customers want to further apply innovative 5G technologies. For example, after replacing the PLC northbound industrial Ethernet with a 5G LAN, one customer decided to also replace the PLC southbound industrial bus to realize wireless control to IO (C2IO).

After more than a year of exploration, China Unicom, together with Great Wall Precision and Huawei, carried out a benchmark industrial joint innovation project, becoming the first in China to apply the ultra-reliable low-latency communication (URLLC) capabilities

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The multidimensional 5GtoB network architecture of one centralized cloud and one distributed network gives China Unicom's 5G Private Network PLUS differentiated competitive advantages such as quick network deployment and service provisioning, as well as higher security and reliability. It is also the key to 5G applications' quality innovation, efficient expansion nationwide, and realization of business value.

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proposed for 5G-Advanced to an automotive manufacturing OT onsite network. In this project, China Unicom verified the 4 ms wireless air interface latency and 99.999% reliability — additional capabilities proposed for 5G-Advanced — reducing line loss, downtime, and commissioning time to enable quick service rollout.

China Unicom also worked with the State Grid in Jiaxing, Zhejiang Province, becoming the first to verify the application of integrated sensing and communication for providing protection against illegal drone flights. Base stations with this feature can collect data such as drone locations, angles, and speeds to support the continuous management of drone movement trajectories. This reduces the risk of power grid failures caused by unauthorized drones.

In addition, China Unicom has commercially launched a 5G-based high-precision positioning application for vehicle management in factories, which is already being used by Midea and BMW.

In the future, China Unicom plans to press on with its efforts in emerging areas like 5G-enabled fully connected factories, XR services, and Internet of Vehicles (IoV). In this regard, we are working closely with partners on 5G-Advanced innovation to develop new capabilities.

Improvements in both quality and quantity

China Unicom's efforts in 5G private network have been fruitful, thanks to the focus on R&D into innovative 5G private network technologies. One major achievement was the 5G Private Network PLUS solution, which was officially launched in December 2021. Soon after, in February 2022, the extended 5G Private Network PLUS product series was launched at MWC Barcelona, including private networks for edge interconnection, highly-reliable campus networks, and customized network slicing. And finally, in May 2022, China Unicom launched the 5G Free-Mobility Private Network solution and the 5G Private Network for Multiple Campuses solution.

In less than a year since the initial launch of the 5G Private Network PLUS, China Unicom successfully improved both the quality and quantity of industrial private network services, as well as replicating many innovative 5G applications across China.

Beyond that, China Unicom has also been actively contributing to the development of a broader 5G private network ecosystem. With its 5G IoT OpenLab, the company is driving industrial digital transformation by working with a number of industry partners, including the China Academy of Information and Communications Technology (CAICT), the State Grid, Guangdong Provincial Government Service Data Administration, Midea Group, FAW Group, Beijing University of Posts and Telecommunications, and Huawei.

Thanks in no small part to these efforts, China Unicom and Huawei were jointly awarded the Enterprise 5G Leadership Award at the 2022 5G World Summit. Their 5G Capital and Hainan Healthy Island projects were also both winners of the GSMA's GLOMO Awards in 2022.

In addition, China Unicom has continued to ramp up exploration into core technologies like 5G-Advanced and their industrial applications, leading the way in boosting the digital transformation of industries such as manufacturing, power grid, and IoV.

Looking ahead, China Unicom will continue to advance the digital transformation of industries and their 5G applications, and accelerate the upgrade of traditional industries towards digitalization, connectivity, and intelligence.

China Mobile Enters Golden Period of 5G Industry Applications: 5G Use Cases Grow by Over 100%

China Mobile has recently developed an effective approach to speed up its deployment of 5G applications across various industries, processes, and links. This approach has already been successfully replicated on 5G private networks across different industries at scale, implementing more than 15,000 5GtoB use cases to date.

By Yang Peng,
Deputy General Manager of the Industrial Energy Sector Development Dept of the Government & Enterprises Branch of China Mobile Communication Co., Ltd.

China Mobile has entered a golden period of 5G industry applications. In 2022, its 5G use cases more than doubled year-on-year, launching more in one year than in the previous two years combined. What's more, China Mobile launched more use cases for vertical industries in six months than during the whole of 2021.

5G applications have already seen large-scale deployment across different vertical industries. Meanwhile, the large-scale development of 5G private networks has further spurred the development of China Mobile's data and information communication technology (DICT) business, with its DICT business revenue reaching CNY70 billion (a 40.8% year-on-year increase) during the first three quarters of 2022.

> China Mobile also works with industry partners to apply 5G for transforming the real economy with digitalization, connectedness, and intelligence, as well as promoting digital and intelligent production, lifestyles, and social governance.

Leveraging 5G to empower enterprises

Through the large-scale application of 5G in more and more industries, China Mobile has been working hard to integrate 5G into enterprise production and people's everyday lives. These efforts have already received wide acclaim from all kinds of enterprises. Indeed, many enterprises are now convinced that 5G infrastructure will be at the heart of future digital-intelligent transformation. In particular, in the industrial energy sector, 5G has been applied to a great extent by helping to improve quality and efficiency and achieve flexible manufacturing, ultimately creating more value for enterprises. To make this a reality, China Mobile has been focusing on two primary types of applications:

First, applying 5G to accelerate the digitalization of traditional industries and achieve safer production. For example, the 5G-powered smart mining project in the Wotugou coal mine in Inner Mongolia uses a 5G private network to integrate intelligence into coal transport. This means that personnel are no longer needed in key areas like electromechanical chambers, which has led to over 46% fewer workers needing to go down into the mine each day. At the Ningbo-Zhoushan port, workers use 5G to remotely operate port machines from a central office, saving them from scaling gantry cranes to move containers. In this way, a single worker can now remotely operate four gantry cranes, reducing overall workforce requirements while significantly improving work efficiency and safety.

Second, applying 5G to promote the development of emerging industries, driving innovation and upgrade in manufacturing. For example, in its 5G-powered smart factory in Fujian province, CATL has deployed a highly secure 5G private network that connects more than 40 factories across eight cities in six provinces. The company has also used 5G for a host of new applications, such as ultra-high-speed AI-based visual inspections and real-time big data analytics and detection.

China Mobile also works with industry partners to apply 5G for transforming the real economy with digitalization, connectedness, and intelligence, as well as promoting digital and intelligent production, lifestyles, and social governance.

The challenges facing large-scale commercialization of 5G in the B2B market

The comprehensive application of 5G into various industries has propelled 5G private network application and development into a critical stage. Despite the numerous achievements already made, we must be acutely aware that 5G development still faces a series of challenges.

First, a unified and standard engineering service process needs to be developed for 5G projects. During the early implementation of 5G projects, we built many 5GtoB showcases and accumulated important project delivery experience. However, the delivery and operation efficiency of these projects was relatively low because the use cases were highly customized for specific industries. As such, the industry needs to continue exploring and defining a unified engineering service process that can be used to pave the way from 5G showcases to large-scale applications. For example, in 5G smart electricity projects, carriers have to implement network construction and maintenance on live grids. However, the qualifications and construction quotas required for carriers to do this on live grids are different from those in general conditions. This means that carriers and industry enterprises will need to work together to explore more feasible and practical solutions to guide subsequent project implementation.

Second, deterministic 5G private network assurance still needs to be improved to support deployment in more industries. For example, the industrial energy sector has high requirements when it comes to deterministic networking. As 5G industry applications extend from peripheral auxiliary activities to core production activities, enterprise requirements for 5G private networks will continue to increase. Larger bandwidth, lower latency, and wider connectivity will no longer be enough. Instead, higher network stability and reliability will also be needed. Although the industry has already begun to explore deterministic network assurance, we still need to work with other industry customers to promote verification and optimization.

Third, 5G private networks need to be further integrated with existing network technologies. Considering both value customer asset reuse and the convergence of different enterprise elements and processes, in-depth integration of 5G private networks with existing network technologies will be necessary for the further development of industrial networks. We've already made great progress converging 5G with technologies such as Wi-Fi, RFID, and UWB, which will undoubtedly bring significant economic benefits and practical value for customers. However, further integration of new technologies with existing networks calls for active participation of industry and market players, along with professional institutions.

In addition to these three key challenges, common issues to be tackled by the industry include the high price of modules and terminals, incomplete 5G private network services, and difficult monetization due to SMEs' sensitivity to prices. However, we believe these issues will likely be resolved and transformed into 5G development milestones as the industry value chain matures, the B2B and B2C markets converge, and customers gain more confidence in 5G industry applications.

Building a "1+1+1+N" product system to promote 5G and industrial Internet convergence

China Mobile has long been committed to promoting the convergence of 5G and the industrial Internet, as well as building a "1+1+1+N" product system. "1+1+1+N" stands for one type of competitive 5G industrial terminal modules, one good 5G industrial private network, and one strong industrial Internet platform to provide assurance for industrial Internet security on which N 5G application scenarios can be developed.

At the terminal level, China Mobile has already made great efforts to promote the support of industrial terminal modules for protocol standards, as well as to meet the industry value chain's cost reduction needs.

China Mobile has also taken measures to promote the transformation of industrial terminals into devices and the large-scale development of the industry value chain. These measures include centralized procurement of industrial terminals, organizing supply-demand alignment meetings, self-development of terminals in key industries, and other cooperation and introduction efforts.

At the network level, China Mobile has made use of 5G private networks to strengthen support for industrial premises. This has helped ensure deterministic assurance for many services and is allowing 5G to develop from best-effort in B2C settings to deterministic network experience required in B2B settings.

Intrinsically deterministic 5G networks will be the direction of future evolution as such networks can provide enterprises with deterministic uplink bandwidth, latency, and positioning capabilities. In addition, China Mobile will upgrade the connotation, capabilities, and services of 5G private network products to implement one-stop management of 5G private networks. China Mobile will also actively participate in industrial Internet innovation and development projects, and work with enterprises to build high-quality industrial Internet networks.

At the platform level, China Mobile has leveraged its industrial platform to better support the development of specific industries and regions. Based on our previous explorations and experience, we have updated the OnePower platform by integrating 5G with AI, IoT, cloud computing, big data, and edge computing technologies (known as 5G+AICDE) while considering industry customer requirements, industry landscape, and ecosystem capabilities.

At the same time, China Mobile has built dedicated sub-platforms and general-purpose applications for more than 10 fields, including electric power, metallurgy, chemical industry, mining, and manufacturing. We have also built a regional industrial Internet platform to help enterprises in a region migrate to the cloud and enable local governments to accurately implement policies. This platform can also be used to better connect upstream and downstream players across the industry value chain to efficiently promote industry transformation and development.

To date, we have already constructed recursive nodes in nine provinces and deployed level-2 nodes in 16 provinces and cities.

At the application level, China Mobile has made efforts to strengthen the support of industrial applications for typical scenarios. This includes working with multiple leading organizations in industrial, academic, and research fields in order to build more than 30 typical application scenarios and multiple industrial Internet showcases for "5G+" (China Mobile's plan to speed up the integration of 5G into every industry and walk of life), as well as to implement nearly 3000 5G+ industrial Internet projects. At the same time, we have actively promoted the formulation of multiple 5G+ Industrial Internet convergence standards and have continuously expanded 5G applications from peripheral auxiliary activities to core production activities.

At the security level, China Mobile has established a comprehensive 5G+ industrial Internet security assurance system. We have also launched our "One Center + Four Systems" program (one secure OAM center, together with secure technology, management, operation, and ecosystem cooperation systems) to provide comprehensive services ranging from pre-event prevention to in-event monitoring and post-event responses, as well as to meet differentiated requirements of various 5G+ industrial Internet security solutions.

In early September, China's Ministry of Industry and Information Technology issued the Guidelines for Construction of 5G Fully Connected Factories. The Guidelines encourage 10,000 enterprises in China to build 5G fully-connected factories during the period of the 14th Five-Year Plan. To support the construction of fully-connected 5G factories, we have built a comprehensive "1+1+1+N" capability system and deployed the OnePower industrial Internet platform in 26 provinces based on the 5G networks supported by more than 1.25 million 5G base stations and industry-specific 5G private networks.

Going forward, China Mobile is open to working with more ecosystem partners to enhance the service capabilities of "5G fully connected factories" and contribute more to the construction of the 5G+ industrial Internet ecosystem.

The 5G Dynamics: Massive Adoption Drives Massive Monetization Opportunities

5G adoption is rapidly gaining momentum, presenting a tremendous opportunity for further growth over the next decade. Device availability and affordability are key for consumer adoption, with the latest GSMA Intelligence research report — 5G Device Evolution and Outlook — highlighting the 'spark' that will drive both uptake and operator revenues. FWA, for example, is one of the early 5G use case successes, helping operators create new revenues thanks in part to 5G CPEs becoming more abundant and cheaper. At the same time, with 83% of operator CEOs expecting B2B to be the greatest 5G revenue driver, we cannot ignore the role enterprise digital transformation will play.

Based on research from GSMA Intelligence

The 5G journey that started sometime in 2018 with a few initial rollouts has today achieved unprecedented growth. In many high-income countries, 5G penetration has surpassed 50% of the population. Despite the adversity brought by the pandemic and the delays in spectrum auctions in some markets, 5G investments remained undeterred over the past two years. The availability of affordable 5G terminals has triggered an upward trend for 5G in both developed and developing markets alike. Shipments of smartphones and customer premises equipment (CPEs) are growing rapidly worldwide. With growing adoption of industrial 5G, the market for industrial devices will also witness a boom in the coming years.

5G to achieve 5.2 billion connections by 2030

According to GSMA Intelligence Q2 2022 tracker, 219 operators worldwide (excluding regional US and Canadian operators) in 83 markets have already conducted spectrum auctions. It is expected that 642 operators covering 225 markets will launch commercial 5G by the end of 2030. Consequently, 5G adoption is expected to grow from 738 million connections, covering just 9% of the population in Q2 2022, to 2 billion by 2025, and 5.2 billion by 2030. Such a high pace of 5G network rollout is substantially higher that of 3G or 4G. Whereas 5G accounted for more than 5.5% of mobile connections 18 months after its launch, 3G and 4G could not exceed 2.2% penetration during the same interval, a GSMA study found.

Mobile operators across the world are ramping up 5G investments to meet the surging demand from the consumer and enterprise segments in 2022. The network lays the foundation, content and services inspire adoption, and devices facilitate the journey. Given this, there is an urgent need to massively scale 5G infrastructure to spur the adoption across consumer, home, and industrial customer segments. Indeed, network coverage expansion — and therefore service availability — is a contributing factor for driving devices adoption.

5G smartphone trends

Our recent research — 5G device evolution and outlook: the search for a spark — has identified some interesting trends across devices in consumer, home, and enterprise segments. The consumer segment is by far the largest part of the devices market, with smartphones accounting for the vast majority, followed by tablets, dongles, and virtual reality (VR) headsets. The market for smartphones has rebounded from a pandemic-induced fall of 10% in 2020 to a 5% increase in 2021 globally; however, there is significant regional variation and higher growth rates among early-adopter vanguard countries such as South Korea, the US, China, and the UK.

Smartphone pricing has been an important factor driving 5G adoption. Handset pricing in lower income markets has dropped significantly during the past year. While in the US and Europe the average selling price (ASP) dropped by around 5% in 2021, in emerging markets, it dropped by 15-20%, according to Counterpoint Research. Innovative Original Design Manufacturer (ODM) strategies have led to the

availability of smartphones in the sub-USD200 range in markets like China and other East Asian economies. Rather than selling directly to consumers, ODMs here make phones on contract orders either for original equipment manufacturers (OEMs) or for operators as white-label products. The greater manufacturing scale and chipset supply capability in these countries favor such strategies, which pay off well considering that 35-40% of smartphone sales happen directly through operator stores.

Manufacturers of high-end phones are also pursuing innovative strategies to gain market traction. Apple and Samsung occupy the mid and upper ground (USD500+), while a number of Chinese OEMs have positioned their offerings below that, with prices falling further in 2022. The market also witnessed different types of trade-in schemes targeting the high-end phones in the USD500+ range. In the UK, for example, trade-ins account for 15–20% of new handset sales, while this trend can be seen in other markets as well. Other strategies include interest-free financing schemes, which are offered for premium phones, especially from Apple and Samsung. Repayments are made in installments over two to three years.

Technology traction in smartphones

The growing traction of smartphones is also attributed to their underlying technology and feature sets. The higher resolution camera has been a major feature update for almost every manufacturer over the last 10 years. Other smartphone features that today's customers look for include battery life; NSA and SA support; FR1 and FR2; Wi-Fi 6; NR in FDD/TDD; supplemental uplink; eSIM and NR carrier aggregation. Similarly, the processing and mapping capabilities for augmented reality (AR) and VR functionality will turn these devices into anchor points for separate form factors such as glasses and VR headsets. These handsets are also emerging as a conduit to other service and entertainment apps rather than purely staying as a standalone unit. As such, revenue premiums associated with hardware and airtime tariffs will depend on providing these features with a clear 'leap' over what is possible with the currently available options.

5G FWA dynamics and adoption trends

With 5G capable of delivering more than 10x the speed of 4G, 5G Fixed Wireless Access (FWA) is emerging as the most promising home broadband access technology. 5G FWA should see strong household penetration rise between 2021 and 2025. As of Q1 2022, 74 fixed broadband service providers had launched commercial 5G FWA services across 38 countries. Nine countries in developed markets will attain or surpass 10% penetration and form a benchmark for 5G rollout and adoption. Over the next four years, 5G FWA connections are expected to grow by around 90% per year on average across the 52 countries that have either launched or announced a 5G FWA service.

In countries where fiber broadband penetration is high, operators are keen to develop 5G FWA to increase their market share or supplement areas with poor cable/fiber coverage. However, in markets that have low penetration for fixed broadband (such as the Philippines), 5G FWA is perceived as an option to improve connectivity for the unconnected segment. Consequently, such countries will see faster-than-average growth. Also, countries where the fixed broadband technology mix is skewed towards xDSL (e.g., Austria, Bahrain, the Nordics, and Australia) can leverage 5G FWA to upgrade the legacy DSL. Given this, GSMA Intelligence predicts that FWA connection growth will be driven by a combination of new subscribers in greenfield areas (mainly in developing markets) and subscriber migration from xDSL, cable, and FTTH solutions (mainly in developed markets).

CPE innovations to drive 5G FWA economics

Innovations in 5G FWA CPEs will also drive the FWA subscription uptake. Major technical improvements that favor 5G FWA solutions are massive MIMO

(mMIMO), sound reference signal beam selection, and 5G beamforming. The massive MIMO capability brings drastic improvements in throughput and efficiency while also reducing energy efficiency. SRS beam selection allows CPEs to switch between beams for optimized signal reception, whereas 5G beamforming and streamlined installation capability eliminate the need for aerial installation on roofs or outdoor fascia. Along with these, other advancements like Wi-Fi 6, NR carrier aggregation, and O&M for TR069 and TR143 standards will drive the adoption of CPEs.

Driven by these innovations, CPE units can provide 5G FWA with 2.0–3.5 times higher spectral efficiency than 5G mobile broadband (for smartphones) for the next few years in the event they meet criteria such as the immobility of the CPE (situated closer to windows), multi-user pairing and other enhanced technologies. This is important for the economics of the 5G FWA business case as it provides the underpinning for increased asset efficiency and revenues as operators monetize home data usage. GSMA Intelligence analysis suggests that 5G FWA can, under certain infrastructure conditions, bring potential cost savings of up to 80%, 70%, and 45% versus fiber to the premises/building (FTTP/B) in rural, suburban and urban geographies, respectively. These cost savings are valid under the three most common operator 5G FWA deployment scenarios and are based on total cost of ownership (TCO) modelling for Europe, Latin America, and the US.

5G FWA CPE shipment and pricing trends

5G CPE prices are falling fast, actively contributing to 5G FWA rollout. GSMA Intelligence predicts that, by 2023, the average cost of a 5G FWA CPE unit will be just over US$100 and that, by 2024, 5G CPEs will be priced almost on a par with 4G CPEs. Overall FWA CPE shipments are projected to grow at an annual rate of 25% through to 2026. Meanwhile, CPE vendors are rapidly making 5G FWA routers available, pushing down prices. In little over a year, the number of announced devices grew by over 31%, reaching 213 announcements by April 2022, with 120 5G FWA CPE devices commercially available from 72 vendors. Similar trends can be seen in the home FWA segment as well, with connectivity, device availability, and features making a strong impact on the service adoption. With the increased availability of diverse CPE equipment with

support for high-gain antennas, mMIMO, Wi-Fi 6, NR carrier aggregation, and O&M for TR069 and TR143 standards, FWA is set to upscale in the coming days.

Industrial 5G: device adoption trends

Demand for industrial 5G is growing on the premises that 5G, with its ultra-high speed and low latency, will support innovative services such as e-health, connected vehicles, connected cities, real-time gaming, smart homes, and learning through VR and AR. Devices catered to enterprise applications can be categorized in to three: basic connection devices, general devices, specialist devices.

Basic connection devices provide the basic 5G network access. This group includes CPEs, gateways, routers, and dongles for data transfer. This is the most important device category as they are the enablers of 5G applications.

General devices are industrial devices such as cameras, drones, automated guided vehicles (AGVs), or on-board units that are fitted with 5G modules and can be used across many applications and industries. Among these, drones are the most demanding as they require continuous 5G coverage. AGVs and cameras, meanwhile, do not demand large-scale coverage, making them easier to deploy.

Specialized devices are those integrated with 5G modules or dongles. Examples include equipment for underground mining such as shearers and excavators fitted with 5G connectivity for remote control; special 5G cameras adapted for safety or explosion-proof requirements; 5G broadcast backpacks; and 5G medical trolleys. They will take longer to develop and integrate. While the number of such devices that are commercially available is lower than in the consumer segment, the number at the trial and live deployment phases is growing.

With the growing adoption of industrial 5G applications, the price of industrial 5G devices is expected to continue to fall in the coming months. Reduced capability, or RedCap, is expected to be commercialized in 2023, leading to reduced complexity and hence lower power consumption for 5G devices. This will also drive cost efficiency. With the increase in

> Building a good 5G infrastructure network is the prerequisite for 5G terminals to move towards more consumers and services. Shipments of smartphones and customer premises equipment (CPEs) are growing rapidly worldwide. With growing adoption of industrial 5G, the market for industrial devices will also witness a boom in the coming years.

implementation expertise and know-how making 5G applications less onerous and more achievable for SMEs and large enterprises, 5G device-based solutions can effectively become the preferred rather than alternative option. As of May 2022, the number of 5G devices designed for enterprise applications announced totaled 1373 (though not all were commercially available).

Major verticals and use cases of 5G applications

5G applications are being trialed and implemented in several verticals, predominantly in manufacturing, retail & logistics, construction, mining, transport, warehousing, agriculture, and healthcare. The unmanned drones used in agriculture and retail delivery, along with the HD video applications for commercial security, are some of the initial industrial use cases of 5G. Solutions for the different industries can make use of one or multiple 5G applications, as well as one or more 5G device types, whether general or specialist.

Listed below are some of the major trials and deployments across major use cases.

Smart factories

The Huaheng Factory in China is using 5G and Mobile Edge Computing (MEC) to power AGVs for asset tracking and smart warehouse operations in an environment that requires smart vehicles for on-site logistics and operations.

Mining

Pangpangta Coal Mine in Lvliang, Shanxi, China, launched a 5G-supported, smart mining project in 2020, integrating 5G 10-gigabit-class industrial ring networks in two areas of the mine.

Health

The Futian Medical Consortium in Shenzhen, in partnership with China Mobile and Huawei, embarked on a project to establish a private 5G healthcare network and 5G medical terminal R&D.

Ports

In 2020, Zhejiang Seaport Group, China Mobile Zhejiang, Shanghai Zhenhua Heavy Industries (ZPMC), and Huawei signed a strategic cooperation agreement on the Ningbo 5G Smart Port to implement 5G-based smart operations for ports.

Power grid and utilities

In April 2022, Florida Power & Light (FPL) partnered with Percepto to announce the deployment of hundreds of drone-in-a-box (DIB) systems.

Retail and logistics

Manna Drone Delivery in Ireland uses drones to deliver directly from restaurants and supermarkets to consumers' homes in Balbriggan, Dublin.

Environment and wildlife

The National Trust in the UK is leveraging unmanned drones using Beyond Visual Line of Sight (BVLoS) to count the number of seal pups in the Farne Islands, off the Northumberland coast.

What next: scale 5G users and revenue

As 5G adoption is expected to enter the next phase of development among early adopters, it is time to think of the strategies that help scale the adoption across consumer, home, and industrial settings. Ensuring reliable, faster, and secure connectivity is important to spur the adoption of consumer 5G services. Focus on content and service differentiation can lead to increase in network usage and average revenue per user (ARPU). Device affordability is another major factor driving consumer adoption of 5G, as evidenced in markets with competitive pricing strategies. Industrial 5G adoption will be largely driven by the vertical-specific capabilities offered by the service provider. And finally, device diversity is important in driving success across several implementation scenarios.

How will 5G change Europe for the better?

Euronews Debates

The rollout of 5G is gaining traction in Europe, leading many to question how this new generation of mobile technology will change the way Europe lives, works and interacts. The planned successor to 4G mobile networks, the 5G rollout is in process and the infrastructure is being laid out. There are 214 5G networks already live, with the many to be found in China, South Korea and the US.

Providing the fastest connection yet for mobile users, it is crucial that Europe adopts the technology to stay level with global leaders. During the debate, Euronews Science Correspondent Jeremy Wilks asked an expert panel about the ways 5G is being implemented across Europe, how it will benefit European productivity, and the security and energy issues surrounding the technology.

The panel comprised: Laurent Leboucher Chief Technical Officer of Orange, Alex Sinclair Chief Technical Officer of GSMA, Dr. Philip (Xiaodi) Song Chief Marketing Officer Huawei Carrier Business Group.

European 5G coverage is behind markets in China, South Korea and the US, but there has still been significant momentum in the past few years. There are 108 5G networks across 34 markets in Europe already, with a goal of at least one network in each EU market met in 2020.

What are the challenges to European 5G rollout?

One of the key issues halting the uptake of 5G in Europe is the complexity of navigating the breadth of

> Over the past three years, the world's top 20 operators, by the number of the 5G stations, saw an average revenue per user increase by more than 10 per cent.

network carriers across so many distinct states. While China's population is over 1.4 billion people, there are just four major carriers in the country. The comparative ease with which China can politically and commercially navigate 5G rollout is shown by its recent results.

In just three years, there has been incredible growth, Dr Song explains. "By the end of October, more than three million 5G base stations deployed around the world. So over the past three years, the world's top 20 operators, by the number of the 5G stations, saw an average revenue per user increase by more than 10 per cent," Song says.

Increased profits and faster rollout are clearly desirable, then. So what's the picture like in Europe? Leboucher explains that Orange is seeing impressive results with 5G rollout in French urban areas. "User experience is already double what a 4G customer can experience in terms of bandwidth. So it means that in all cases,

it's more than 200 megabits per second in cities," Leboucher says. One issue that's key to progress is the release of spectrum licences. These licences are the permissions given by governments for entities to have exclusive right to a frequency band, essential for setting up a mobile network. Leboucher notes that Poland is yet to grant Orange a spectrum licence, although he expects it to be done very soon.

Another challenge to deployment will be the ability to create a seamless network across the EU. In China, 5G has already allowed for continuous internet network use while travelling, yet it is still a common occurrence for a European train passenger to lose signal as they cross an EU border. Huawei solved the issue in China by deploying multiple smaller base stations along motorways, guaranteeing coverage, explains Dr Song. Leboucher explains that Orange is experimenting in an EU-funded project to create this seamless service handover between the borders of Germany, France, Luxembourg and Belgium. Given this, Leboucher asserts confidently that the EU should hit its 2025 target for widespread 5G coverage

5G, What is it good for?

The debate then turned to the benefits that 5G will bring society when it is fully rolled out. At an individual level, Dr Song noted how 5G has already improved experiences for sports fans worldwide. "An operator in Greece has already launched a new basketball game live streaming service. It offers the 5G preview so it can blend a viewing and interactive experience," Song explains. It is only with the bandwidth capability of a 5G network that a sports event can simultaneously stream multiple camera angles to the thousands of individuals' phones in a packed sports stadium. The technique has

also been utilised at home, Sinclair points out, with Formula One races giving viewers the choice of which camera angle/driver they want to follow the action with. “That's a pretty high capacity demand,” Sinclair notes.

Other home technologies, like virtual reality gaming and the metaverse will also require increased bandwidth for seamless connections. However, it is probably in professional applications that 5G will have the most impact, the experts note.

Improved speed and efficiency of internet services are essential for the running of many major industries, from tech to medical. This will be particularly the case in dangerous industries, requiring remote controlled equipment. “Throughout Africa, 5G now has been deployed in mines to enable remote operation,” Dr Song explains. “This improves working conditions for miners and makes them safer and happier in their work,” he adds. Similarly, Dr Song points out an example in Kuwait, where the oil and gas industry is leveraging 5G’s higher capacity and reliability across 800 kilometres of wells for higher speed safety alarms.

Safety and the environment

Any conversation about mass deployment of 5G has to consider the security and environmental issues of such a widespread technology. Concerns around 5G have abounded since its introduction, ranging from conspiracy theories linking it to the COVID-19 pandemic, to more genuine data security worries.

GSMA's Alex Sinclair notes that despite public caution, "5G is the most secure generation ever produced". This is thanks to features such as the encryption between devices and the network. If there is a security risk, it actually comes from 5G existing alongside previous generations, 2G, 3G and 4G. When 2G was first implemented in the 1990s, the security paradigm that necessitates encryption was not standard. “Some attackers will basically try and take advantage of that by bidding you down. They'll pretend they don't support 5G. So even if you've got a 5G device, they might basically try and force you back to an older technology that would have more weaknesses,” Sinclair explains. From Huawei’s perspective, Dr Song also reassures that they “are working tirelessly to deal with the security and the trustworthiness of quality products.”

Another concern with the increased rollout of 5G is the impact that these networks will have on the environment. Again, Sinclair explains there is less to be worried about than it may seem. Although the amount of data created today is orders of magnitude higher than it was 15 years ago, the amount of energy required for the increased data hasn’t gone up. “That's largely because each successive generation of technology has been much more energy efficient,” Sinclair says. “5G is about 10 times more energy efficient than the 4G network,” Dr Song adds. Finally, Orange's Leboucher points out that the advances in network connectivity that 5G provides will also provide companies the opportunity to reduce their carbon output, through data efficiencies.

“It's not just about reducing energy consumption or controlling the energy consumption of the network and also reducing the CO2 impact of networks. It's also even more important to use and leverage 5G to help other companies within their own businesses manage scarce resources better to manage and consume less energy. Because we will leverage more data, we will be smarter,” Leboucher concludes.

5G Driving Network Performance & Consumer Experience to New Highs

By Mark Giles,
Chief Industry Analyst, Ookla

Ookla provides industry-leading, trusted network intelligence and testing solutions that help connect consumers and the industry. We are driven by the mission to measure, understand, and help improve connected experiences across the world. With the help of our innovative testing tools, we help consumers understand what connectivity means and how it's evolving with 5G. Apart from the renowned Speedtest® and Downdetector® platforms, Ookla provides a growing suite of end-to-end solutions to enterprises, helping them leverage data to gain insights across their networks and of the experience of their customers. Worldwide, operators, regulatory bodies, businesses, government agencies, non-profits, research

organizations and many others use the insights provided by Ookla to analyze, optimize, and publicize networks around the world. Currently, we are adding new capabilities to our enterprise tools to help measure customer experience across areas like video streaming, video calling, social networking, and gaming.

5G delivering on the promise

As operators across the world ramp up 5G investments and launch innovative new services for consumers and enterprises, network performance remains a critical factor in deciding the success of these investments. A July 2022 survey conducted by Ookla to evaluate the expectations of smartphone users, just prior to 5G launch, resonates with this sentiment. According to the survey, 42% of smartphone users surveyed believe faster connection speeds would improve the mobile experience delivered to them, while 24% mark reliability as the primary concern that impacts their experience. Indoor coverage is another crucial factor to consider as 21% mark that as their priority while outdoor coverage was the primary concern for 10% of the consumers. There's one more factor, the latency, which can emerge as a primary concern as users gain more understanding about 5G applications and how latency can impact their experience.

However, the good news is that with 5G, operators have already been delivering on the promise of faster speeds. In one of our analyses, where we monitored 5G network performance at various major events, we see that operators continue to push the envelope on speed and performance of their networks. Two major recent events that we covered, the Expo 2020, Dubai, and NFL Football, Los Angeles 2022, had achieved 983 Mbps and 874 Mbps as median downlink speeds respectively. In terms of the uplink speed, Expo 2020 and MWC 2020 scored higher with 103 Mbps and 81 Mbps median downlink speeds respectively. We have seen similar trends with other major events across the U.S., in London, Tokyo, Paris, and more. This upward trend will continue, as we move towards more standalone 5G networks and to 5G Advanced, and also embrace the new era of 5G with the latest releases of 3GPP standards that enable more efficient usage of higher frequency spectrum. We await some major announcements in this regard in the upcoming World Radiocommunications Conference (WRC) 2023 at Dubai.

What's more significant about 5G is that, it can enhance the user experience across a wide range of user applications, and this in turn can lead to increased network usage and thus increased ARPU for operators. Take, for example, the impact of 5G on the video experience across different regions as they transition from 4G to 5G. During our analysis of video samples across regions, we have found that the median time to start video has come down drastically, and at the same time, a greater proportion of video samples are viewed at higher resolution. As in the case of video, 5G brings significant improvement in gaming experience as well. This indicates the drastic improvement in latency as we move from 4G to 5G. Again, the use cases in countries like Indonesia, Malaysia and Philippines have topped the chart in latency reduction, gaining nearly 20 ms improvement with 5G. These instances show 5G improves the overall experience across demanding applications. We also see significant improvement in customer engagement while moving from 4G to 5G. When we analyze consumer NPS scores, we see time and time again that users on 5G networks are much more likely to be net promoters than those on 4G networks.

In this context, the next focus for the industry is to improve the capabilities of 5G and scale it further. According to Ookla data, the vast majority of users still spend a majority of their time connected to 4G networks. Only 10-30% percent of Speedtest users in markets in Asia Pacific that have launched 5G spend a majority of their time on 5G networks. Thus it's time for the industry to scale up 5G coverage. With the availability of sufficient mid-band spectrum, and industry initiatives to promote re-farming and re-allocation of sub-GHz spectrum, the scenario will improve further. 5G adoption is also impacted by the availability of devices. Having affordable 5G devices and tariff plans can really catalyse 5G adoption. Finally, in order to spread the benefits of 5G to the mass market, we need to continue to create more and more innovative use cases, and build awareness about them.

> As operators across the world ramp up 5G investments and launch innovative new services for consumers and enterprises, network performance remains a critical factor in deciding the success of these investments.

5G Leads the Stride

At Huawei's Global Mobile Broadband Forum (MBBF) 2022 held in Bangkok on October 25th, the company's Rotating Chairman, Ken Hu, delivered a keynote titled "5G Leads the Stride". During the keynote, Hu noted that "5G has grown faster than any previous generation of mobile technology, but more can be done to fully unleash its value."

By Ken Hu, Rotating Chairman, Huawei

As the global economy slowly recovers, many industries are seeking growth through digital transformation. 5G has created unprecedented opportunities by enabling new use cases, applications, and models in all industries.

From deployment to rapid development

5G has grown faster than any previous generation of mobile technology. In just three years, there are now over 200 5G networks and more than 700 million 5G users around the world.

This rapid development is driving new shifts in consumer behavior. For example: High-definition video now accounts for 60% of all 5G traffic. And new mobile applications like short videos, livestreaming, and cloud phone are driving growth in DOU, ARPU, and revenue.

Even more exciting is the progress on the B2B side. We're seeing many brand new 5G-powered applications in industries like oil and gas, mining, manufacturing, and transportation. For example, applications like autonomous mining trucks were not practical without 5G.

These applications are not only innovative — they're generating real commercial value for carriers too. In China, for example, the numbers are adding up fast.

In 2021, Chinese carriers brought in almost USD500 million from 5GtoB projects. That's from connectivity alone. The exciting part is, 5GtoB projects have also generated 10 times that amount from new revenue sources, like data and integrated ICT services.

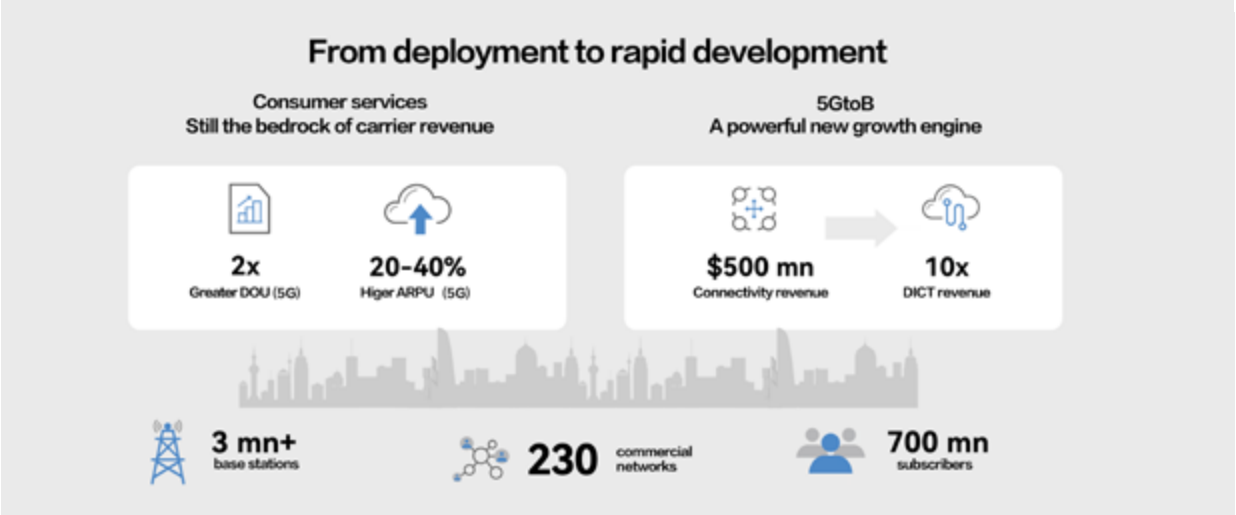
I'm confident that this momentum will continue, and 5GtoB services will become a powerful new growth engine for our industry.

New growth opportunities for carriers

Starting back in 2012, after 10 years of R&D, investment, and pilots, 5G is finally in the fast lane. We should all be proud of the progress that we've made.

But this is only the beginning. There's more we can do to fully unleash the value of 5G. In the consumer market, more than a billion new 5G devices have shipped. Some carriers have achieved a 5G traffic ratio greater than 50%, but for many carriers, it’s still lower than 20%. There's a lot of room to push these numbers up.

At the same time, carriers can explore new experience-based revenue models, such as premium packages that guarantee speed and latency. From my observations, these are already becoming popular in Europe and South Korea. And they are growing fast.



As for the 2B market, 5G is a key enabler for digital transformation. 5G's wide coverage and fast speeds are perfect for scenarios like smart grids and smart transportation.

In other domains like mining and manufacturing, companies can leverage 5G's reliability and fast uplink for scenarios like video inspection and remote controls.

By unleashing the full capabilities of 5G, we can help industries go digital and unlock new growth for carriers.

Building out networks for better user experience

To seize these opportunities, there are a few things we need to do. First, we need to keep building out networks and improving user experience.

Right now, 5G only covers 30% of the global population. That's still a big gap with 4G.

In addition to coverage, we need to optimize networks for different types of user experience. For example: Chinese carriers have optimized their 5G networks for TikTok and other popular video services. They have greatly reduced latency and lag for a much smoother video experience. As we all know, 3G, 4G, 5G — most consumers don't have a clear concept of what these mean.

But the difference in experience is very clear. You can feel it. And better experience is a great way to attract new users to 5G services.

To keep pushing experience to the next level, we also need to push network capabilities to the next level. 5.5G is the path forward.

Together with carriers and industry partners, we've proposed four features for 5.5G networks: 10 Gbps downlink, 1 Gbps uplink, support for 100 billion connections, and native intelligence. To achieve this, the industry needs to come together — define standards, prepare the spectrum, and build out the ecosystem.

Drive service innovation to maximize the value of 5G

Better networks will help us to innovate more on services. For consumers, we can provide a brand new experience with services like extended reality and cloud gaming.

For example, three carriers in China are working on enriched 5G calling services, which include smart conferences, real-time translation, and remote guidance.

These services will provide users with a brand new experience for 5G calls, like multimedia, visualization, and more personal interaction.

For businesses, carriers can go beyond connectivity and provide more comprehensive digital transformation solutions. In the past two years, we have seen many

> 5G's large bandwidth and low latency advantages present operators with the opportunity to fully integrate 5G, cloud, and AI, fully unleashing the value of 5G.

great cases in different markets around the world. Let me share with you some examples.

In Thailand, carriers are working with partners to help a smart hospital in Bangkok provide new services like 5G smart ambulances and remote consultation.

In South Africa, a carrier has helped a mining company find partners to deploy applications on its 5G network. With these applications, the mine has automated many aspects of operations and maintenance.

Not only do these applications provide practical value for industries, moving forward, carriers can also leverage 5G with cloud and AI, to expand into integration services and open up new revenue streams.

Of course, this requires new capabilities, including cloud, system integration, and also consulting and planning for digital transformation.

These all require a different set of core competencies, and Huawei is more than happy to work with carriers to bridge any capability gaps.

5G is developing fast, and there's so much potential out there. But we still have a lot of challenges ahead of us. I'm confident that if we work together, we can make great strides together.

5G Apps Thrive

– 40% of Telcos Launch Enhanced Apps for Consumers

As 5G networks develop and grow in popularity, the number of 5G subscribers surges, providing a key basis for 5G service innovation. In the consumer market, we are noticing diverse 5G applications based on 5G network capabilities in various forms and scenarios, such as new video, XR, and cloud games. Omdia research identifies the typical 5G rich app cases launched by global 5G telcos, and explores how to monetize 5G apps that leverage 5G network capabilities.

By Nicole McCormick,
Senior Principal Analyst, 5G & Broadband Pricing and Strategy, Omdia

The enhanced mobile apps market continues to gain momentum as telcos leverage faster 5G network speeds and lower latency. New Omdia research found that 71 (or 37%) of 5G telcos have launched at least one 5G rich app; either enhanced video, mobile games, Augmented Reality (AR), or Virtual Reality (VR). That is impressive, given the consumer 5G market is only 3.5 years mature.

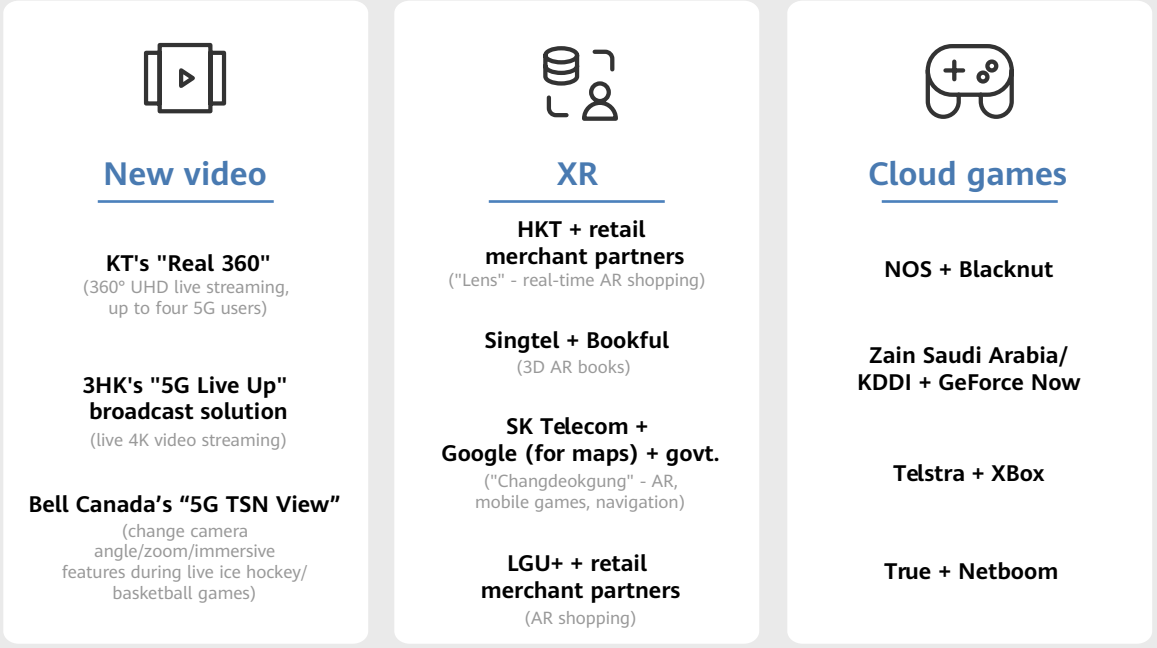
For those that have launched 5G rich apps, the app ecosystem is thriving (see figure 1), with an increasing amount of innovation around video, 4K video apps, XR, and cloud gaming. New video options facilitate 360° UHD live streaming, such as KT's Real 360 video chat service, which requires a Fitt360 wearable terminal that can be worn around the neck. Bell Canada's 5G TSN View enables sports users to change camera angles, zoom in, and enjoy immersive highlights during the streaming of live games — with no headset required. Meanwhile, 3HK's 5G Live Up broadcast solution enables real-time 4K streaming on the uplink and caters to User-Generated Content (UGC) video. The offer includes 100GB of 5G data (about 30 hours of live broadcasting) and 300 viewing hours (thereafter, it's HK$2/hour/person). The solution includes online ticketing so the content creator has a way of generating subscription video revenues. The one-time payment for the encoder, which enables streaming management, is HK$1,200 (US$153).

Meanwhile, AR apps encompass real-time shopping in the case of HKT's Lens app and 3D AR children's e-books. SKT has developed an AR app focused around Changdeokgung, a popular tourist destination in South Korea, that leverages edge networking capabilities for AR navigation and location-specific cloud games. Moreover, by enabling technologies such as AR and VR, 5G has opened new models, with not every monetization route being direct-to-consumer. Rather, as shown in figure 1, telcos can also monetize apps through merchant commissions from retailers.

It is not just China, Korea, and Japan that are leading 5G rich app development and collaboration; launches are reflective of other regions, including Europe, Latin America, the Middle East, and North America. Moreover, app bundling innovation is not restricted to developed markets, but is also relevant to emerging markets, like Thailand.

Bundling of 5G rich apps is commonplace, with telcos in the US and Asia reserving premium apps for those on the most expensive 5G plans, thereby driving upsell. Also, telcos in Hong Kong and Thailand — and a host of other markets — attempt to charge a subscription fee for premium apps. Cooperation on content with partners takes many different forms; white labeling or a wholesale content partnership are the most common as most telcos do not organically develop 5G applications from an incubation stage.

Figure 1: 5G facilitates live 4K streaming, AR and cloud games



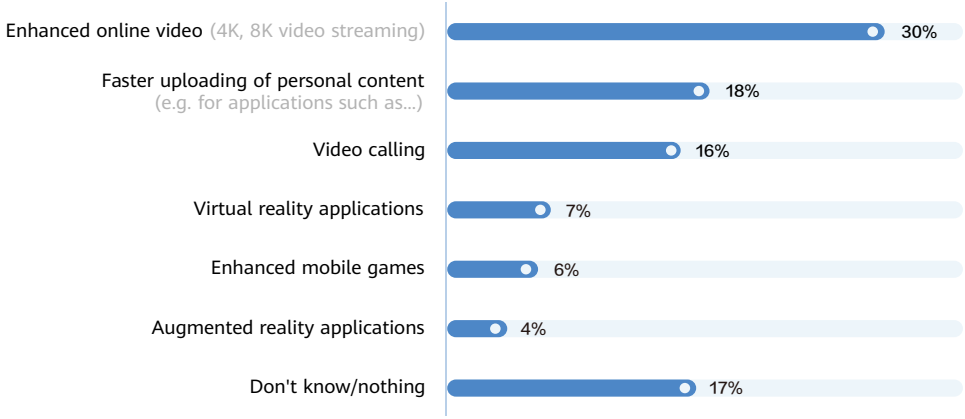
Source: Omdia

4K video streaming voted the most popular 5G app

Omdia's Digital Consumer Insights 2022 survey found that 4K video apps remain the application consumers are most interested in using on 5G, as shown in figure 2. Faster content uploads scored 18% in the poll. Meanwhile, consumer interest in VR and AR apps stood at a combined 11% in the survey. In a separate question, 28% of respondents said they would be interested in accessing AR/VR apps as part of a mobile or broadband service.

In a separate survey, telcos agree with consumers — online video is a key driver of consumers to 5G. Advanced messaging, video calling, and cloud gaming were also considered key 5G drivers. At the end of 3Q22, there were 637 5G plans that included at least one 5G rich app. More than half of the plans (57%) led with a bundled 4K video app, followed by 27% with cloud games as the lead app. VR/AR apps were the main app in 13% of plans, with the metaverse taking 3%.

Figure 2: What is the main application that you are most interested in using on 5G?



Notes: n=12,178
Source: Digital Consumer Insights 2022: 5G, Broadband and Bundling

Telcos don't need to reinvent the wheel, but partner, partner, partner

The basic notion of 5G is that it offers something more compared to 4G, and that additional value warrants a moderate premium from consumers. In contrast, one of 4G's main marketed benefits was that it enabled 'video to be watched on a train' — hardly enough to justify paying more for over 3G. The evolution to 5G, however, enables more network capacity, a big speed jump — 300Mbps to up to 2Gbps, currently — and with edge network capabilities meaning lower latency.

In terms of monetization, operators with 5G network coverage that reaches beyond just hotspot areas are able to:

- Upsell consumers based on speed
- Upsell consumers based on the improved performance of 5G rich apps
- Upsell consumers based on larger data allowances

Upselling consumers from 4G is exactly what most telcos are doing. We asked operators about consumer 5G price plan premiums — some 59% of telcos said they charged a premium over 4G, although overall Average Revenue Per User (ARPU) in some markets remains challenged due to price competition.

For some, the new 5G ecosystem can be challenging to navigate. But getting apps to market is a joint effort, where insight from ecosystem partners is crucial. Whilst telcos have not been very good at sharing intelligence with each other, as far as apps go, this is changing with global content alliances and Tier 1 telcos showing increasing willingness to export apps to other operators in overseas markets.

Hand in hand with app innovation, is pricing model innovation. We are seeing more telcos offering a range of business models to consumers, from subscription apps to free teaser apps designed to entice consumers onto the 5G network. But more innovation is needed as operators upgrade to next-gen networks and future business models will need to evolve beyond just "the consumer pays". With network slicing, for example, new pricing models will need to evolve where the employer or even developer pays the telco.

Last, but very important to consumer monetization upselling, are devices. Here we are not talking about smartphones per se, but wearables (such as XR glasses) that will truly propel the performance and experience of next-gen apps to the next level. In short, the goal is for everyday objects to become increasingly connected,

> New Omdia research found that 71 (or 37%) of 5G telcos have launched at least one 5G rich app; For those that have launched 5G rich apps, the app ecosystem is thriving , with an increasing amount of innovation around video, 4K video apps, XR, and cloud gaming.

and wearable devices to become smaller and lighter. In Korea, Nreal's smart AR glasses are already available, and Mojo has developed lenses that sit on the white of the eye for AR. Verizon, Motorola, and Lenovo also recently agreed to partner on a hands-free wearable neckband, designed to hold the computing power so that glasses can become smaller. Next-gen wearables need not only to be practical and lightweight, but also affordable. To meet the affordability goal, operators will need to further innovate around device payment options for consumers.

5GtoH, Redefining New Concept of Home Broadband

Zain is a pioneer of mobile telecommunications in the Middle East. They believe 5G will be the key enabler of the Kingdom of Saudi Arabia's (KSA's) Vision 2030. Pursuant to this vision, Zain has made significant advancements in leveraging 5G's speed and also in terms of utilization of the network.

By Tiago Rocha,
Chief Marketing Officer, Zain KSA

Zain KSA first rolled out 5G in 2019, becoming the first to fully launch a commercial 5G network in the country. It was a landmark achievement as we launched our network in 27 cities across the country on a single day, with 2600 sites going live simultaneously. Since then, we have been pursuing an exciting journey in 5G covering new sites and adding new customers.

Currently, we have a presence in 53 cities, enabled by around 5000 active 5G sites. In some cities, our 5G traffic is already higher than that of 4G. Back in February this year, we reached a very important milestone by launching our first 5G standalone live test, achieving 2.4 Gbps of throughput during a major event hosted in KSA. We are also advancing on carrier aggregation by leveraging Huawei MetaAAU.

In response to the developments in 5G, Zain KSA has been honored with several industry awards, including the Best 5G User Growth Award in 2021. We have also been singled out by leading benchmarking agencies like Open Signal and Ookla in categories such as the best 5G network, fastest 5G network, best video experience, best gaming experience, and so on.

> "In fact, the FWA segment has been growing 100% YoY since 2019, and we expect this growth to continue or even double in the coming months. All of this is driven by Zain's innovative strategies designed to scale up adoption and address customer requirements."

5GtoH: Redefining the concept of home broadband the Zain way

Fixed wireless access (FWA) is a strong area of focus for Zain KSA. Of our total customer base of 9 million, almost 1.1 million belong to the FWA category. In fact, the FWA segment has been growing 100% YoY since 2019, and we expect this growth to continue or even double in the coming months. All of this is driven by Zain's innovative strategies designed to scale up adoption and address customer requirements. This, in turn, helps us monetize 5G more effectively and earn the best value from services. Our 5G FWA strategy delivers on five key demands: reliable & fast Internet, stable Wi-Fi at home, flexible tariff offerings, innovative services, and high-quality devices. These strategies also align with our business goals, allowing us to realize higher average revenue per user (ARPU) with 5G — around 30% more compared to 4G.

Although Zain does not have a vast footprint in fiber, in a way, we still directly compete with the local fiber to the home (FTTH) players. In 5G FWA, customers tend to have higher expectations on the reliability and speed delivered by 5G, so delivering on this promise is the first and foremost prerequisite in monetizing 5G for the home segment. With 5G, Zain KSA has been able to increase the average speed 10 by times compared to 4G. Nowadays, in most of the cities in KSA, we are delivering an average of around 250 Mbps of speed per customer per month, compared to around 25 Mbps with 4G. We also see there is a significant rise in the network usage, not only due to the impact of the pandemic, but also because of the better experience offered by 5G network. This has led to a sudden increase in data traffic — almost three times including customers who just migrated from 4G to 5G. Indeed, this is going to put some pressure on return on investment (ROI) in the initial stages.

Second, there is a need to focus closely on indoor coverage to deliver stable Wi-Fi experiences at home.

This is very important for KSA because the majority of residential structures in the country are horizontal, not vertical. There are very large households, many of which are villas, making it more challenging to give customers the required experience, at least of the quality delivered by fiber. To ensure this, we have bundled customer-premises equipment (CPE) together with a Wi-Fi-mesh extender in the majority of our 5G offerings, allowing customers to get good Wi-Fi coverage in every room. We also offer a 5G Home Premium package that includes a 5G outdoor router with Wi-Fi-mesh extender to address the even higher demands from premium customers for indoor coverage.

The third consideration is the tariff. Since 5G is a new technology, customers expect greater flexibility in selecting the plan in the beginning, before moving up the ladder as the demand increases. Accordingly, we have designed three unlimited data plans, based on the download speeds. They are: 5G Home Basic with 100 Mbps download speed, 5G Home with 200 Mbps download speed, and 5G Home Premium Online plan with unlimited upload and download speeds. In addition, there is 5G Home Movies plan with 200 Mbps download speed along with free movie subscriptions from popular content platforms. We also provide the flexibility to choose the contract length, including two years, one year, or even no contract.

Fourth, it is extremely important that we deliver innovative services, especially in terms of content across video streaming, cloud gaming, music, esports, and more. With this, we are also able to reach out to diverse customers with varying needs. We have learnt much from our peers in China, Korea, and Thailand in this regard. The 5G Movie package is one such offering wherein we bundle free movie subscriptions from leading over the top (OTT) streaming platforms like OSN+ and Starz Play, among others. Meanwhile, as gaming gains huge popularity in KSA, we have launched the 5G Home + Cloud gaming device bundle that allows customers to opt for a gaming console like VR glasses, a smart home device, or even a tablet. We were also the first in the country to introduce a family package that combines a 5G home proposition with mobile. This offer comes with a tariff structure combining the FWA with the voice lines, enabling significant savings for customers. We have also launched several attractive promotional offers during special seasons, in addition to the regular promotions that we engage in to build a positive impression about our brand and its offerings.

Next, we need to focus on the quality of the devices. With 5G, it's obvious that the quality of the device directly impacts customer experience. Indeed, an underperforming device will jeopardize the quality of the 5G network, leading to poor customer experience and unfulfilled service-level agreements (SLAs). As such, we are committed to delivering the best quality indoor access equipment to suit our 5G customers. Whether it's part of the bundled offer or standalone CPEs, or even gaming consoles or tablets, we will ensure that they meet the industry standards and specs required to deliver the 5G service at the required level.

While focusing on the above five crucial components, Zain KSA also engages in industry-wide partnerships that align with the company's mission to deliver the best connectivity experience as well as the content the customers search for. The partnership with content providers is an important milestone in our services. In addition to the partnerships with three important video streaming platforms in the region, we have also been associated with LG Uplus for innovative TV content and Nvidia for cloud gaming services through GeForce Now. This is important for Zain KSA, especially considering the growing traction around esports and cloud gaming in KSA. We were the first in the country to launch cloud gaming, which we are also providing in other countries in the region, including Jordan and Oman. Zain KSA was ranked first in the Game Mode report issued by Saudi regulator CITC for the first quarter of 2021, recording top connectivity performance in four of the most popular video games: Fortnite, FIFA 21, Apex Legends, and Dota 2. We launched the 'Zain Esports' brand, marking the beginning of a year-long calendar of large and exciting regional online esports tournaments comprised of multiple flagship events as well as smaller, regular community tournaments with attractive cash and device prize pools to boost the online game ecosystem.

To sum up, Zain KSA's success is drawn on our proposition: we don't sell just connectivity, we sell very good connectivity with amazing experience, and we don't sell just the content, we sell very good content and the right content that customers are looking for.

Cross-Generation 5G Experience for Business Success

Thailand is one of the first countries in the Asia Pacific region to deploy 5G. The 5G network is the backbone of the Digital Thailand initiatives. Operators are in the process of migrating from 4G to 5G and also looking to 5.5G or 5G Advanced. They are actively pursuing 5G monetization opportunities across various consumer and industrial sectors. With this aim, operators are investing in 5G technologies that enable new use cases across different verticals.

By Saran Phaloprakarn,
Head of Mobile and Consumer Products Department,
Advanced Info Service Plc., AIS Thailand

AIS 5G Strategy

AIS owns the largest share of 5G spectrum in Thailand. We have low band with 300 MHz, mid band at 2.6 GHz, and high band at 26 GHz in the mmWave spectrum. The mid-band spectrum is widely used for coverage in metro areas, whereas low band is leveraged for suburban and rural areas. The mmWave band is planned for dense urban deployment. While low-band deployments promise greater coverage, mid-band provides greater bandwidth and hence a better user experience. AIS has covered 85% of the population with both low band and mid band, and we hope to cover 88% by the end of 2023.

During the past two years, we witnessed rapid growth in the adoption of 5G devices, thanks to the availability of these devices across multiple price ranges. In Thailand, smartphones are now available for less than USD200. With operators subsidies, the price can be further reduced to as low as USD30. Thailand's device strategy has been paying off well, as it revolves around a "triple win" thinking, benefiting device makers, operators, and end users. Operators can also bundle content offers along with the device, which will open up new monetization opportunities. As users spend more time on the network, operators will benefit from increased network usage and thus increased ARPU.

Having said that, customer expectations for 5G revolve around three popular promises: higher speed, lower latency and low power for machine communication, hence the relevance of respective technologies like eMBB, URLLC, and mMTC. However, we should remember that 5G cannot deliver all the three features simultaneously on a single network because each of them requires different network configurations. This situation has led to the concept of 5G network slicing. With network slicing, we partition the 5G network for different settings so that the different slices can support different types of applications, for example, one for mobile, another for AR/VR, and the third one for autonomous vehicles, etc.

Building Success through 5G: The OT Strategies

The unrivalled balance of bandwidth, latency, capacity and security enabled by 5G networks makes them the ideal operational technology (OT) networks to deliver 24x7 connectivity for high-volume and always-on production processes including warehousing, supply chain and logistics. In order to deliver 5G for industrial scenarios, operators will require the support of experts in the Operation Technology (OT) and System Integration (SI) domain. In smart manufacturing, for example, telcos provide the network, but they need the OT provider for the hardware. While operators can support private network and network slicing, they need software and applications from the OT providers. Also, when operators deploy capabilities like Edge, Cloud and an IoT platform, they need support from the SI. Thus, the co-existence of all three pillars is critical for driving the success of enterprise 5G.

5G promises several operational gains for businesses. Data visualization provides operations personnel and customers with deep knowledge and experience overlays. Ubiquitous access to data and computing power helps improve efficiency and intelligent management of resources. The data generated from sensors can be leveraged to improve current business models and unleash new ones. With agile automation capabilities, industries can enable automation with minimal trade-offs on customization, flexibility or quality. The trusted connections across 5G network can enable critical services which deliver on the promises of network uptime and secure connectivity.

Realize Business Gains with AIS 5G Next-gen Platform

AIS has developed a next-generation platform with a focus on delivering high levels of user experience for

both toC and toB customers. AIS' next-gen platform allows high levels of scalability and customization, supporting a wide range of consumer and industrial applications. This will help drive the adoption of applications including immersive entertainment, travel, education, wellness and gaming. To complement this, AIS also launched new AR/VR services which deliver highly immersive applications, blending the best in the real and virtual worlds.

For enterprises, the next-gen platform aggregates the 5G network with edge computing, public cloud and an applications ecosystem. With this, a wide range of new business services are enabled. Built on a hybrid cloud platform, AIS next-gen 5G platform for enterprises allow customers to quickly deploy applications, while still offering the scalability and flexibility required in new application development scenarios. For AIS, it opens the door for new services, partnerships and revenue opportunities.

AIS next-gen platform can reduce application deployment time from months to weeks or even days. Businesses can also realize significant savings, about 20-25%, on hardware costs. The time to market is reduced as it allows businesses to launch at small scale and then scale up. The edge capabilities at multiple locations allow them to expand the service to those locations, with greater promises such as near zero latency. The platform is also built with an application marketplace from global SaaS providers, promising large-scale growth by leveraging world-class applications.

5G and Beyond

We believe that 5G is not just a faster alternative to 4G, but a lot more than that. It has the capability to enable several next-gen applications while also enhancing the performance of a large number of applications across consumer and industrial scenarios.

Beyond 5G is 5G Advanced or 5.5 G. Unlike 5G, 5G Advanced allows you to use two features at a time. For example, by combining a domestic machine type communication with eMBB, we could enable the uplink centric broadband that allows us to have very high-speed uplink for machines that support applications like machine vision or HD video uploading. The combination of eMBB with URLLC will allow us to have high speed and low latency to support applications like rich XR and holographic. The combination of machine communications with low latency will allow us to have harmonized communication with sensors, leading to real-time sensor capabilities.

We expect that 5G Advanced specifications will materialize soon, in 3GPP Release 18; if so, by 2025, operators will be able to upgrade the radio network to be ready for 5G Advanced. They also need to automate their core networks and adopt trends like cloudification and next-gen applications driven by 5G and beyond.

To summarize, throughout history, technology has helped humanity make significant strides. With innovative technologies like those from Huawei, we can realize the true potential of 5G. Let's walk the journey together to make the world happier and a better place to live.

> Thailand's device strategy has been paying off well, as it revolves around a "triple win" thinking, benefiting device makers, operators, and end users. Operators can also bundle content offers along with the device, which will open up new monetization opportunities. As users spend more time on the network, operators will benefit from increased network usage and thus increased ARPU.

5G Innovation, Accelerating Business Success

In the digital era, connectivity is the key that brings us together, making lives easier and more productive. The development of 5G has driven connectivity into another remarkable age marked by superior speed, significantly lower latency, and higher performance that bring about even better user experience for consumers, businesses, and vertical industry sectors. With this exceptional performance, 5G technology took less time for customers around the world to adopt in comparison to its predecessors such as 3G and 4G technology. While 3G took approximately two years to gain momentum and 4G three years, 5G technology took less than a year for customer adoption rate to pick up.

By Tanaphon Manavutiveth,
Co-Group Chief Commercial Officer,
True Corporation Public Company Limited

Amongst the ASEAN countries, Thailand has the second fastest growing 5G market following Singapore. The rapid speed of growth is the culmination of consistent government support in readying networks to deliver 5G benefits to the people in addition to the local mobile operators' collective effort to drive 5G awareness across the nation and to establish 5G ecosystem in preparation to serve various kinds of consumer and business use cases. At the end of 2022, 5G users in Thailand have reached over 10 million users while 5G networks have reached more than 85% population coverage.

Factors to drive 5G success in Thailand

True Corporation strives to build a complete 5G ecosystem with five major driving factors: network, device, use case, partnership, and regulations. This will pave the way for future growth and capture all the needs of consumer and business segments.

Network readiness is the backbone of the 5G ecosystem. With the relatively early release of 5G spectrum in Thailand as pushed by the government, True now possesses the most complete seven frequency bands, suitable for all types of usage ranging from 3G, 4G to 5G applications. With the goal to provide excellent 5G connectivity for all, we have accelerated True's 5G genius network rollout and expansion to promote 5G availability to everyone across the country. Our 5G networks now cover all 77 provinces in Thailand, with 99% coverage of Bangkok Metropolitan Area (BMA) and 100% of the Eastern Economic Corridor (EEC) area where many large industries are located. Positioning True 5G as a genius technology that sustainably changes the country, True Group commits to provide the best 5G network for all Thais.

One of the integral parts to encourage 5G upgrade

amongst consumers is 5G device availability. True rides on the rapid expansion of the 5G smartphone market, making offers on a wide selection of great handset devices from leading brands such as Huawei, Apple, Oppo, Samsung, and more. In addition, to promote affordability and variety of 5G devices to serve all kinds of customer segments, we have expanded upon our assortment of device price range with the introduction of True's own OEM 5G device priced at entry level (below USD200). We also strive to empower customers with our multi-privilege schemes such as True Point reward for discount redemptions, and partnership with Ascend Money to offer loan and installment facility to buyers for better device affordability. Moreover, omnichannel approaches were adopted to encourage 5G device accessibility to customers. With the combination of traditional retail and e-commerce from True and strategic partner's channels such as 7-Eleven, Makro and Lotus's, we have covered more than 15,000 locations across the country and offer special device campaigns and promotions.

The ecosystem will not be completed without strong use cases to encourage adoptions. 5G technology has unlocked new potentials for digital entertainment as industry reports have shown that 5G upgrade increases Thai digital content consumptions on HD videos & music, cloud gaming, and immersive VR/AR content. Therefore, 5G service differentiation by content fulfillment is essential to capture consumer segments.

To deliver a more immersive and meaningful 5G journey to our customers, True has cultivated 5G-rich content ecosystems which consist of four branches. (1) 5G Xclusive, a content library full of immersive 360° XR/VR experience ranging from lifestyle, music, travel and more. (2) True HD Video Streaming, a content library which provides access to original content, exclusive content, local & international live shows, movies, music, series, and sports. (3) True Cloud AR, a gaming platform developed in partnership with Nonvoice Metaverse, the leading platform for innovative 5G AR apps. Lastly, (4) True 5G Cloud Gaming, a platform developed in partnership with NetBoom to bring unlimited PC game titles directly to the user's mobile phones without worrying about high spec requirements, internet speed, and latency issues.

5G as a growth engine for businesses

Capabilities enabled by 5G will become one of the key growth engines for contemporary business to unlock new potentials. Similar to consumer segments, enterprise 5G users also demand robust network capabilities to deliver the guaranteed bandwidth and address the requirements of latency and reliability different use cases across different industries may have. 5G technology will enable businesses and enterprises to improve operational efficiency and enhance productivity as various 5G business applications are developed into solutions for different vertical industries.

Throughout our 5G journey, partnership plays an important role in our success. Apart from collaboration with leading domestic and international alliances, particularly China Mobile, the world's largest mobile phone operator, together with various potential industries such as agriculture, education, manufacturing and others, we have collaborated with one of our closest partners, Huawei, and the National Broadcasting & Telecommunication Commission (NBTC), Thailand's telecommunication regulator, for two of our biggest 5G projects yet: (1) to transform Krungthep-Apiwat (Bang Sue) Grand Station into the first smart railway station in Thailand, and (2) to develop Siriraj Hospital into a word-class 5G smart hospital, which is the first and largest 5G smart hospital in ASEAN.

In both projects, we have provided Southeast Asia's first commercially deployed Multi-Access Edge Computing (MEC) to deliver fast and reliable connectivity with near-zero latency to support massive IoT connections and high level of data control, security, and privacy — a necessity to power both smart hospital and smart railway station. This can help serve several emergency medical applications such as robot-assisted remote surgery, remote patient monitoring, emergency care, and more.

In addition to MEC, we and our partners have also developed many solutions and real 5G use cases to meet each industry's need. In the 5G Smart Station

project at Krungthep-Apiwat (BangSue) Grand Station, True has developed AI security system, service robots, smart trolleys, and automated wheelchairs to enhance customer experience and journey, while in the Smart project at Siriraj Hospital, we have developed smart logistics and 5G ambulance solutions. Our unmanned vehicles can be remotely controlled from the command center via True's 5G network which can be helpful for delivering medicines and documents needed, thereby encouraging automation and efficiency of the entire system across departments. 5G ambulance is becoming one of the essential assets for the hospital. As the patient is brought to the ambulance, the 5G-powered applications will launch automatically, simultaneously checking patients' vitals while transmitting patient records to the relevant departments in order to prep teams of physicians to be ready before the patient even arrives at the hospital. The success case of Siriraj Smart Healthcare will become the role model for many other traditional hospitals across the country to transform and adopt smart healthcare systems enabled by 5G technology.

To summarize, the success of 5G in Thailand requires a collective effort from all stakeholders in the ecosystem, including the mobile operators and network providers, device vendors, government regulators, technology and equipment providers, vertical industry partners, and the end users. It is an elaborate ecosystem that is still expanding at an unimaginable speed. We need to come together to engage in a fruitful collaboration to develop new solutions and create new values to make each of our 5G journeys more meaningful and rewarding for all.

> True Corporation strives to build a complete 5G ecosystem with five major driving factors: network, device, use case, partnership, and regulations. This will pave the way for future growth and capture all the needs of consumer and business segments.

Building 5G Private Networks for Industry Transformation

As a leader in 5G networks in Africa, MTN deployed 5G isolated networks with a host of applications. Through this network platform, MTN realizes market monetization and revenue growth, promoting economic development.

By Brite Devassy,
Senior Manager of Network Strategy, MTN

MTN is the largest mobile operator in Africa, serving over 282 million subscribers across 19 markets in the Middle East and Africa. The service revenue for MTN last year was 170 billion rand; and we expect this to grow this year, especially with the growing 5G customer base in both B2B and B2C segments. In South Africa, MTN provides 5G coverage to 20% of the country's population and aims to reach 25% by the end of this year. We have set the Ambition 2025 strategy with a focus on five key enablers: second-to-none technology platforms; leading customer experience; best talent, culture, and future skills; value-based capital allocation; and environmental, social, and corporate governance (ESG). We want to ensure that these five enablers are central to everything we do as we move towards private networks.

5GtoB market scenario

Several operators around the world have kicked off their 5GtoB journey within private networks, and there are numerous private networks running on LTE as well. Analysys Mason forecasts that the market for private networks comprising 5G and LTE will exceed 20,000 networks by 2026, and enterprise spend on these networks will reach USD5 billion in 2026. Manufacturing and mining are the top two verticals benefitting from private networks, with a combined share surpassing that of the rest combined. MTN has been a forerunner in private networks in South Africa, especially in mining. Our collaboration with Huawei to power South Africa's first 5G metal mine for Zijin Mining Group has been ground-breaking. The 5G-based ICT solutions not only provide high-speed 5G broadband access, but also enable smart mining solutions like vehicle remote control, IoT, and driverless trucks, among others. Currently, we are providing private networks to over 14 companies in the mining and ports sector in South Africa.

Private networks drive industry digital transformation

Private networks are widely being deployed across mining and manufacturing. With gigabit speeds and stable millisecond-level latency, 5G enables a host of advanced applications like predictive maintenance, precision monitoring, remote control, and augmented guided vehicles and machinery. Private networks are also transforming sectors like healthcare, retail, transport & ports, construction, media, and agriculture. In healthcare, private networks support critical services like patient monitoring, AI-enabled diagnosis, and connected ambulance. In retail, major use cases are developed for customer journey analytics, contextual advertising, and inventory tracking. The transport & ports sector largely benefits from traffic and parking analysis, smart city traffic management, and connected car driver assistance. In the construction industry, private networks enable AR-based training and video analytics for quality assurance, whereas in the media industry, the use cases mainly revolve around live video & broadcasting, temporary compute for events, and edge content delivery network (CDN).

5G isolated networks' gain over sliced networks

5G isolated networks are emerging as the ideal network solution for a number of industry scenarios. However, many enterprises are still in two minds as to whether they should deploy isolated on-prem networks or network slicing. With network slicing, you can segment the network with various qualities of service and service level agreements (SLAs), to make sure that whoever wants a portion of the network will get it for their particular use case. However, the reality is that in sectors like mining, enterprises want total isolation of their network elements. They want to make sure that they have their own radio network sitting on-prem, wherein they can tailor SLAs depending on their requirements. The intention is to gain complete control over the network, and in doing so drive efficiency. 5G isolated networks are also known for their latency gains because the entire processing happens at the core data center, eliminating concerns associated with processing in other data centers or application environments.

MTN's smart mining journey with 5G isolated network

MTN's 5G isolated network serves as the backbone of the smart mining projects. There are three phases of deployment: communication, product monitoring, and product automation.

Communication is about providing the basic connectivity, to get the process up and running. Most of the mines are remote and have no connectivity. The handsets owned by the workers also have poor 4G connectivity, even for basic consumer services. Clearly, the challenges are enormous. By deploying a private network for the mine, the company can provide superfast connectivity to all employees working there. 5G is a lower cost alternative to fiber in large-surface mining areas with hard soil and challenging terrain. We have also implemented surveillance using IoT and camera devices for information tracking and vehicle tracking, which is applicable in scenarios such as fatigue detection, vehicle health check, and more.

The second phase, production monitoring, consists of two steps: belt monitoring and security monitoring. Belt transmission is the predominant way to transport ore from underground to surface. The whole production process may breakdown once the belt is broken. With smart mining, all such processes are supervised and inspected automatically. For security monitoring, MTN's private 5G network provides a complete set of smart campus solutions comprising access control, license plate, and attendance monitoring. It also performs production flow tracking; explosive management; equipment inventory; and monitoring of illegal operations such as smoking, passing under equipment or belt seat, and the like, to improve operations and ensure safety of the people and industrial assets.

Traditionally, mining requires a series of complex and dangerous operations to be performed manually, posing a threat to the lives of the workers. Without connectivity and proper monitoring, they are forced to work in a high-risk environment. Remote management can greatly improve the safety and efficiency of operations. With automation, machines take charge of the dangerous tasks, helping to avert potential casualties. Indeed, the value brought by such improvements to safety is unquantifiable. Automation also enhances the value of operations by helping reduce the waste during ore sorting. With machine vision and mechanical arm sorting, metallurgical customers can reduce the waste rock proportion, leading to faster return on investment (ROI).

In short, 5G isolated networks bring great value, efficiency, and safety to mining scenarios. As a leader in 5G networks in Africa, MTN has the ability to build, support, and deploy 5G isolated networks with a host of applications. The network works like a platform where we take advantage of these applications to monetize, grow, improve, and drive the economy within the markets that we operate. We think it's invaluable to any operator that's looking towards the 5GtoB journey. We are keen to drive industry partnerships to jointly build use cases that benefit industries, their people, and humanity as a whole.

> 5G isolated networks bring great value, efficiency, and safety to mining scenarios.

Changing Lives with Technology — Embracing the 5G Era

5G has now been in commercial use for three years, during which time it has underpinned pandemic prevention and control, improved people's lives, and spurred economic development. From the outbreak of the pandemic in early 2020 to today's large-scale commercial use, China Mobile Hubei (Hubei Mobile) has always been at the forefront of 5G innovations, especially when it comes to improving short-form video experience.

By Li Jian,
Planning Department Director, China Mobile Hubei

> Short-form video services are closely intertwined with customer perception, which is subjective. Therefore, a key component of network support is to map network construction standards with customer perception.

5G's high bandwidth and low latency ensure connectivity and facilitate production

Wuhan, Hubei was one of the five 5G pilot cities designated by the China Ministry of Industry and Information Technology, with Hubei Mobile subsequently beginning commercial use of 5G back to 2019. When the COVID-19 pandemic broke out in Wuhan at the beginning of 2020, Hubei Mobile proactively applied 5G to fight the pandemic. In the space of just 36 hours, we built 5G base stations in the Huoshenshan and Leishenshan hospitals. Thanks to 5G's high bandwidth, live streams could be broadcast to allow hundreds of millions of people across China to witness the rapid construction of two hospitals, boosting public confidence in the fight against the pandemic.

During the early days of the pandemic, Hubei Mobile overcame numerous challenges to ensure the availability of communications and services needed to support pandemic prevention and control. We rapidly deployed 30 5G base stations to ensure 5G coverage of key venues, with a total of 140 5G base stations playing a key role during this critical time in Wuhan.

As the outbreak plateaued out, Hubei ramped up its

economic and social recovery. Resumption of work and production in different industries in the province gave rise to new service needs for 5G. Committed to supporting the post-pandemic recovery, Hubei Mobile released a diverse array of 5G video services such as cloud-based video conferencing. This not only helped to attract investment but also provided cloud-based classrooms for students.

Taking advantage of 5G's high bandwidth and low latency, Hubei Mobile launched a 5G thermal imaging temperature detection system that integrates intelligent video analysis, technologies for thermal imaging temperature measurement, and 5G networks, ultimately achieving millisecond-level response and real-time backhaul. These systems were rapidly deployed and put into use in key locations throughout Hubei, such as railway stations, highway intersections, coach stations, and large supermarkets, leveraging information technologies to create a "first line of defense" for the resumption of work and production.

Improving network capabilities to meet the needs of rapidly-developing short-form video services

5G has fundamentally transformed and upgraded both network capabilities and user experience. Over the past three years, Hubei Mobile has built and deployed more than 45,000 5G base stations, covering both urban and rural areas spanning cities, counties, and towns. We have provided users with high-quality 5G services that feature wide coverage, high bandwidth, and no frame freezing.

As one of the first 5G pilot cities, Wuhan now has a wealth of experience in 5G construction. Recently, Wuhan became one of the first cities in China to implement the "Extending Radio and TV Broadcasting Coverage to Every Village" project. This project helps to bridge the gap in ICT development and support the development of the digital economy, and has already won wide acclaim from a wide spectrum of commentators. Furthermore, Hubei Mobile has improved all aspects of people's lives with new 5G features. Nowadays, short-form video services such as TikTok are seeing unprecedented growth. According to one survey, users who frequently use short-form video services account for 80% of all users and consume about 40% of all network traffic. Against this backdrop, while strengthening basic network capabilities, Hubei Mobile further improves services and capabilities for widely-consumed short-form videos.

Short-form video services are closely intertwined with customer perception, which is subjective. Therefore, a key component of network support is to map network construction standards with customer perception.

To this end, Hubei Mobile set up a dedicated team. First, the team made bold assumptions and performed careful theoretical verifications, before analyzing 5G parameters and video service characteristics. And finally, it identified the first frame latency as a key experience indicator for short-form videos, as well as being closely related to field intensity distribution of 5G signals. Based on all of this, Hubei Mobile came up with a development tool to simulate customer experience and verify the mapping of 5G network parameters using the simulated data.

Hubei Mobile put together a team of hundreds of people, situated in train stations, airports, universities, and commercial premises, to simulate the short-form video experience of customers using this development tool. The vast amount of data obtained by the team verified the assumption that the first frame latency of short-form videos is strongly correlated with the average field intensity of 5G network signals.

Through such theoretical design and practical verification, Hubei Mobile has improved short-form video services by reinforcing network base stations and optimizing network parameters. And thanks to these efforts, the short-form video viewing experience has been enhanced and traffic has increased.

Recently, Hubei Mobile took the findings from the research into short-form video experience improvement and applied them to 5G network planning and construction. Based on our analysis of how to improve short-form video experience in Jiangbei, Wuhan, we added hundreds of 5G sites. The measurement report

for users viewing HD short-form videos showed that the coverage rate increased from 85.4% to 89.2%. As a result, the proportion of HD videos at resolutions of 720p or higher increased from 77% to 83%, which in turn instigated a 12.4% increase in 5G traffic and a 5% increase in network-wide traffic. This further verified the research results of the dedicated team for improving short-form video experience.

Based on data analysis and practical verification results, we created a short-form video experience network construction solution and developed a digital tool to support 5G network planning in Hubei. We believe that, with the further promotion and application of innovative achievements, we can offer customers the ultimate experience of "ultra HD, zero wait, and zero frame freezing".

Gazing at the stars while keeping our feet firmly on the ground

Since 5G was put into commercial use three years ago, China has entered a critical period of large-scale 5G application. Indeed, 60% of the world's base stations are in China. Everywhere, down to townships and rural areas, is covered with 5G. What's more, the commercial use of 5G has entered a virtuous circle, with 5G becoming increasingly prevalent.

Regarding the future of 5G, Hubei Mobile has kept a close eye on the development trends of the 5G industry. Today, full-awareness interaction is redefining how we communicate, and industries are replacing information silos with full connectivity. In 2023, 5G R18 will be frozen, officially marking the advent of the 5.5G era. Its iconic 10Gbps downlink, 1Gbps uplink, 100 billion connections, and endogenous intelligence capabilities will become the backbone of the digital economy. Hubei Mobile has been actively exploring innovative 5G applications and has gradually promoted the commercial use of new services. In addition, we have made ample preparations to support the rapid development of the industry. We have continuously optimized the network to improve user experience, as well as expanding the coverage in urban and rural areas. And finally, we have taken practical measures to fulfill the social responsibilities of the communications industry.

For example, in the business domain, Hubei Mobile and Midea built the world's first fully connected 5G home appliance factory, which officially began production in Jingzhou on August 18 this year. In its workshops, over 1000 automated machines and devices are operating efficiently. 5G has been applied in 15 scenarios, such as 5G production line monitoring, AGV scheduling, and AI quality inspection. More than 500 5G CPEs and other devices have been used to seamlessly connect each link. What's more, overly complex pipelines and wires in ordinary workshops are a thing of the past, with all production equipment now connected with 5G. And as the world evolves from traditional manufacturing to intelligent manufacturing, we will actively enable manufacturing enterprises to transform. This will enable industry digitization and digital industrialization, injecting new vitality into the manufacturing industry in Hubei and the country at large.

Hubei Mobile has also implemented the 5G Smart Yangtze River project, which is gradually upgrading coverage along the Yangtze River to 5G. The project forms an end-to-end networking solution and provides a digital platform that integrates functions such as smart waterway management, emergency command and dispatch, and remote enforcement of fishing bans. We have been improving the 5G smart "digital eye" and continue to promote the modernization, digital governance, and green development of the province with ecosystem protection as a priority. We will also apply 5G in ecological protection areas such as the Yangtze River Basin and urban wetlands.

In addition, we have expanded network coverage to villages, highways, and roads to further bolster our efforts to build a digital economy.

With the advent of the 5.5G era, we are ready and willing to explore more cooperation opportunities, as well as create new social value for consumers and businesses in user experience improvement, intelligent industry cooperation, and digital government management.

The 5G X-Cube: Scaling up Customized 5G Network Success Replication

Supported by the 5G X-Cube, China Telecom has passed the 0→1 stage and entered the 1→N stage of rapid development. The company has built more than 3800 customized 5G networks, several of which have become replicable success cases for the large-scale deployment of 5G applications. In this article, China Telecom details the definition and operation model of the 5G X-Cube, and shares the company's experience and success stories in promoting the large-scale development of 5GtoB. This article can serve as a reference or be used for industry exchanges.

By Cao Lei, PhD, Deputy General Manager of the Government and Enterprise Information Services Business Group, China Telecommunications Corporation

Over the past three years of commercial use, time and time again 5G has demonstrated its potential through integration within a wide range of industries. Several 5G industry applications have been created and deployed on a large scale.

None of this would have been possible without the concerted efforts of the entire ICT industry. As a major force in 5G network deployment, China Telecom has readily taken on the role of national vanguard. Over the past three years, China Telecom has recorded some incredible achievements in 5GtoB settings. For example, it has successfully delivered more than 4800 customized 5G network projects and more than 16,000 5G DICT projects. The company has also enabled the digital transformation of various industries through the application of 5G.

As 5GtoB solutions mature, a growing list of industries are starting to realize the role that 5G private networks can play in digital transformation. That said, different enterprises have their own pain points and scenarios, resulting in varying requirements for customized 5G networks. This presents both a new challenge and opportunity for China Telecom.

The 5G X-Cube for customized 5G networks

To achieve the large-scale development of 5G private networks, carriers must be able to meet the customized requirements of industry customers in real time and quickly replicate the experience of success cases on a large scale. With this in mind, China Telecom launched the 5G X-Cube to meet vertical industries' requirements for customized 5G network services.

The 5G X-Cube is an online intelligent expert system of China Telecom's customized 5G network services. It serves as both a reference model and modeling tool for developing overall solutions for industry customers in 5G scenarios based on the analysis and restructuring of 5G device, network, cloud, edge, user, and service capabilities. The design of the 5G X-Cube focuses on six areas: service requirements, technical parameters, atomic capabilities, standard products, service solutions, and business models. This is intended to realize modular encapsulation, standardized output, and scaled application. Specifically, the 5G X-Cube can modularize and standardize requirements, capabilities, and products to form a composable and innovative capability platform, which quickly translates industry customer requirements into customized network configuration parameters. This ensures that customers' specific 5G requirements can be met in real time.

Modular, standardized, and scaled capabilities allow the 5G X-Cube to quickly replicate experience of success cases. To date, the 5G X-Cube has been widely used in customized 5G networks built by China Telecom across 31 provinces (including autonomous regions and municipalities) in China. In addition, over 670 projects have already made use of the 5G X-Cube's encapsulation solution, which supports the work of more than 2200 frontline personnel from 15 industries such as steel, coal, healthcare, port, and electronic manufacturing. This fully showcases the 5G X-Cube's ability to provide intelligent tailored templates for industries.

The 5G X-Cube has already won high acclaim within the industry. In September 2022, the 5G X-Cube took home first prize in the 5th Bloom Cup 5G Application Competition. In November that year, it won the Best General-Purpose Product Award in the Bloom Cup finals.

Success stories leading to industry-wide replication

Through the 5G X-Cube, China Telecom has produced a series of typical success cases alongside its partners. Such success stories act as beacons for industries, paving the way for the future success of others.

Dongsheng Thermal Power: 5G-powered smart thermal power

Guodian Inner Mongolia Dongsheng Thermal Power (Dongsheng Thermal Power, for short) was the first company in China to launch a 5G-powered smart thermal power plant joint innovation practice base. By

> The 5G X-Cube can modularize and standardize requirements, capabilities, and products to form a composable and innovative capability platform, which quickly translates industry customer requirements into customized network configuration parameters. This ensures that customers' specific 5G requirements can be met in real time.

taking advantage of 5G networks, the company has overcome industry bottlenecks, transforming from a traditional enterprise to a digital, intelligent one.

In the past, thermal power generation faced many pain points and challenges, such as a lack of decision-making approaches for intelligent maintenance, severe security risks regarding communications inside and outside generator sets, low inspection efficiency, blind spots in monitoring, and low data utilization rates.

By leveraging 5G private network capabilities, Dongsheng Thermal Power has innovated five application scenarios: monitoring, data collection, control, inspection, and communications. 5G cameras have been employed to quickly cover blind spots without manual laying of cables, ensuring real-time backhaul of operations in covered areas. This has overcome the industry painpoint regarding a lack of remote monitoring in confined spaces within thermal power plants. In addition, 5G private network eMBB slicing, based on edge computing, has been used to achieve fast initial device screening onsite. Meanwhile, 5G, multi-access edge computing (MEC), and AI have all been adopted to identify failures in boiler rooms, which has reduced the number of accidents.

With the support of 5G, Dongsheng Thermal Power has shortened the period of monthly routine maintenance to 5.2 days, as well as reducing its network deployment costs by CNY500,000/year and maintenance costs by CNY310,000/year. With fewer boiler-room failures, the number of managers needed for each generator set is reduced by 1, in turn improving O&M efficiency. Overall, it is estimated that the annual value created by the Dongsheng Thermal Power project is about CNY5.68 million. Most importantly, the project has significantly improved the working environment for employees. These outcomes fully demonstrate the value of the project.

The success story of Dongsheng Thermal Power is testament to 5G being the best solution for building the digital infrastructure of intelligent thermal power plants. In addition to the clear economic benefits brought to Dongsheng Thermal Power, the company's exemplary practice in intelligent transformation has triggered a new trend in infrastructure construction across the industry, with 33 enterprises visiting and learning from Dongsheng Thermal Power. In light of Dongsheng Thermal Power's success, six thermal power enterprises from Beijing, Jiangsu, Zhejiang, and other locations in China have started replicating the company's best practices.

Jiangxi Xinghuo Organic Silicone Plant: 5G-powered smart factory

The Jiangxi Xinghuo Organic Silicone Plant of China National Bluestar (Group) Co, Ltd. (Xinghuo Organic Silicone Plant, for short) is one of the world's top 3 organic silicon companies. However, this large company has faced a number of roadblocks on its digital transformation journey.

To address the hurdles on the way to achieving "high-quality transformation characterized by green, refined, intelligent, and sustainable global operations," Xinghuo Organic Silicone Plant held a workshop themed "5G-powered smart chemical factory" in 2019, and teamed up with partners such as China Telecom and Huawei, as well as research institutes, to establish a joint 5G innovation lab. China Telecom also began the deployment of a pilot 5G network for the plant, aiming to lay the foundations for a 5G-powered smart chemical factory.

Through the joint efforts of companies, universities, and research institutes, Xinghuo Organic Silicone Plant was able to build an enterprise virtual private network based on the 5G Multi-access Edge Computing (MEC) solution in 2020. Subsequently, as of 2021, the plant had developed 10 innovative 5G-powered applications, such as 5G digital-twin factory, 5G + AI security monitoring, 5G online quality detection, 5G drone/robot inspection, and 5G modular-based big data, converging them all into an integrated platform.

Digital technologies — such as 5G, IoT, AI, machine vision, and augmented reality (AR) — have played a key role in the digital transformation of the plant. The plant uploaded data to the platform in real time through the 5G/NB-IoT network and performed an AI-based analysis of the machine failure mechanism model to inform decision-making in areas like machine status identification, failure diagnosis, and predictive maintenance. This has helped facilitate prediction of machine failures and ensured the normal operation of machines.

The application of 5G and machine vision in online detection has helped optimize quality monitoring

standards and eliminate the need for manual detection, which results in heavy workloads and missed detection, thereby improving detection efficiency and reducing economic losses.

With 5G-powered smart terminals, energy consumption data can be uploaded to the 5G back-end monitoring system and monitored in real time. This data is then used for AI-based analysis of the energy consumption trend, enabling the plant to keep track of energy consumption.

5G-enabled AR inspections, supported by remote guidance, can accurately locate invisible components within devices. In addition, 5G-enabled AR terminals allow experts to provide remote guidance in the form of audio, video, and image annotation for reduced operational costs and improved production efficiency.

By combining multiple digital technologies with production scenarios, Xinghuo Organic Silicone Plant has been able to reduce O&M and labor costs, improve product yield, and create a safer production environment. The project has reduced employee violations by 78%, lowered production management costs by 20%, improved product inspection efficiency by 75%, and improved the predication accuracy of process safety performance by 80%.

Thanks to the achievements and advantages demonstrated by the project of Xinghuo Organic Silicone Plant, the 5G smart factory model has been replicated and promoted throughout the chemical industry. This model has now been adopted by a host of smart factory projects, including those of Hunan Hengguang Technology, Nantong Xingchen Synthetic Material Company, and Jiangxi Pinhan New Material, covering eight provinces and cities in China.

Promoting the large-scale application of customized 5G networks

Supported by the 5G X-Cube, China Telecom has worked with its industry partners to tackle the complex requirements and scenarios, as well as help customers successfully build customized 5G industrial networks

and achieve intelligent transformation.

The 5G X-Cube has made it possible for other industry players to draw on the successful experience of success cases. This is because the 5G X-Cube has extracted a complete set of industry templates that cover scenario-specific capabilities and networking solutions based on the success cases, and applied the industry template encapsulation solution to replicate these success cases on a large scale.

Nowadays, customized 5G networks have passed the initial 0→1 stage of development and are entering the 1→N stage of rapid development. However, this is easier said than done. Large-scale deployment and business success cannot be achieved overnight, and certainly not without the coordinated efforts of all parties.

China Telecom's achievements in customized 5G networks has garnered high acclaim from its customers. The company has eagerly fulfilled its social responsibilities, focused on customer requirements in order to promote 5G development and deliver better user experience, and continuously improved the 5G X-Cube in terms of innovative technologies, product solutions, and practical implementation.

If you want to go fast, go alone; if you want to go far, go together. Moving forward, China Telecom will work alongside partners to build 5G OpenLab, making it the first carrier to build an open lab for convergent 5G applications in the industry. In addition, China Telecom will work with its partners to incubate industry solutions and build the 5G X-Cube ecosystem, all with the aim of promoting the application of customized 5G networks in different industries.

Based on success cases, China Telecom will continue exploring new models for the application of 5G in different industries, in order to promote their intelligent digital transformation and fully utilize customized 5G networks, ultimately contributing to China's digitalization.

Laying the Foundations for 5.5G, Building on the Success of 5G for Even Greater Prosperity

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