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How will 5g change the world?

5G: Powering the Internet of Things

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Future Gazing Through 5G

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Saihanba is a cold alpine area in northern Hebei Province bordering the Inner Mongolia Autonomous Region. It was once a barren land but is now home to 75,000 hectares of forest, thanks to the efforts make by generations of forestry workers in the past 55 years. Every year the forest purifies 137 million cubic meters of water and absorbs 747,000 tons of carbon dioxide. The forest produces 12 billion yuan (around US$1.8 billion) of ecological value annually, according to the Chinese Academy of Forestry.

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Wang Yi: China-India Friendship and Cooperation Surging like Yangtze and Ganges

Chinese State Councilor and Foreign Minister Wang Yi answered questions at a press conference on China's foreign policy and relations on the sidelines of the second session of the 13th National People's Congress in Beijing on March 8. Wang Yi remarked that 2018 was an important year in the history of China-India bilateral relations.

The historic meeting, attended by President Xi Jinping and Indian Prime Minister Narendra Modi in the central the Yangtze city of Wuhan, created a new pattern for high-level exchange between the two countries, enhanced mutual trust and friendship between the two leaders and clarified the major direction for development of China-India relations, Wang said.

On the general direction of development of bilateral relations, Wang stressed that China and India, as two ancient civilizations with a total population of 2.7 billion and two developing countries and emerging economies, should cooperate with each other to realize our dreams, provide each other with important opportunities to develop our economies, and work hand in hand to contribute to the revitalization and prosperity of Asia.

China-India High-level Track Two Dialogue

A high-level track two dialogue between China and India was held from March 25 to 26 in Manisar in India's northern Haryana state. Former Chinese State Councilor Dai Bingguo and former Indian National Security Adviser Shivshankar Menon delivered keynote speeches at the meeting's opening ceremony, which was attended by more than 40 former Chinese and Indian government officials and academics.

The dialogue was jointly held by the Institute of South Asian Studies of China's Sichuan University and the Institute of Chinese Studies in India. The first such dialogue was held in Meishan, Chengdu, capital of Sichuan Province, in November 2017.

Ambassador Luo Zhaohui: Dragon-Elephant Tango

Chinese Ambassador to India Luo Zhaohui authored an article published in Indian media titled "Dragon-Elephant Tango Creating the Asian Century" on April 4 for the occasion of the 69th anniversary of the establishment of diplomatic relations between China and India.

Although China-India relations have experienced ups and downs, friendly cooperation has always remained the general trend and norm, Luo declared in the article printed in *The Indian Express*.

The current sound momentum of development has not come easily and should be cherished, he stressed. With an eye on history, the ambassador made the following observations:

First, the two leaders have always firmly grasped the general direction of the development of China-India relations and always made corrections at crucial moments, which has navigated the ship of China-India relations through storms to forge ahead. Second, the forward momentum is now unstoppable. From the perspective of a peak-valley fluctuation model, the fluctuation interval is becoming shorter and shorter which demonstrates the sensitivity, maturity and adaptability of China-India relations. Third, people-to-people exchange is the "glue" for bilateral relations. Personnel exchanges between the two countries exceed one million. Various fields such as culture, education and others have continuously strengthened the basis of public opinion. Fourth, pragmatic cooperation is the "ballast stone." China has been India's largest trading partner for consecutive years. China and India have growing potential for cooperation

in fields of medicine, information technology and interconnectivity. Fifth, multilateral cooperation is the "growth point." By speaking in one voice, the two countries are injecting new impetus into the development of bilateral relations. Sixth, managing differences is the "stabilizer." China and India should move in the direction of enhancing mutual trust, expanding cooperation and narrowing divergences.

century, China and India should strengthen solidarity, maintain positive momentum of sound and steady bilateral relations and uphold the common interests of emerging economies and developing countries.

Vijay Keshav Gokhale said India is willing to maintain high-level exchange with China, enhance mutual understanding, accommodate each other's concerns and promote greater development of India-China relations.

China-India Film Production Dialogue

On April 18, China-India Film Co-Production Dialogue, a theme forum of the Beijing International Film Festival, was held in Beijing. The event featured many filmmakers from both countries sharing views on improving cooperation and development of the film industry.

Indian director and screenwriter Kabir Khan illustrated that despite differences in languages, the two countries share many similarities in culture and expression methods of film and television. He suggested that directors of cinematic co-productions explore new and different storylines to integrate various perspectives and resources into one film.

Foreign Minister Wang Meets Indian Foreign Secretary Gokhale

On April 22, Chinese State Councilor and Foreign Minister Wang Yi met with Indian Foreign Secretary Vijay Keshav Gokhale in Beijing.

Wang reported that in the year since President Xi Jinping met Prime Minister Narendra Modi in Wuhan, the two countries have made great progress in bilateral relations and comprehensively promoted cooperation at all levels in various fields. Facing unprecedented global changes in the last

"Made in India" Conference in Chengdu

On April 26, a "Made in India" promotional conference kicked off in Chengdu under the guidance of the Consulate General of India in Guangzhou and sponsored by India Corner, Chengdu. Representatives from the Indian Ministry of Commerce and Industry and Sichuan business circles held talks on promotion and negotiation.

India Corner, a non-profit program sponsored by the Indian Ministry of External Affairs, was launched in 2018 to promote the country's modern culture and tourism as well as cooperation and exchange with other major countries in the world.

How Will 5G Change the World?

By **Xiang Ligang**

The importance of 5G is not only its faster speed, more efficient energy consumption and lower latency, but also the facilitation of the Internet of Everything. Unprecedentedly wide-ranging functionality is the heart of 5G.

The fifth generation of mobile communications (5G) has been hailed as a "new engine for the digital economy." As the platform for new technologies and industries such as artificial intelligence, the Internet of Things (IoT), cloud computing, blockchain and video social networking, it will provide key support for initiatives such as Made in China 2025 and Industry 4.0.

With the help of 5G technology, mankind will enter an era of intelligent internet featuring mobile interconnection, intelligent sensing, big data and deep learning. The mobile internet will break through limitations of traditional broadband, eradicate problems such as internet latency, allow simultaneous access by huge amounts of terminals, and achieve radical breakthroughs in data transmission capacity. Moreover, its capacity in intelligent sensing, big data transmission and deep learning will be fully leveraged as a powerful service system form.

THREE TYPICAL SCENARIOS FOR 5G

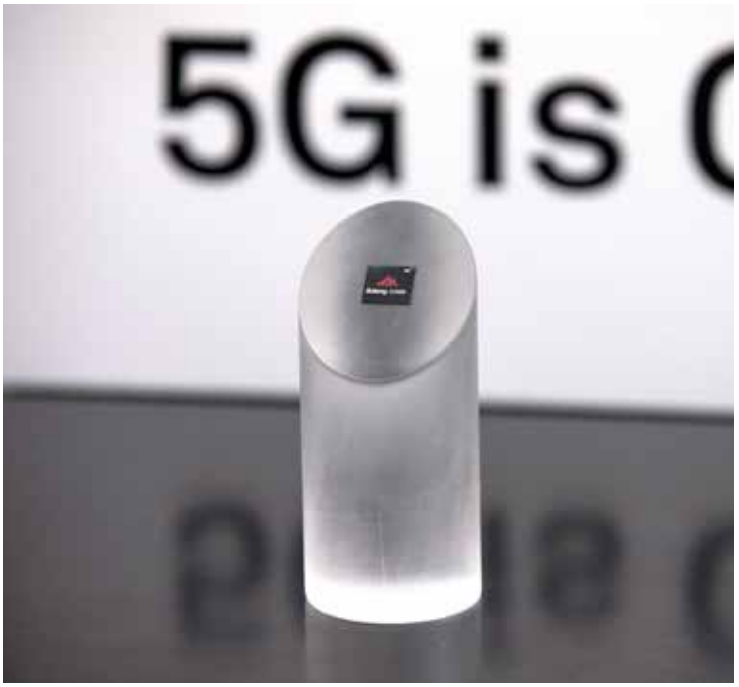
To understand 5G, we must first get to know its application scenarios. According to the 3rd Generation Partnership Project (3GPP), the services foreseen in the 5G era fall into three typical scenarios: Enhanced Mobile Broadband

(eMBB) such as 3D/ ultra-high-resolution video services, Massive Machine Type Communications (mMTC) such as large-scale IoT deployment and Ultra-Reliable and Low Latency Communications (uRLLC) such as automated driving, industrial automation and other services that require low latency and reliable connection.

Compared to existing mobile broadband services, eMBB can substantially enhance user experience. In the 4G era, users have enjoyed upload speeds of 6Mbps and download speeds of 50Mbps, which have fallen behind demand. The value of eMBB lies in its ability to raise the theoretical speed of mobile broadband up to 1Gbps, greatly improving user experience.

The importance of eMBB for services requiring ultra-broad bandwidth such as live broadcasting, high-resolution video and virtual reality (VR) is clear. For instance, due to underdeveloped optical fiber infrastructure, some regions in the United States and Germany still suffer from limited internet access. The application of eMBB will, to some extent, fix this problem while enhancing user experience by providing faster internet access.

As a form of large-scale IoT, eMTC will enable massive machine-to-machine communications. One of the key features of 5G is that it transcends human-to-human communications by realizing man-to-machine and machine-to-machine communications.



January 24, 2019: Huawei holds a release of 5G and Pre-MWC 2019. The Balong5000, a baseband chip for 5G, is released. VCG

Low energy consumption and massive access are two basic requirements for IoT. Increasing amounts of terminals such as street lamps, parking lot sensors, manhole covers, intelligent locks, air purifiers, heaters, refrigerators and washing machines need to be connected to the IoT, many of which lack a stationary power supply and use batteries instead. So, they must be energy-efficient. IoT terminals will also see a sharp increase. China's mobile terminals are expected to increase to 10 billion, of which more than 80 percent will be IoT terminals.

With the help of eMTC, IoT terminals can reduce energy consumption to an ultra-low level so batteries need only be recharged once a month or less.

Traditional communications have relatively low requirements on reliability of the network. However, scenarios like automated driving, industrial robotics, flexible automation and intelligent manufacturing represent higher demand for reliability and latency of mobile communications. The application of uRLLC can meet their demands.

To achieve ultra-reliability, the mobile communications network must operate stably and smoothly, free from external disturbances. The 4G network can achieve a latency as low as 20 milliseconds, but uRLLC can shorten the figure to 1 to 10 milliseconds. The ultra-reliable and high-secured communications

capacity of uRLLC can enable self-driving cars and industrial robots to respond immediately the moment they receive commands. The realization of uRLLC requires support from a multitude of technologies such as edge computing and web slicing.

These three typical scenarios represent the global mobile communications industry's basic vision for the 5G era.

SIX FUNDAMENTAL FEATURES OF 5G

The three typical scenarios of 5G will remove limitations on speed of previous generations of mobile communications and enable users to enjoy faster internet access while using less energy and experiencing lower latency. In some cases, 5G will leave imaginations behind. Moreover, 5G has six basic features that make it superior to its predecessors:

Faster speed. The most obvious difference users feel with every generational change in mobile communications is increase of speed. Compared to its predecessors which measure speeds with MB, 5G can provide an average download speed of 1Gbps, with a peak speed of 10Gbps. After 5G technology is widely applied at intelligent mobile terminals, users' internet experience will be considerably enhanced. It is noteworthy that alongside cell phones, the 5G network will also support the eMBB scenario. Currently, a variety of terminals for this scenario are under development, which will foster new market opportunities and operational mechanisms.

For instance, online live broadcasting has witnessed exponential growth and generated massive business opportunities in the 4G era. 4G can offer an upload speed of 6Mbps, so high-resolution live broadcasting is not fast enough to let multiple users use the service simultaneously. The upload speed of 5G can reach 100Mbps and the application of web slice technology can avoid network congestion, ensuring better live broadcasting. In this context, every user could become a live broadcasting service provider, presenting challenges to live broadcasting of online media portals and traditional television stations.

Higher internet speeds can also generate new business opportunities. For example, the VR industry is expected to achieve breakthroughs in the 5G era. At present, most VR experiences are less than satisfying. An important reason is speed limitations. The arrival of the 5G era will bring a great opportunity for the development of the VR industry.

Higher internet speeds will also turn such concepts as remote medical care and remote education into reality. Remote medical care depends on low-cost internet that supports high-resolution video transmission and low latency. All of these require high-speed networks.

Ubiquitous networking. Only a ubiquitous network can support increasingly enriched services and scenarios. For example, underground parking lots are usually void of mobile signals. Although inconvenient, it remains tolerable today. When automated driving is the norm, self-driving cars would not be able to operate in underground parking lots without mobile signals. Therefore, a pervasive network is necessary.

Ubiquitous networking means full coverage in both width and depth. Full coverage in width means signals should reach any area with human activity including high mountains and deep valleys that previously didn't need networks. Intelligent transportation and other services all need a stable, reliable network. Moreover, with a 5G network, numerous sensors can be deployed to monitor the natural environment, air quality, changes in topography and even hints of earthquakes.

Full coverage of depth refers to high-quality signal coverage. In the 5G era, places like toilets and underground parking lots that used to lack mobile signals will be covered by high-quality mobile networks. In the future, flush toilets at homes could perform urinalysis and upload examination results to the cloud. With the help of big data, sensors could identify your physical conditions and help you improve health. This application will become an important component of future intelligent health management system and play a significant role in improving human health.

To some extent, ubiquitous networking is more important than high data transmission speed. Prior to the 4G era, people often

encountered no signals or weak signals when using their cell phones. This was because the mobile communications network mainly used high-power macro base stations of immense sizes, which cannot be deployed very densely. In the 5G era, micro base stations will be gradually built to cover peripheral areas that are inaccessible to macro base stations, thus making a ubiquitous network possible. When the day comes, all smart terminals will be able to break limitations in terms of time, location and space, and signals will be accessible in every corner of the world.

Low energy consumption. With the constant development of technology, network speed is becoming faster and faster, but the power its equipment consumes is also increasing accordingly. To support massive IoT applications, 5G must take this factor into account.

A prominent example is wearable devices. Despite their rapid development in recent years, wearable devices still face many bottlenecks, one of which is high energy consumption causing an unsatisfying user experience. In the future, all IoT devices will need mobile networks and power. Most will be powered by batteries. Therefore, it is necessary to reduce their energy consumption to lengthen working durations. The goal is to enable most IoT devices to require recharging only once a week or even a month to enhance user experience and make them indispensable in daily life.

Currently, low energy consumption of those devices is achieved mainly by two solutions: one is eMTC led by American telecommunication equipment giant Qualcomm and the other is NB-IoT led by Chinese telecommunications equipment company Huawei. NB-IoT is based on the cellular network and occupies a frequency band of 180 KHz bandwidth. It can be deployed in GSM, UMTS and LTE networks to reduce costs and achieve smooth upgrading. Although its data transmission speed is only 20K per second, NB-IoT can substantially reduce energy consumption to ensure long working duration of devices. This is not only conducive to massive deployment of all kinds of equipment, but also meets the requirements for low energy consumption of 5G IoT application scenarios.

The three typical scenarios of 5G will remove limitations on speed of previous generations of mobile communications and enable users to enjoy faster internet access while using less energy and experiencing lower latency.

Devices with low energy consumption are widely needed. River water quality monitoring is one example: If monitoring sites are set up at an interval of several to dozens of kilometers along the river, results might be inaccurate and locating pollution sources would be more difficult. However, it will be costly to set up a large number of traditional monitoring sites. The only solution is to build low-cost monitoring sites with an enough density to return data in a timely manner. With the help of low energy consumption technology, monitoring sensors that need battery changes only once every six months can be embedded along the river, which will cut maintenance costs.

Low latency. For application scenarios such as automated driving and industrial automation, a highly reliable 5G network is a necessity. Generally, latency of 140 milliseconds doesn't impede human-to-human communication. However, such latency is unacceptable for such scenarios as automated driving and industrial automation.

To meet the demands of those scenarios, the 5G network must offer ultra-low latency. Technologies such as edge computing are predicted to be applied in the 5G network, enabling it to achieve latency lower than one millisecond. The ultra-low latency of 5G will definitely boost the development of self-driving cars and the Internet of Cars.

In 2017, China's first low-altitude digital aviation

March 14, 2019: The Appliance & Electronics World Expo 2019 is held in Shanghai. With the theme of "AI-Smart Life," the Expo showcases the new concept of "Smart Life · Global Platform" with the latest artificial intelligence technology. The picture shows a visitor experiencing smart home appliances with AI functions. VCG

innovation base was unveiled in Shanghai. The base is equipped with both 4G and 5G networks and aims to explore the possibility of building an "air corridor" through low-altitude aviation tests. Thanks to broader bandwidth, higher speed and ultra-low latency of 5G, drones can achieve more accurate control and immediate communication.

Another key area for low latency application is industrial control. A running numerically controlled machine tool must stop immediately when it receives a stop command. If not, it cannot produce high-precision components. With the help of low latency technology, the machine tool will be able to respond as soon as relevant commands are sent to ensure the precision of the components it produces.

Internet of Everything. The basic mode of mobile communications is cellular communications. Currently, each base station can only connect 400 to 500 cell phones simultaneously. The International Telecommunication Union (ITU) expects the 5G network to support a million connected terminals per square kilometer. Ericsson forecasted that by 2020 there will be 50 billion connected devices around the world. It is estimated that China alone will have 10 billion connected mobile terminals by 2025.

Such predictions are based on two reasons: First, in the 5G era, each person or family will have several terminals. A variety of intelligent devices will emerge and become interconnected via the 5G network to form a real intelligent IoT. In the future, the mobile internet will be ubiquitous. Statistics show that by 2018 the number of connected mobile terminals had reached 1.5 billion in China, of which the majority were cell phones. In the 5G era, the majority of connected terminals will be various articles for daily use such as glasses, stationery, briefcases, waist belts

and shoes. Almost all home appliances such as intelligent door locks, air purifiers, humidifiers, air conditioners, refrigerators and washing machines will be connected to the mobile internet and share data with each other.

Second, some previously unconnected devices such as automobiles, manhole covers, street lights and dustbins will be connected to the internet and work in a smarter way. 5G will enable those devices to become "smart". Moreover, many new smart products will emerge to make life more convenient. For instance, smart indoor environment devices will be able to monitor air quality at homes, and control air purifiers, air conditioners and heaters according to monitoring results. In the future, perhaps all devices including wearable widgets will be able to connect to the mobile network, forming a powerful database and achieving the seamless integration of virtuality and reality. This will usher people's lives into a new intelligent era.

The Internet of Everything will also create massive market opportunities. With the expansion of the 5G network, the number of connected devices will increase to hundreds of million to more than 10 billion. As data collecting terminals, those devices will greatly enhance the mobile network's service capacity, based on which cloud platforms and artificial intelligence will see further development.

Reshaping the cyberspace safety system. The traditional internet focuses on issues such as data transmission speeds and unimpeded communications, with "freedom, openness and sharing" as its core values. The 5G-based intelligent internet will have more diverse functions and focus on building a new social and living system. For this reason, its core values are identified as "safety, order, efficiency and convenience."

Safety is the paramount requirement of the intelligent internet. In the 5G era, human society will face grave threats if the cyberspace safety system isn't reshaped. If automated driving is easily hacked, self-driving cars could be hijacked as depicted in some sci-fi movies. Similarly, users' personal information and safety will be exposed if intelligent health systems and smart home systems are hacked. Imagine the world such connectivity but without proper safeguards.

The 5G network must solve safety problems from the bottom up. From the very beginning, the 5G network should introduce a solid safety mechanism and data encryption. The network shouldn't be totally open, and specialized safety mechanisms should be established for some specific services.

According to the latest *China Statistical Report* on Internet *Development* published by the China Internet Network Information Center (CNNIC) in August 2018, 71 percent of Chinese netizens were engaged in online shopping and online payment, and 71.9 percent of mobile internet users used their cell phones to pay. It is predicted that in the 5G era more and more commodities will have IoT sensors to meet the needs of unattended retail stores. With the help of big data, cloud computing and artificial intelligence, safety problems related to mobile payments will be gradually solved. All major financial institutions are working to develop new mobile payment products. Intelligent terminals will help ensure the safety of mobile payments, and the cyberspace safety system is expected to be reshaped.

With the arrival of the 5G era, the traditional internet protocol suite–TCP/IP–will face challenges. The traditional internet features a weak safety mechanism with data largely transmitted without encryption. This situation cannot continue in the era of the intelligent internet. With large-scale deployment of 5G, more safety problems will emerge. All countries in the world should work together to form a new cooperation mechanism to organize a new cyberspace safety system together.

The author is a renowned observer of China's telecommunications industry, a mobile internet theorist, director-general of Zhongguancun Information Consumption Promotion Alliance, and a guest professor at Century College, Beijing University of Posts and Telecommunications. He has 20 years of experience in telecommunications research and practice. Recently, his book The 5G Era *was published by China Renmin University Press. The book introduces the basic technologies and features of 5G and analyzes 5G's impact on all relevant sectors. This article was excerpted from the book with permission.*

India and 5G: Preparing for a Quantum Leap

By **Aravind Yelery**

With its credible capacity to bolster communication and national growth, 5G is expected to bring about a revolution in the way data is transmitted and used in India, from agriculture and education to public safety and disaster management.

In India, where mobile communication with 4G technology is a luxury for most of the semi-urban and rural population, the central government has taken a forward-looking approach to pursuing the quantum leap to 5G. With several technological and policy roadblocks to get past, India's experiment with the adoption and implementation of 3G and 4G had been quite disappointing. With its promising growth rate, it is inevitable for India to consider 5G technology an essential component to becoming a digital economy.

TECHNOLOGICAL LEAP

Globally, the standardization of 5G has already accelerated the competition among technological companies. The standard for the standalone version is expected to be in the final round of experimentation. This acceleration of the standardization work plan will enable early 5G deployment in several markets. Countries like the US, Japan and South Korea are setting up for the expected major 5G network deployments from 2020. Networking and telecommunications giant Ericsson forecasts over 1 billion 5G

November 23, 2017: The fifth Global Conference on Cyberspace opened in New Delhi. Indian Prime Minister Modi attended the conference. VCG

subscriptions for enhanced mobile broadband by the end of 2023, accounting for 12 percent of all mobile subscriptions. A Nokia report indicates how 4G LTE contributed to 92 percent of the total data traffic in 2018. Nokia's annual Mobile Broadband India Traffic (MBiT) Index study in 2018 also reveals that the 4G growth came at the cost of 3G data traffic, proving the rising demand for cutting-edge technology services. By the end of 2018, there were more than five times as many 4G subscribers as there were 3G subscribers. The report also claimed that the average data usage grew by 69 percent in 2018, to touch 10GB per user per month in December 2018. The rising demand for data services and competitive data tariffs has helped the subscriber base. The situation for 5G is expected to be much more intense.

INDIA'S OPTIONS AND DELIVERABLES

The Indian mobile market and telecommunication peripherals have been increasingly dominated by advanced technologies beyond 3G. 4G connectivity, which was rolled out in phases since 2012, benefitted the Indian consumers immensely. The asking rate for high-speed data connectivity continues to rise and has put pressure on Indian service providers to meet the demand. Already, a competitive and price-sensitive market has created challenges for telecom service providers as well as the government agencies to adapt quickly. India's mobile market has also seen a steep rise in 4G subscriptions over the past few years, and this growth is expected to continue with the rollout of the 5G revolution. Going forward, as the government and service providers gear up for 5G-enabled services, there remain several challenges to tackle as well.

It is important to remember that the 4G technology – a phenomenon barely older than four or five years – continues to contribute to India's digital transformation, and LTE technology was still the dominant mobile access technology by the end of 2018. The 4G technology offered

under different specifications in India is not standard but still continues to seep through Tier-1 and Tier-2 cities to the smaller towns and below. In India, the number of LTE subscriptions continues to grow strongly and has been forecast to reach 5.5 billion by the end of 2023.

Globally, business opportunity for telecom from 5G technology is expected to double from US$500 billion to US$1 trillion by 2028, and it will enable productivity growth to historical levels. For government agencies and service providers in India it has become obvious to start exploring options to build the country's own 5G ecosystem and put them in place so that the integrations can happen in time.

In September 2017, Indian government set up the 5G Steering Committee to suggest a road-map for the adoption of 5G. It was a high-level forum focused on 5G technology, attended by representatives from the ministries of communication and information technology, and science and technology, as well as those from industry and academia.

In early 2018, while the committee was investigating India's 5G prospects, the government asked select major telecom service-providers to partner with telecom gear-makers and showcase India-specific 5G use cases by early 2019. In August 2018, the 5G Steering Committee submitted its recommendation, identifying the 5G roadmap and recommended that the Indian government announce the policy for the allocation of the 5G spectrum. The panel also noted that 5G would be critical for various areas including agriculture, education, public safety and disaster management. Among the key recommendations and action plan outlined in the report were spectrum policy; regulatory policy; education and awareness promotion; application and use case labs; participation in international standards; development of application layer standards; and major 5G trials.

November 25, 2018: India Mobile Congress (IMC) opened, in New Delhi, the second since 2017. VCG

Under deployment, said the report, 5G could be rolled out in tandem with technological advancement being achieved globally. An early rollout with efficient 5G networks would maximize the value offered by this new technology. The plan also aimed to build India's industrial and R&D capacity in the design and IP dimensions of 5G. The experts have already suggested pushing the manufacturing sector to join the tech sector's leap by expanding the manufacturing base in 5G for both semiconductor fabrication as well as assembly and test plants.

In terms of operationalizing these recommendations, the Indian government expects to complete processes for 5G spectrum auction and roll out services by 2020. Though there are growing speculations about whether India's telecom ecosystem is ready, the Indian government seems to have geared up to announce the policy as soon as the field trials are done.

At the level of regulation, the Telecom Regulatory Authority of India (TRAI) would continue to play a critical role in deciding the calendar for initial, partial and full deployment of 5G services. The infrastructure, rules and policies are being developed concurrently. It is expected that TRAI will auction

about 8,644 MHz of telecom frequencies at an estimated total base price of 4.9 million Indian rupees, which includes radio waves for 5G services.

Since the global pilot launches have already begun, the making of the spectrum cannot be delayed. In 2018, Verizon launched a home broadband service using the next-generation wireless technology and AT&T brought 5G services to a dozen cities. In China, telecom operators have conducted pilot launches as well. Going forward, 2019 will see the launch of actual 5G wireless networks along with phones that will run on them. And for when this happens, Indian regulators guarantee that 6,000 Mhz of spectrum for 5G can be made available without delays.

PLAYERS AND STAKEHOLDERS

The task to make 5G a reality is a challenge and requires streamlining. After receiving the feedback from the Steering Committee, the Indian government established task forces to cater to the various aspects of the 5G ecosystem. Considering the vast potential of 5G for ushering in a major societal transformation by enabling a rapid expansion of the role of information technology across manufacturing, educational, healthcare, agricultural, financial and social sectors, India must embrace this opportunity by deploying 5G networks early, efficiently, and pervasively, as well as emerge as a significant innovator and technology supplier at the global level. Emphasis should be placed on 5G touching the lives of the rural and economically weaker economic segments so as to make it a truly inclusive technology. Hence, the following nine task forces have been set up: 5G Spectrum Policy; Regulatory Support for Efficient 5G Deployment; 5G Trial Suggestions; Application Layer Standards for 5G India; Education Awareness Promotion Summary for 5G India; Use Case Labs for 5G India 2020 HLF Summary; Action Plan for Participation in Global Standards and Forums; Aligning Govt. Investments in Academic Research to Impact 5G Products and Services; and Recommendations for Creation & Management of a large Indian IP Corpus for 5G Technology. Most of the task forces have submitted their reports.

5G trials are being planned for the end of 2019 or early next year. Early deployments may take place in the second or third quarter of 2020. The government is preparing to let the present telecom service providers take the opportunity to procure the trial spectrum and airwaves at minimal or no cost for a reasonable duration to carry out 5G trials.

OPERATIONAL AND FINANCIAL FEASIBILITY

Although India has laid out a road-map to meet its 5G requirements, the path ahead is arduous. The bigger telecom companies are exercising caution before taking a plunge into the cycle of future-based investments while the ecosystem and standards for 5G are in the testing and preparatory stage. Global developments have been of significant help, by providing examples and advice on how 5G technologies can be better understood and used. India also showed interest in seeking Huawei's help in 5G pilot testing and in September 2018, soon after the Indian government approved the new National Digital Communications Policy 2018, Huawei was invited to participate in the trials. A forerunner in the 5G arena, Huawei has invested heavily in 5G-related core technologies and in developing the core competencies.

With its credible capacity to bolster communication and national growth, 5G is expected to bring about a revolution in the way data is transmitted and used by consumers and other players in India. Especially in an era where artificial intelligence and data are more effectively utilized by public agencies and companies, quality network connectivity plays a crucial role. With a focused network, 5G will help conserve power and energy. The role of the Indian government in ensuring 5G's development without compromising on technological standards, impacting the customer experience and creating prospects for the market is critical. Several challenges lie ahead but by observing a clear road-map, India's 5G dreams will likely very soon turn to reality.

The author is a Senior Research Fellow at Peking University HSBC Business School.

The Inevitable Trend of 5G

—Interview with Yu Shaohua, Academician of the Chinese Academy of Engineering (CAE) and Deputy General Manager of China Information and Communication Technologies Group Corporation (CICT)

By **Anita Yin**

The process of digitalization, networking and intelligence has resulted in global integration of cyberspace, the physical world and human society. With unimaginable capabilities in information sensing, transmitting, storing and processing capacity, 5G networks will create infinite possibilities.

The internet connects more than 200 countries and regions worldwide and serves more than 3.55 billion netizens. Undoubtedly, the development of wireless mobile communications technologies will exert far-reaching influence on the world. Like many other countries, China is gearing up to introduce the newest generation of mobile connectivity: 5G.

In the 5G era, it will take only seconds to download a high-resolution movie, and data transmissions with high requirements for immediate response such as live broadcasts, high-resolution television, virtual reality, mobile gaming, navigation, trading and remote controlling will become faster and more convenient. Recently, *China-India Dialogue* (CID) sat down with CAE Academician and CICT Deputy General Manager Yu Shaohua to discuss the current status quo and future challenges for commercial usage of 5G in China.

CID: WHAT ARE THE MAIN CHARACTERISTICS OF 5G MOBILE COMMUNICATIONS TECHNOLOGY?

Yu Shaohua: 5G offers higher speed, wider coverage and connectivity, lower latency and greater reliability. The vision and key capacities of 5G have been identified through support in three major scenarios:

March 4, 2019: The first 5G trial base station for civil use in Tianjin begins operation in the Minyuan area of Heping District, marking the beginning of 5G operation in the city. IC

enhanced mobile broadband, ultra-reliable and low-latency communications, and massive machine-type communications. Indices such as transmission speed experienced by users, latency, connection density, mobility, and peak rate have also been determined. Consider enhanced mobile broadband as an example: In terms of speed, 5G allows users to download at a speed of 1Gbps and can achieve a peak rate of 10Gbp, about 100 times faster than 4G. In terms of terminal quantity, 5G supports a million terminals connecting to the internet at the same time within an area of a square kilometer, about 1,000 times greater access than 4G. In terms of latency, 5G can achieve one-millisecond end-to-end latency, 10 times lower than 4G. All technical indices of 5G are expected to grow exponentially compared to the previous generation of mobile communications standards.

Upon reviewing the development process of communications technologies, it is obvious that 3G mainly targeted the needs of individual users, and 4G began to expand to the Internet of Things (IoT), while 5G is expected to facilitate full implementation of IoT and even expand to fields like the Internet of Cars and social management. The industrial internet is another important scenario for 5G applications because the internet is expected to expand from consumption to industry and other realms. With the help of the industrial internet, things like logistics, data flow, personnel flow and capital flow in a factory can be integrated to achieve precise management of every production link, minimize production costs and enhance efficiency to increase market competitiveness.

Furthermore, people now aspire for an era of the "Internet of Everything." When such an era arrives, all things including houses, cars, electric appliances and even molecules and atoms can be connected via a wireless network and achieve real-time data acquisition and even automated

control. Today, China has a population of nearly 1.4 billion. If each person operates several or dozens of home appliances and electronic devices connected to a network, as many as 100 billion terminals would be required. That would be an earth-shaking change.

CID: HOW IS CHINA'S DEVELOPMENT OF 5G TECHNOLOGY GOING OVERALL?

Yu: China's development of wireless mobile communications technologies can be divided into four phases: China was absent from the 1G era, lagged behind in the 2G era, made breakthroughs in the 3G era, and finally caught up with global frontrunners in the 4G era. Due to its strong capacity to stimulate the development of a wide array of industries, 5G has become the focus of competition among telecommunications equipment manufacturers worldwide. Currently, the formulation of international 5G standards is accelerating, and China is gearing up to promote its 5G deployment. Thanks to previous technological accumulation, relevant Chinese enterprises rank among world leaders in 5G-related technological development and intellectual prosperity rights as they closely participate in the formulation of international 5G standards. China's Ministry of Industry and Information Technology announced that it would issue 5G temporary licenses in the second half of 2019. At first, the 5G network will still focus on individual users. China is expected to achieve large-scale commercialized use of 5G by 2021.

CID: WHAT BOTTLENECKS ARE HINDERING CHINA'S 5G TECHNOLOGY DEVELOPMENT?

Yu: China still faces some challenges with development of some core technologies. When the global 5G standards

April 15, 2019: Workers with telecommunication company Headway Group at Huzhou, Zhejiang Province, hasten to produce optical fiber to fulfill an order. The company specializes in the production of communication optical cables and broadband data cables, and its products are widely used in 5G base stations. VCG

are unveiled, we will need to redesign chips and manufacture base station equipment. 5G has strict requirements for costs, sizes, weights, stability, reliability and other indices of chips, software and equipment, as well as the core network, all of which are impossible to be accomplished with one stroke.

For instance, the 5G network needs to simultaneously connect a million terminals per square kilometer in populous cities like Shanghai. This is like enabling a million people to use their cell phones at the same time in the same place—a great test for a series of core technologies and facilities such as chip design, computing capacity and base stations.

Moreover, large-scale commercialized use of 5G needs to consider ratio of return on investment. It will cost a mobile service operator at least a trillion yuan (US$ 146 billion) to build a nationwide 5G network. How can any enterprise hope to recover such an astonishing investment? In the 4G era, WeChat was the top killer app. What will be the dominant app and iconic service in the 5G era? Profitability is the primary concern for enterprises as they promote the development of 5G.

Despite a multitude of challenges, the development of 5G is an inevitable trend. The world is now undergoing a process of digitalization, networking and intelligence resulting in in-depth integration of cyberspace, the physical world and human society. This process is causing profound changes in global competition, security, economics and cultural landscapes. Over the next 20 years, internet and telecommunications technologies are expected to facilitate connectivity between humans, the internet and things as well as systematic integration of the Internet of Everything with all industries and sectors. The 5G network enables unimaginable information sensing, transmitting, storing and processing capacity that will create infinite possibilities.

April 17, 2019: The world's first 5G auto drive bus line operated by Yutong Group opens for trial operation. VCG

CID: WHAT COOPERATION HAVE CHINA AND INDIA MADE IN DEVELOPMENT OF 5G TECHNOLOGIES?

Yu: India is a major emerging market. India now boasts strong capacity in software development for telecommunications but still has much space for improvement in terms of hardware. India is active in applying new telecommunications technologies. Recently, India's minister of communications announced that the country would accelerate construction of its 5G network over the next four years and provide complete 5G services by 2022. From a long-term perspective, India's 5G market has great potential.

Some Chinese companies have played an active role in India's 5G development. Reports have indicated that some Chinese smartphone manufacturers are already building research and design centers in India as they help the country develop 5G solutions that meet the demands of the global market and develop smartphone products tailored for the Indian market. Moreover, Chinese 5G equipment manufacturers are collaborating with Indian mobile operators to carry out tests of 5G applications.

5G: Powering the Internet of Things

—BFA Participants Talk 5G

By ***China-India Dialogue***

When completed, the 5G network is expected to permeate every sector and industry, resulting in developments beyond imagination.

The number of 5G-connected terminals is expected to reach 400 million by 2025, half of which will be in Asia. At the 2019 Annual Conference of the Boao Forum for Asia (BFA), honorable guests, including Miao Wei, China's Minister of Industry and Information Technology, Sung Yun-mo, South Korea's Minister of Trade, Industry and Energy, Li Huidi, executive vice president of China Mobile Communications Corporation, Lei Jun, chairman of Xiaomi Corporation, Chen Wen-chi, CEO of VIA Technologies Inc., and Yang Chaobin, president of Huawei's 5G Product Line, shared views on the future of 5G.

WHAT ARE THE KEYWORDS FOR 5G?

Miao Wei: Openness, cooperation, and a unified global standard.

Sung Yun-mo: Integration. Building 5G infrastructure is important, but connecting 5G with existing industrial facilities is even more important. In the future, 5G will enjoy infinite potential for development.

Li Huidi: 5G will deeply integrate with all industries, permeate every aspect of daily life and promote economic development and digitalization, lifting human society into a new era featuring "intellectual connection of everything."

Lei Jun: 5G will substantially drive the development of various industries. First of all, cell phones will shift to 5G in the coming two years. Second, it will step up the development of the Internet of Things (IoT).

Chen Wen-chi: The most important features of 5G are massive bandwidth and ultra-low latency. Moreover, a 5G network is segmentable. In the 5G era, everything will be linked more closely, and numerous new applications will emerge.

Yang Chaobin: As a new generation of communications technology, 5G brings four key features: massive bandwidth, multi-perspective viewing, multi-connectivity and safer connections.

WHAT DO THE VISION AND ROADMAP FOR 5G DEVELOPMENT LOOK LIKE?

Miao: The 3G era featured three major global standards, a figure that dropped to two in the 4G era. 5G has only a single unified standard worldwide. China has made contributions to the formulation of the 5G standard—it was even dominated by China—but many telecommunication enterprises and research institutions from various countries contributed to it. Indeed, China may take the lead in the number of patents necessary for the 5G standard. However, 70 percent of all patents concerning the 5G standard are held by companies and research institutions beyond China. The 5G standard is a fruit of joint efforts of all of mankind, so we should cherish it from the bottom of our hearts. The benefits of a unified standard are self-evident—it will be crucial for industrial development and application.

As far as application of 5G is concerned, only 20 percent of bandwidth will be used for person-to-person communication, while the other 80 percent will involve communication between things, namely the mobile IoT. In terms of communications, 5G can transmit many things that 4G cannot such as virtual reality (VR) and augmented reality (AR) data as well as the 4K high-resolution signals that Chinese television recently introduced. In terms of transmission, 5G will considerably expand application scenarios.

March 28, 2019: "5G: Bringing Things to Life with the IoT," a sub-forum for the Annual Conference of the Boao Forum for Asia is held in Qionghai, Hainan Province. VCG

The Internet of Cars is expected to be the largest segment of the mobile IoT market. Many predict that self-driving cars will be one of the first applications of 5G. Countries around the world are already committed to advancing development of self-driving cars. Mobile communications are necessary to facilitate automated driving, which requires data transmitted and analyzed much faster than in person-to-person communications. China is accelerating the digital and intelligent transformation of its highways. For instance, alongside the color signals of green, yellow and red, traffic lights will send communication signals for passing vehicles to identify automatically. Moreover, cameras will enable city planners to record and analyze the speeds and driving habits of all passing vehicles to optimally adjust lights to reduce congestion and improve traffic efficiency. To coordinate traffic lights and vehicles in a timely way, 5G technology is a necessity.

Upon its completion, the 5G network is expected to permeate every sector and industry, resulting in the emergence of things now beyond imagination.

Sung: People and things will become connected more closely in the 5G era, creating countless applications. 5G will push the industrial sector to generate massive amounts of data. By combining IoT technology, the network will exert tremendous influence on traditional industries and daily life.

South Korea has long been pushing the commercialization of 5G. In February 2018, 5G services were demonstrated at the Pyeongchang Winter Olympics. South Korea began auctioning the 5G spectrum to mobile telecommunication operators in June 2018, and a completed base station with the necessary equipment began to provide B2B commercial services in October of the same year.

One application scenario to

which South Korea attaches great importance is intelligent manufacturing, namely, upgrading overall production efficiency, optimizing workflow and conducting quality examination in factories with 5G technology. 5G phones will soon emerge in South Korea. Considering the country's relatively small population, we plan to set up a nationwide 5G network for commercial use first.

Li: Looking at potential opportunities brought by 5G technology, China Mobile launched work related to 5G as early as 2012, such as advancing the development of 5G technologies and standards. As China Mobile builds a world-leading 5G network, it is seizing the opportunity to reform its operational mode and allow the move to drive transformation and upgrading of the entire industry. We unveiled a 5G+ Program that aims to integrate 5G and 4G. China Mobile operates the world's largest 4G network, which is comprised of more than two million base stations. The coordinated development of 5G and 4G is crucial for various applications.

Another concept we are promoting is "5G+AI," which eyes the integrated development of 5G with new technologies such as artificial intelligence (AI), IoT, cloud computing and edge computing to provide more diverse applications and better user experience.

We are also committed to building a 5G+ ecosystem with our partners to achieve closer integration of 5G with social and economic development and people's lives to create higher value. Moreover, we are pushing innovation of 5G applications. Recently, China Mobile collaborated with the Chinese PLA General Hospital to complete a remote brain surgery in Hainan Province with the help of 5G technology. Further development of 5G will benefit more and more people in more ways.

Lei: Since the very beginning, Xiaomi has maintained a business mode of "hardware+software+internet services" and aimed to make smartphones ideal for the internet. The biggest difference between Xiaomi and traditional hardware manufacturers is that we never rely on hardware to make profits. In early 2018, Xiaomi pledged to cap the profit margin of its hardware business at five percent with an aim to become a century-old company providing goods for the people by offering quality products at affordable and rational prices. With this business mode, Xiaomi still manages to earn enough profits. A few days ago, Apple Inc. unveiled a new business strategy that sounds very similar to what Xiaomi was doing when it was founded. We believe that the application of 5G on the internet looks like a promising future. Guided by the strategy of enabling our smartphones to connect to all devices, over the past few years Xiaomi has achieved connection to 140 million IoT terminals, ranking first among consumer internet service providers in the world. Not long ago, Xiaomi launched a strategy for smartphone+AIoT dual-engine application. I believe that Xiaomi will find great opportunities for development during the 5G wave.

Yang: 5G is a new generation of mobile communications technology. I believe that over the next 10 years, network construction, technological progress and application innovation in the field of mobile communications will all focus on 5G. Although some countries are already talking about 6G, there is no way it could possibly arrive until 2030 at least. 5G will dominate mobile communications over the next decade. No one doubts that 5G will form mature mobile networks. Now, many see 5G development from different points of view. Some focus on current applications while others eye applications in five or 10 years. Nevertheless, it is vital to let all sectors and industries participate in the formulation of the 5G standard. If the standard was merely formulated by experts on mobile communications and lacked the participation of other industries, we would have no idea whether it would satisfy the demands of those industries.

Finally, I would like to share my views on the development of the 5G industry. In 2018, soon after the release of the first 5G standard, two problems were solved: one concerned bandwidth and transmission speed, and the other was security framework. Huawei joined hands with China Mobile and LG to deploy 15,000 base stations. Based on our trial commercial use in Europe and the Middle East, 5G can certainly achieve super-wide

bandwidth and high speed. We believe that 5G users will enjoy a data transmission speed 10 times faster than the current network. This goal will be certainly achieved. Due to improvements of speed and bandwidth, the cost of 5G services will surely be reduced by a big margin.

Another concern is safety. Over the past five years, regulating agencies from more than 20 countries as well as dozens of companies have discussed challenges facing future mobile networks as they have defined a complete security framework and mechanism. For example, as a wireless communication system, the 5G network will definitely transmit data wirelessly. For example, 5G adopts 256-bit encryption. It would take Tianhe-2, one of the world's fastest supercomputers, millions of years to crack 128-bit encryption, let alone 256-bit encryption. In the 5G era, we must consider the possibility of cyber attacks using future quantum computers. Even if that were to happen, we would still be able to maintain safe, reliable communications.

In fact, the 5G standard passed by the 3rd Generation Partnership Project (3GPP) defines relatively complete bandwidth and security frameworks. The 5G Release-16 standard is expected to be unveiled in 2020. Next, 5G will expand to massive machine-type communications (mMTC) to support massive IoT applications, which is expected to arrive by 2021 or 2022 during the Release-17 and Release-18. By that time, we will see all primary goals of 5G realized. For players in the IoT industry, it is not necessary to wait for the mMTC standard to carry out relevant business. Mobile operators in China and South Korea have widely deployed enhanced machine-type communications (eMTC) to foster IoT business to help drive 5G. We can now attempt IoT applications with the help of the eMTC network.

ARE YOU CONFIDENT ABOUT THE FUTURE OF 5G?

Miao: I have always been confident about 5G.

Sung: I predict that Xiaomi cars will soon reach the market. I believe we will realize this dream because 5G will generate unlimited possibilities. We have launched many projects related to 5G, and countries around the world have reached consensus in this regard.

Lei: For now, Xiaomi is still focused on 5G smartphones. We already unveiled 5G smartphones at the Barcelona Mobile World Congress (MWC) in February 2019.

Li: China Mobile is a network operator. Equipment manufacturers are upstream of us, and application businesses are downstream. China Mobile is like a porter shouldering two ends of a pole. We hope to truly enhance the end-to-end strength of the industry with our 5G network. We have already launched trial commercial use and will realize large-scale commercial use next year. By then, our 5G network will be able to support diverse application scenarios as it delivers low latency and massive connections. We will need large amounts of multi-modal, multi-frequency, and multi-form terminals at various prices ranging from high and medium end to low end. I hope that manufacturers will release medium- and low-end 5G cell phones next year so that more users will be able to experience 5G services.

Chen: I too am confident about the future of 5G. At present, trial 5G networks cannot stand alone. Driven by the Ministry of Industry and Information Technology and mobile operators, the industry is prepared for standalone networking. Standalone networks will bring enormous benefits, so I'm confident about the future of China's wireless communications industry.

Yang: When a new generation of communications technology is born, terminals are always the primary bottleneck and problem. For instance, 4G standards were already unveiled in 2008, but the first 4G cell phone didn't appear until 2011. The situation is different for 5G. Soon after the release of the 5G standard last year, almost all major smartphone manufacturers unveiled 5G prototype terminals for commercial use at the Barcelona MWC in February 2019—even though not all of them could connect to the 5G network. However, smartphones released by Huawei and Samsung can already work on the 5G commercial network. We are confident about the future development of 5G.

5G Battle Royale

By **Ankit**

As the global commercial launch of 5G services approaches, heads are turning to see which market manages to lead the way. India, a major force in the mobile data market, is a key contender this time around.

The number of mobile phones globally is expected to reach 5 billion this year. Accessibility of smartphones and tablets has caused a surge in mobile data consumption and subsequent demand for faster and more reliable connections. Cellular standards are becoming faster than ever, and we have already been introduced to the fifth generation of mobile technology, known as 5G.

5G is all the rage in tech circles worldwide. The cellular standard targets high data speeds, reduced latency, energy saving, cost reductions, higher system capacity and massive device deployment. The term has been floating around since last year, and 5G already saw its first few practical applications at the Mobile World Congress in Barcelona in February.

Most major brands showcased 5G-enabled and capable devices, essentially announcing the mainstream arrival of fifth-generation cellular connectivity. Phones, tablets, computers and numerous Internet of Things (IoT) gadgets were displayed. Still, everyone is waiting to see the full potential of the technology play out. But will a market like India have to wait

September 26, 2017: A salesperson displays the JioPhone at a store of the Reliance Industries' Jio telecoms unit, on the outskirts of Ahmedabad, India. Reuters

slightly longer? How ready is its telecom infrastructure for 5G?

INDIAN INTERNET REVOLUTION

While the internet, in the form of wired and wireless connections, has been available widely in India for the better part of the past two decades now, the country's internet revolution gained new momentum in 2016 with the emergence of Reliance Jio, a telecom operator owned by one of India's richest citizens, businessman Mukesh Ambani. Jio substantially cut data and call rates, vastly improved India's network availability, and most importantly, popularized 4G connectivity.

Reliance Jio crossed the 50-million subscriber mark within 83 days of its launch and attracted 100 million subscribers in less than six months. The operator managed to indirectly consolidate the Indian telecom market, leaving only two major private players and one government-backed competitor left. The ARPU (Average Revenue Per User) dropped for all operators, causing several smaller players to bleed out and eventually collapse or merge with bigger peers.

The mobile data market further benefited from the launch of the JioPhone, a unique smart feature phone with 4G VoLTE capabilities. 4G cellular standards blended with the affordability and accessibility of feature phones proved a solid formula for success in the Indian market, with reports estimating the JioPhone's sales having reached over 50 million in less than two years.

April 20, 2016: An employee waits for customers at a billing counter inside a Bharti Airtel store in New Delhi, India. Reuters

The process of India's transition to 5G, however, has not been smooth. The Telecom Regulatory Authority of India (TRAI) usually allots cellular spectrum, split geographically, to the highest bidders, who carry out feasibility tests, trial runs, and then proceed to a public launch. However, the spectrum isn't yet up for bidding. The Indian government is expected to announce a 5G roadmap by June 2019. It has promised an auction sometime in the second half of 2019, which would give operators enough time to prepare for a late-2020 or early-2021 commercial launch. But the reality on the ground remains complicated.

Except for Reliance Jio, Telecom players in India fear high costs, which may lead to bidding hesitation. This will allow Jio to outbid everyone and gain the biggest first-mover advantage the market has seen. The resulting scenario will be starkly different from the 4G revolution because other players won't even have any spectrum to test.

SURVIVAL OF THE FASTEST

As a pioneer in 4G affordability and availability in India, Reliance Jio is also confident in its role as a leader of India's 5G wave. The telecom operator has already demonstrated multiple 5G trials with self-driving cars, surveillance drones and other rescue mobility devices. If cellular spectrum bids in India go as planned, we could see Reliance Jio raking up a sizeable share. It can then use that advantage to launch commercial services as soon as 2020. If Jio does indeed manage to pull this off, it will dominate the market, absorbing all new 5G mobile users in 2020.

Of course, affordability is key. 5G smartphones are already available, but

not for less than US $1,500. Considering that the average smartphone retails for about $190 in India, most consumers won't be jumping to grab the 5G phones anytime soon.

Jio will look to tap into this market with its own 5G-capable mobile phones. We might see cheaper options from the company, possibly even a successor to the JioPhone, that offer 5G support. In fact, top officials of the company have hinted at just that by stressing that the device ecosystem is critical in ensuring operators aren't just sitting on spectrum as they wait for affordable devices to reach the market.

Once the biggest player in the market, Airtel has seen its share of ups and downs—mostly the latter—over the last couple of years. As a result, the company's ARPU and overall revenues have taken a hit since the Jio 4G revolution. Airtel CEO Sunil Mittal has confirmed that his company will not be purchasing any 5G spectrum at the prices TRAI has set. He believes that the current pricing is unsustainable and that companies might have to charge users a premium to avoid major losses. At these prices, he wants ARPU in the Indian market to reach approximately 300 rupees, up from its current figure of 100 rupees. However, the 5G spectrum is a necessary evil that Airtel must invest in to stay in the game.

Back in February 2018, Airtel collaborated with Chinese communications giant Huawei to perform India's first 5G network trial under a supervised test setup. Airtel claimed that 5G mobile networks could theoretically offer data speeds up to 100 times faster than current 4G standards. The test trial resulted in a user throughput of more than 3 GBPS using the custom setup.

Subsequently, Airtel has sought to collaborate with Nokia to conduct trials with its "homogeneous fronthaul solution" to prepare for the impending 5G network launch in India. This solution is expected to provide higher capacity for Airtel, which is required for the expected data load.

And finally, Airtel has also partnered with Cisco with a promise to build "India's largest 5G-ready IP network" as soon as possible. Reliance Jio also depends on Cisco to provide network architecture.

While Airtel is hesitant about 5G spectrum allocation and its supposedly inflated pricing, India's largest telecom player, Vodafone Idea (previously two separate companies, Vodafone and Idea), has a clear plan: it wants Indian authorities to organize the spectrum auction only after 2020. The company's representatives argue that the market doesn't really yet have many users for the new technology and would be better off delaying the rollout.

Vodafone Idea argues that the biggest application for 5G would be IoT and that current 2G/3G/4G standards are adequate for 95 percent of current applications in this space.

But a primary concern is the high cost if spectrum bidding takes place earlier than it would like. Vodafone Idea does not want Reliance Jio to dominate before it even makes a first move. In a somewhat savvy move, however, Vodafone Idea has launched full-fledged tests of 5G networks in India. It has partnered with Swedish telecom hardware manufacturer Ericsson to source 5G-ready network equipment.

September 26, 2016: A man speaks on his mobile phone next to a Vodafone advertisement in Kolkata, India. In most of India's rural areas, 4G service is still a luxury. Reuters

This equipment is expected to prepare Vodafone Idea for the upcoming 5G launch in India.

This suggests that the telecom company is taking the 5G fight as seriously as other players but wants to delay the spectrum auction as long as possible for obvious reasons. As per the latest official update, Vodafone Idea is apparently ready to provide 5G services using its existing allocated spectrum to meet requirements from niche markets like virtual reality and medical use cases. The Vodafone-Idea merger is still ongoing and expected to be complete by June of next year. The company is attempting to avoid major strategic decisions before the two units are consolidated.

Bharat Sanchar Nigam Limited (BSNL), India's state-owned telecom provider, hopes to change its fortunes with the advent of 5G standards in India. Top officials from the service provider absorbing heavy losses have claimed that BSNL will launch 5G services the day of the global launch.

While the company's chances in the new market may be slim, BSNL is leaving no stone unturned to ensure the opportunity to capitalize on this development, as it did with 4G availability in India. BSNL partnered with telecom hardware providers Nokia and Ericsson as early as 2017 to perform early tests and trial runs as early as possible.

With Nokia, BSNL plans to initially leverage its 4G services and prepare them for an upgrade to 5G with better equipment and smart manufacturing. Much like Vodafone Idea, BSNL also believes that a lot of usage cases for 5G will be in the IoT space, so it is building smart gadgets to soon leverage the advantages of the 5G technology.

BSNL will be working with Ericsson to develop new 5G use cases, enable knowledge-sharing on 5G technology concepts and study industry trends in the space. BSNL will utilize Ericsson's existing resources to work on applications in 5G areas like rural connectivity, connected healthcare, industrial automation, public safety, video surveillance, energy and agriculture.

BIG PICTURE

While India may be a fast-growing mobile market, China still has the greatest number of mobile subscribers. The country's largest operator, China Mobile, has outfitted a six-mile road with 5G-capable cell towers. The company claims it to be the world's largest 5G trial so far. Since late 2018, China Mobile has been actively carrying out wireless communications tests with IoT devices in a bid to completely embrace the 5th generation cellular connectivity. China aims to be the first mover, and thus the key player, in this major technology paradigm shift.

As for 5G rollout in the U.S., most major telecom operators in the country have already announced commercial plans for 5G deployment. While Verizon and Sprint will start rolling out 5G capabilities in select areas in the first half of this year, others like AT&T, T-Mobile, and US Cellular are planning to target the second half of 2019. This has been made possible by early freeing up of spectrum by U.S. authorities back in 2016. Only Charter Communications, a minor player, seems to be still testing 5G services without a solid rollout roadmap.

South Korea has been the swiftest of the lot. The world's first 5G services emerged there, when all telecom providers deployed services simultaneously on December 1, 2018. In March 2019, South Korea set the goal to become the world's first "full-fledged" 5G-capable mobile network nation. Compatible Samsung smartphones, a South Korean brand, were already poised to capitalize on the advantages of the new network.

In the hardware sector, Samsung and Huawei – two of the biggest smartphone OEMs (original equipment manufacturers) in the world – have unveiled flagship 5G-capable smartphones: Samsung's Galaxy S10 5G and the Huawei Mate X, respectively. Additionally, several hardware vendors around the world have showcased 5G-capable IoT devices. As we move towards a global commercial launch, the spotlight remains on which market will manage to win the 5G race. India, a force in the mobile data market, is one of the biggest contenders today.

The author is a technology journalist based in New Delhi.

Global 5G: The Cost of Doing Business

By **Li Jianfeng**

Everyone expects innovation in mobile equipment after the popularization of 5G. But 5G requires huge investment and much remains to be seen.

5G, the next generation of telecommunication, is expected to be deployed in major countries and regions over the next few years. Theoretically, 5G will offer extremely high speeds for mobile downloads (over 1G/s), low delay (lower than 1ms) and excellent network stability. Deployment of the 5G network will be significant. Such a strong network will inspire innovation in many areas such as Internet of Things and autopiloting, and spur unprecedented breakthroughs in science and technology.

HOW MUCH MONEY IS NEEDED?

New technology needs new funding, and building a 5G network demands a massive amount of money. Estimates of the capital needed vary, but the basic consensus is that it will be two to three times the money spent on 4G. Why? Technically, a 5G network consists of two parts. The first is the front-end wireless access network, which is characterized by a high-frequency band and a high-density antenna system. The high-frequency band can achieve extremely high download speed, but it cannot transmit information over long distances, and its ability to penetrate buildings is relatively weak. Therefore, it is necessary to set the antenna system in almost every place, including indoors, to relay and strengthen the signals.

The second part is the 5G core network at the back-end, which is characterized by separated software and hardware. The software allocates network resources based on cloud computing. In the traditional 4G network and networks of earlier generations, hardware resources were allocated according to region, and network capacity was built according to regional needs. It was a fixed arrangement. But demand for bandwidth is like demand for electricity—there are peaks and valleys. The challenge for telecommunication companies is to balance demand for peak and low tide periods, as well as demand across regions. When the hardware and software are separated, the network's resource allocation can become dynamic and

flexible. Hardware construction can be centralized, and software can flexibly allocate network resources according to different requirements or even offer customized services for specific scenarios through software. This is the biggest attraction of 5G to telecommunication companies: Upon completion, operational cost will be reduced significantly.

According to estimates of institutions, the cost of a complete 5G network will be two to three times that of a 4G network, which means that pressure on telecommunication companies to spend will mount in years to follow.

Although telecommunication companies around the world are all discussing 5G, it's not about increasing demand for them. During every technological upgrading, telecommunications industries around the world haven't attained better pricing. Just the opposite has happened: Customers have paid less and less and received more and more service. 5G will be no exception. Few customers will be willing to pay more for a 5G network because the speed, capacity and price of 4G meet their current needs. As for commercialization of 5G, numerous long-term possibilities exist, but clear and specific application in the short term has been lacking. As a result, investors hoping 5G will boost the performance of telecommunication companies are probably in a disappointment.

ALL DECIDED BY COST

If 5G won't increase sales revenue, how is it generating so much industry enthusiasm? The answer is cost.

The mobile data consumed by users continues is to grow exponentially and shows no signs of slowing down for many years to come. Planning network construction to meet such growth in demand is one of the biggest challenges facing telecommunication companies. At present, the global 4G network capacity is partly unused, but it will be overwhelmed within two to three years. At that time, costs will soar if they continue to meet increasing demand with 4G infrastructure.

According to estimate by the Boston Consulting Group, if the telecom companies only

April 17, 2019: Journalists try 5G mobile phones. China Mobile begins to distribute 5G-capable devices in Zhejiang Province. IC

rely on the 4G network to meet the demand on growth of data consumption, the per capita user's cost to telecommunication enterprises will increase exponentially after 2022, quadrupling by 2025 compared to 2018. If a sturdy 5G network is deployed, telecom companies will even realize a reduction in per capita cost for the network.

EUROPE AND THE U.S.: INCOMPLETE 5G

Because of the high cost of 5G construction, which cannot be financed with higher pricing in the short term, European and American markets are adopting a step-by-step strategy to build 5G. Over the next 12 to 18 months, major European and American countries will see major telecom operators claiming their networks upgraded to 5G, but these so-called 5G offerings are likely to be incomplete. In some areas where users are concentrated, telecom operators will adopt a 5G frequency band for the front-end wireless access network. At the same time, major telecom operators in the same country also share as many hardware resources as possible to save on investment. In the back-end, however, the core network will still be built on the infrastructure of 4G. The advantage of this approach is low cost. The disadvantage is that it will not fully realize the potential of 5G nor really reduce the cost.

Along with the same problem as Europe, the U.S. has an additional problem in that some high-frequency bands of 5G were allocated to naval communications. This has caused commercial telecommunication companies to spend considerable energy to circumvent this frequency band, which added a lot of difficulty to network design.

Due to such speed bumps, deployment of 5G in the Europe and the U.S. will be rather slow. According to an estimate from Airspan, a supplier of broadband wireless equipment, only 3.4% of mobile phones and 12% of data transmitted around the world will be based on 5G by 2022.

It is worth noting that Japanese electronic commerce and internet company Rakuten has announced ambitious plans for entering telecom industry. Not concerned with an existing outdated network, Rakuten is eyeing construction of a complete 5G structure network from both front-end and back-end. Rakuten representatives are confident they will be able to cut the consumer price of telecom services in Japan in half. Rakuten's bold plans for 5G should not go unnoticed.

CHINESE MARKET: THE REAL 5G

China boosts incomparable advantages in building 5G. First, it is a national strategy. 5G construction in Europe and the U.S. has always been purely managed by telecom enterprises, which are usually unable to make long-term decisions on investment because they must consider both short- and long-term profitability. Their governments can give some support through policies, but money is limited due to tight profit margins. 5G deployment in China, however, is guided by the government's painstaking efforts and is based on the idea that present costs will benefit future generations. While Western countries look for the shortest route to a return on investment, China's long-term game has lifted its infrastructure to the best of developing

April 4, 2019: 5G service commercial in Seoul, South Korea. South Korea's three major telecommunication operators launch 5G services, the first in the world. The country takes the lead in launching commercial 5G services ahead of China and the United States. VCG

countries as it has made critical contribution to China's economic boom over decades. "Made in China" has become an unmistakable icon of the global supply chain. Ongoing enthusiastic construction of 5G in China is as important as China's past endeavors to build roads, bridges, railways, harbors and airports. The technology will make significant contributions to China's scientific and technological innovations over decades to follow.

Second, China has cost advantages. Like Japan and South Korea, China has built a dense wireless access network, much denser than in Europe and the U.S. As a result, deployment of 5G will not only be very fast, but also cheap.

Due to the impact of trade friction with China, the U.S. has deliberately overblown the issue of cybersecurity with Huawei, with a real intention of keeping the company out of construction of 5G. But America's plan will probably fail because China's advantages are so strong. The motivation for countries to build 5G is to lower costs, and Huawei's plan has outstanding advantages in cost. Huawei's plan is estimated to cost only half of comparable plans from Western countries. As discussed, governments of Western countries don't have the ability to subsidize 5G construction. Consequently, based on cost considerations, most countries around the world, especially European countries, won't be able to resist Huawei's high-end products and services.

January 29, 2019: Workers with China Unicom in Tongling, Anhui Province test the performance of 5G base station equipment for commercial use. VCG

OPPORTUNITIES FOR INVESTMENT

Telecommunication operators probably won't perform well. According to experience in technological upgrading, companies will engage in major spending over two to three years. And the spending won't produce more revenue. As a result, cash flows of those operators during the early stage of upgrading will deteriorate glaringly. The capital spending on 5G will likely exceed that of the previous upgrading, so the cash flows of telecommunication operators remain a worry.

Manufacturers of 5G equipment will probably thrive in one to two years. Also according to experience, manufacturers will enjoy a boom in the early stage and then peak in two to three years according to the classic S Curve (Growth curve models) and will see a fall in both shipments and unit price.

Finally, industries that offer services for 5G will also see steady profits. Many services involving the 5G network are reproducible services that cannot be replaced easily or attained from a competitor. The biggest player involved could be the telecommunication tower industry. Towers that are densely deployed are important assets. The construction of 5G will require countless towers, and telecom companies will pay for renting equipment for these towers constantly. Rent becomes part of the cost for telecom companies, which will provide a steady cash flow for tower industries. However, investing tower companies should take local regulations into account. Countries regulate different threshold to the industry, and have their own pricing strategies, which directly decide profit rate of assets of towers.

What is most anticipated, however, is innovation in mobile equipment after 5G goes mainstream. We are just seeing the beginning, and it's looking like huge potential. More scenarios for application now beyond our imagination will emerge.

Not all companies involved in 5G can prosper. In recent years, we have seen the price of stock shares of companies with names including "telecommunication" skyrocket, which is probably overenthusiastic.

The author is responsible for global stock investment for EFG International.

Applications of the Internet: Consumers to Industry

By **Lu Tingjie**

Rather than a solo show for telecommunications operators, 5G will become an incubator and catalyst for social innovation.

After four generations of development, mobile communications technology is now entering the 5G era. Its process of evolution has produced an amazing coincidence: odd-numbered generations have all involved disruptive technologies that changed the "rules of games" by creating new application scenarios while even-numbered chapters have been mere optimizations and improvements on predecessors.

1G made wireless communications possible and resulted in the emergence of the earliest cell phones. Because they adopted analog technology such phones featured unsatisfying call quality and often crossed lines. 2G introduced digital coding technology, making cell phones smaller and better, but it still only met the demands of person-to-person speech communications. 3G enabled mobile phones to connect to the internet. In the 3G era, Steve Jobs brought Apple iPhones and the app store to the world, redefining the mobile internet and coming in "over-the-top" of mobile networks. Reappropriated from basketball in the mobile internet realm, "over-the-top" refers to a device providing various applications without the support of any physical network. Adoption of 4G technology substantially improved call quality and data transmission speed, satisfying the fast-growing needs of mobile broadband users.

From 1G to 4G, mobile communications technology had always been focused on applications for individual users such as person-to-person communications and man-machine communications. 5G marks another revolution of communication technology, and will open up an era of the Internet of Things (IoT). The 5G network can connect people, humans and computers, humans and things, machines and things and various applications. More importantly, it creates an "ocean" to bestow on informationized applications of enterprises and industries the capacity to connect to the IoT, Internet of Cars and industrial internet.

Undoubtedly, the key to the success of 5G lies in a successful business mode that

can foster a healthy business ecosystem. In the 5G era, mobile operators will adopt four major business modes based on data traffic, connections, web slices and integrated solutions, respectively.

The first business mode is based on data traffic. The first application scenario to mature in the 5G era will be enhanced mobile broadband (eMBB) mainly targeting individual consumers. In this scenario, data traffic will be the main product of mobile operators, who need to accelerate the upgrade of users and adopt differentiated data traffic charging patterns.

Second is the business mode based on connections. For a scenario of massive connections, revenues from connection services will be the main source of income for mobile operators. In this case, operators can provide standalone connection services including some terminal equipment and modules and charge users according to IoT equipment SIM cards.

The third business mode is based on web slices. In the 5G era, mobile operators can provide customized web slices for different vertical industries and sectors to support their business development. Users in vertical industries can directly buy web slices from operators.

The fourth business mode is based on integrated solutions. Currently, many manufacturing enterprises are facing challenges as they move towards digitalization, networking and intelligence. Based on 5G services, mobile operators can provide industrial enterprises with a full set of solutions ranging from connections in and beyond factories to digitalization of equipment terminals and platform upgrading. Compared to the other three modes, this business mode has higher added value. Operators will face more rivalry in vertical industries, so competition will be fiercer.

Innovation in 5G business modes should not merely depend on mobile operators. Indeed, operators provide empowerment tools for various industries, but achieving innovation still rests on the shoulders of industries themselves. Obviously, it will be hard for telecommunications operators to provide customized communications services for all administrative and corporate clients in a wide range of realms. However, operators can open their capacities and let industrial clients determine their own vertical solutions based on their most pressing demands. Clear business modes are necessary for the development of 5G. We need to consider the problems this technology can solve, the revolutions it can bring to society and how to create suitable application scenarios and profit models.

Thus, rather than a solo show for telecommunications operators, 5G will become an incubator and catalyst for social innovation. Of course, some "middleware" companies will integrate communications capacities of different mobile operators and provide communications services for clients from various areas as virtual operators.

Many believe that 4G changed daily life while 5G will change society. But, how exactly will 5G change society? In my opinion, it will change the operating efficiency of society, industrial ecosystems, rules of market competition and even national competitiveness.

For example, the operating system on most desktop computers is Windows. With the arrival of the mobile internet, Microsoft didn't move on from Windows but instead the Windows Mobile operating system for mobile phones was a failure. The two operating systems specially designed for smartphones—IOS and Android—have prevailed. As our world enters the era of the IoT, new operating systems will definitely emerge, presenting great opportunities to change the rules of the game. Such new operating systems will probably generate new business logic or technological innovation.

Over the next five to eight years, 5G will permeate every aspect of daily life and reshape the ecosystem of the digital economy. It will kindle a revolution in terms of platforms, technology, networking and many other areas, drive the development of national economies, and change the rules of the game in human society for decades to come.

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Rural India's Boundless 5G Potential

By **Lohith Amruthappa**

From precision farming to disaster management, effective deployment of 5G technology in India's villages could be transformative.

The usage of broadband cellular network technology in India has been on the rise in the last decade. According to the 5G Steering Committee, chaired by professor A J Paulraj, the cumulative economic impact of 5G on India can reach US $1 trillion by 2035. The benefits of this cutting-edge fifth-generation broadband technology extend to both urban and rural areas, and in case of the latter, it could transform agriculture, healthcare, transportation and roads. The potential is endless.

Global markets are justifiably upbeat about 5G. Telecommunications companies are claiming that in all likelihood, the new technology will achieve faster speeds, higher bandwidth and low latency. For businesses and policymakers, this could mark a new milestone in the journey towards digitalizing India.

PRECISION FARMING AS THE NEW NORMAL

India's numbers in farming are impressive. It has a vast and diverse agricultural sector, which is among the top three global producers of several crops, and the second-largest fruit producer in the world. Its arable land, as of 2011, measured 159.7 million hectares (394.6 million acres) and was the second-largest globally, after the US. India is therefore in need of evermore technological capabilities to optimize its productivity and efficiency in agriculture, and maximize output.

The private sector is striving to build the future of farming. Mahindra Group, a household automotive manufacturing company, launched GPS-enabled driverless tractors with unique features like auto steering, auto-implement lift and geo-fencing lock, to name a few. Powered by cloud servers, the Mahindra Group's DiGiSENSE technology stores and retrieves information from multiple sources. Agriculture equipment maker Escorts has ambition plans to introduce autonomous tractors two years from now, which can be used for seeding, tilling and spraying of crops without human operators. With wireless high-speed internet and GPS synchronizing into a smart grid infrastructure, 5G will help these companies to avoid earlier common

March 20, 2015: R. N. Sahoo, a senior scientist at the Indian Agricultural Research Institute (IARI), prepares to install a high resolution remote sensor used for crop mapping in a wheat field at IARI in New Delhi. REUTERS

functional failures.

The problem of marginal land holdings is widely seen as an unfixable cog in the rural economy wheel. Thanks to 5G, newer companies will emerge, offering long-range rental drones that can record and transfer a stream of motion graphics at the rate of 1 Gbps speed with unparalleled precision for plant-scouting and spraying. Already, a Mumbai-based automation technology start-up has developed an electric autonomous tractor for renting out to farmers who own smaller pieces of land. Rentals as a service will be a new trend in the domain of farming equipment. 5G helps businesses like these to achieve high-accuracy positioning in automation.

Bharat Broadband Network Limited (BBNL), set up by the Indian government, has laid optical fiber cable up to 3,19,702 km. This project, named BharatNet, has rolled out broadband services to over 250,000 village offices. India consequently no longer suffers from major cases of connectivity gridlock in villages. 5G will further cut down the transmission delay and accelerate data collection to unprecedented speeds. In the coming years, precision farming can be achiever through high-speed internet to collect data between the farming equipment and other applications.

ERA OF SMART FARMING ON ITS WAY

To a great extent, Internet of Things (IoT) is a novel workaround technology to overcome severe water shortage. Its increased ability to monitor humidity, soil moisture, temperature and intensity of light in real time significantly reduces the likelihood of water wastage. 5G will increase data accuracy, playing an important role in overall plant growth.

Data-based dairy farming too is on its way, and fast. By planting RFID Tags and sensors to track the health conditions of cattle, farmers can eventually improve cow nutrition, leading to increased dairy farming productivity. Immediate access to the most up-to-date physiological data insights, milk production forecasting, diet change recommendations, news of pregnancies and vaccination reminders are sent in real time to farmers for better decisions.

Farming across India has major disparities in income. Those in the non-agricultural sector earn three times as much as their agricultural counterparts. Mounting fluctuations in commodity prices are a source of great distress. Through calculating large amounts of data in milliseconds, AI predicts price movement in commodity trading. 5G will thus lend a new invisible hand to farmers in the decision-making process.

In 2018, the Ministry of Agriculture & Farmers' Welfare set a vision to double the income of farmers by 2022. The new-age technology will ensure the government's farm support schemes reach the small and marginal farmers.

THE FUTURE OF HEALTHCARE

It is one thing to rollout a healthcare plan for nearly half a billion Indian citizens. It's entirely another matter to bring healthcare to the doorstep for poor people living in the lesser-populated regions and isolated areas, whenever needed. This fundamental problem is yet to be solved. The highly touted 5G is expected to transform the healthcare sector, enabling remote monitoring of patients and at-home diagnosis, eliminating the need to travel hours for treatment in the country's far-flung areas. A strong wireless network will help doctors in performing pre-planned robotic surgeries from remote locations. Doctor-on-demand platforms will be able to offer patients with a plethora of verified medical practitioners for instant online consultation.

The power of centralized data in a cloud platform is largely unexplored. Data speeds around 10Gbps mean that not only can large files of medical images be stored, but also, the download times of ultra-HD videos, and X-ray and ultrasound scans will go down to literal seconds. Given the access to massive amounts of data generated by private medical practitioners, private and government hospitals, data scientists and predictive analytics teams can leverage it to avoid any future virus outbreak and detect epidemic-prone diseases.

September 28, 2012: A farmer uses his oxen to till his land in front of a satellite dish set up in an adjacent field in Narayangaon. REUTERS

HANDLING PUBLIC SAFETY

According to the Ministry of Home Affairs, "about 60 percent of the landmass is prone to earthquakes of various intensities; over 40 million hectares is prone to floods; about eight percent of the total area is prone to cyclones and 68 percent of the area is susceptible to drought." Rural areas are extremely vulnerable to natural disasters.

Powered by 5G, eMBB (enhanced Mobile Broadband) and mMTC (massive Machine Type Communications) solutions will be predominantly used in public protection and disaster relief radio communications.

The next-gen devices will be more sophisticated than land mobile radios, and enable organizations engaged in rescue work to respond in real-time to disaster-hit regions. The shift from LTE (Long Term Evolution) broadband technology empowers better collaboration between various institutions in the disaster areas. 5G-enabled MCC (Mission Critical Communications) are far superior to the current MCPTT (Mission-Critical Push-To-Talk) technology. One of the most notable enhancements to MCC is that first responders can leverage a unified platform to communicate with various agencies.

For example, during a wildfire, firefighters can currently only talk via radios. With 5G-enabled devices, firefighters can send videos, media files, receive drone footage and participate in group chats. The good news is that all this communication can be done without a tower.

EXPERIENTIAL LEARNING

Students from rural India are often forced to move to cities, away from their homes, to attend expensive preparatory classes for top educational institutions' entrance exams. The kids and their parents experience tremendous socio-economic pressure due to the lack of quality and affordable education. But with online coaching, students can learn anywhere and anytime. Indian educational startups have begun focusing on personalized teaching and immersive learning via computers, mobiles and VRs. 5G will boost the broadband speeds, and enable students to learn through Augmented Reality (AR) and Virtual Reality (VR). Samsung India has already launched VR content for the students of Jawahar Navodaya school to enable them to experience the magnificent Sun Temple in Konark, through Samsung Gear VR.

March 20, 2015: Researchers analyse a satellite image for crop mapping at Indian Agricultural Research Institute (IARI), in New Delhi. REUTERS

Rural India has a staggeringly high student-to-teacher ratio. Students experience great difficulty having their doubts clarified. Through deep learning, bots offer personalized teaching based on behavioural traits. By reducing latency, 5G can offer a superior learning environment. Improvements like video content being downloaded in classrooms to assist teachers at a faster pace, without breaking students' concentration, will greatly help.

THE FUTURE OF 5G

Skepticism about 5G coverage in rural areas is understandable. However, industry leaders seem to be confident because narrowband technology can travel ten times further than the existing LTE technology. Small cells offers new alternatives to cell towers, and can be installed in specific geographical locations. With a strong infrastructure, structural reforms in regulations and considerable incentives to private organization, 5G's development in rural areas will be within reach.

Telecom companies should aim to democratize the broadband services to prevent a digital divide in India. The UK has already started a project named "5G RuralFirst," testing Industrial IoT, Agritech, Dynamic Spectrum Sharing, and Terrestrial Broadcast Network projects in rural areas. New-age startups should present a strong business case to the government about the benefits of broadband technology. Enterprises should not limit themselves to merely funding a pilot project.

Instead, trials need to be deployed to a large number of villages to create a solid sample size. This will instill confidence in policymakers to make tectonic shifts in infrastructural reforms. India needs a specific action plan to usher the 5G revolution beyond cities.

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Global Race to 5G

By **David Abecassis, Janette Stewart, Chris Nickerson**

According to the report *Global Race to 5G* released in 2019, the competition for 5G dominance continues in countries around the world.

On April 2, 2019, Analysys Mason, a British telecommunication consulting company, released the latest edition of the report *Global Race to 5G*, which analyzes the situation of the 5G spectrum and infrastructure around the world and compares various national 5G policies.

In the first edition of the report released in 2018, China and South Korea ranked before the U.S. in 5G deployment. However, the latest report shows the U.S. as having passed South Korea to take the lead alongside China.

SPECTRUM WORK CONTINUES

Since the first *Global Race to 5G* report was released in April 2018, preparations for 5G have progressed considerably. 5G is shifting from a technological experiment to deployment and commercialization. Application of 5G has been conducted by telecommunication operators in many countries and regions including South Korea, Qatar, Finland, Estonia and the U.S. So far, application of 5G has unfolded at intermediate frequency bandwidth (eg. 3.5GHz) and high frequency bandwidth (eg. 28GHz). In 2018, many suppliers released 5G devices that can be used at these bandwidths, which are expected to reach consumers this year.

At the time of publication of the report, 5G services were being launched based on either home internet use or nomadic use via 5G routers. Most offered services can be described as "enhanced mobile broadband" (eMBB). Several vendors already announced the launch of 5G smart phones during 2019.

Governments worldwide are continuing to consider the race to 5G in their policy decisions. 5G spectrum assignment progressed during 2018 with regulators in Italy, Spain, the U.K., the U.S., South Korea and Australia completing auctions of the spectrum suitable for 5G deployment. Low-band spectrum, such as the 600MHz and 700MHz bandwidths, is also expected to play a key role globally in providing wider-area coverage for 5G services.

The industry equipment standards group, 3rd Generation Partnership Project (3GPP), is now entering the second phase of 5G specifications ("3GPP Release 16"), the first stage of which is expected to be completed by March 2020 after completion of the initial phase ("3GPP Release 15" specification) in 2018.

With 3GPP Release 16 expected to expand on 5G capabilities in both radius and core components of mobile networks, further service opportunities will emerge as 5G networks become essential components of connected digital opportunities widely foreseen over the next decade.

NATIONAL STRATEGIES FOR 5G

Recognizing the importance of 5G technology and

January 10, 2019: International Consumer Electronics Show (CES) is held in Las Vegas. Exhibiting many cutting-edge technologies, this global exposition for science and technology attracts 4,500 enterprises, including 1,200 start-ups, setting a new record. VCG

mobile networks to provide connectivity for new digital services over the next decade, governments of many leading 5G markets have now published formal 5G strategies and programs of policies to facilitate 5G development and deployment. Examples include: Australia's '5G—Enabling the future economy' strategy, France's '5G Roadmap,' Germany's '5G Strategy for Germany,' Japan's 'Policy to realize 5G in 2020' (in time for 5G services to be available to the public during the Tokyo 2020 Olympics), Spain's '5G National Plan 2018–2020,' the UK's 'Future Telecoms Infrastructure Review' and 'Next Generation Mobile Technologies: A 5G strategy for the UK' and the U.S.' '5G FAST Plan' and National Spectrum Strategy.

In other cases where a specific formalized 5G plan has not been published, national governments are still encouraging the development and commercial deployment of 5G technology as part of broader national broadband plans or digital strategies. For example, in China, the 'Made in China 2025' plan and the 13th Five-Year Plan explicitly aim for commercial launch of 5G services by 2020.

On March 7, 2017, (the Germany Federal Minister of Transport and Digital Infrastructure and members of the Network Alliance for a Digital Germany) adopted the 'Gigabit Germany Initiative for the Future'.

In March 2018, (the Canada Canadian Minister of ISED) announced a joint investment in 5G between the government and industry parties known as the "ENCQOR" project. ENCQOR is a CAD$400 million project to "establish the first Canadian pre-commercial corridor of 5G digital infrastructure," with focus on providing access to 5G networks to SMEs, researchers and academia.

On July 15, 2016, the U.S. government announced the launch of the US$400 million Advanced Wireless Research Initiative (AWRI) led by the National Science Foundation (NSF). The AWRI includes a US$85 million investment in 'advanced wireless testing platforms' via a public-private partnership including NSF and over 20 technology companies and associations. NSF plans to invest an additional US$350 million over the next seven years in academic research that can use these testing platforms. Several complementary efforts by other federal agencies were also announced.

It should be noted that the AWRI is not a 5G specific initiative. Rather, it is a longer-range NSF initiative with the government sponsoring advanced wireless test beds for cutting-edge wireless technologies and use cases.

The Federal Communications Commission (FCC) unveiled its '5G FAST' plan in September 2018. The plan categorizes the FCC's approach to 5G development under the following three primary headings: assignment of spectrum, updating of infrastructure policy and modernization of outdated regulation.

The White House issued a "Presidential Memorandum on Developing a Sustainable Spectrum Strategy for America's Future" in October 2018, calling for development of a National Spectrum Strategy by mid-2019, citing the "imperative that America be first in fifth-generation (5G) wireless technologies."

The article is an excerpt from the report Global Race to 5G.

AI in the 5G Era: Raising the Bar

By **Zhang Zeqian**

AI empowered by 5G will bring unprecedented advances to the leisure industry.

Artificial Intelligence (AI) has been widely employed in the "pan-entertainment" industry in terms of films, televisions, variety shows and games. In film and television, AI has become an emerging technology to promote filmmaking. Also, the technology has been adopted in production and marketing to widen the scope of variety. In games, AI has enhanced stable performance, giving players a more enjoyable experience. In the era of 5G, the development of technology will bring a long string of surprises.

FASTER FILM AND TELEVISION PRODUCTION

In recent years, iQiyi, one of China's most popular online video platforms, released many popular variety shows, films and TV plays such as "I CAN I BB," "Idol Producer," "The Mystic Nine," and "Operation Love," resulting in heavy website traffic. Gong Yu, founder and CEO of the platform, revealed that AI has played an important role in their achievement.

Against the backdrop of a wave of computing reform driven by big data, online users have become comfortable with posting about their interests on various platforms. The video industry is no exception. To better meet consumers' interest, iQiyi goes above and beyond machine recommendation algorithms to deeply utilize AI technology to guide its operations in seven fields: intelligent creation, intelligent production, intelligent annotation, intelligent distribution, intelligent playback, intelligent realization and intelligent customer service. The goal is to provide the most attractive content to viewers. Gong Yu believes that with the help of AI, iQiyi has created a differentiated competitive advantage.

"Although machines still cannot make precise predictions, the AI system at least helps us make more informed judgement," explains Gong. "Already, iQiyi can predict the box office of a film six months in advance with a variance accuracy of 77% thanks to machine learning. In the TV drama flow forecast, the accuracy of the variance six months to a year ahead is as high as 88%. These predictions help us decide whether or not to purchase a movie

February 27, 2019: The humanoid robot Daisy of the American company Cloud-minds is seen dancing during the MWC2019. The presence of devices prepared to manage 5G communications has been the hallmark of this edition. VCG

and what a good price would be as well as guiding our choices on what kinds of movies to produce."

The application of AI technology in the film industry is not limited to iQiyi. Not only is AI helpful in producing popular films and TV plays but also in writing scripts and transferring 2D films into 3D with just a push of a button. David Hasselhoff starred a 9-minute-long sci-fi movie written by Benjamin, an AI algorithm.

Throughout history, film and television scripts had always been human-created. The sci-fi short written by AI made many realize the great potential of AI in innovative work.

In the 2D to 3D technology commonly used in the film and television industry, AI has demonstrated extraordinary capabilities. At the "3D Display and Industry Development Summit" hosted by the Ministry of Industry and Information Technology in September 2017, an AI stereoscopic designer "Zhengrong" developed by DreamWorId Tech demonstrated the technology of automatically converting 2D to 3D format.

According to Zhao Tianqi, founder and CTO of the company, "Zhengrong" is a 3D-making platform based on AI and 3D display technology. Through the platform, regardless of time and location customers can convert a ground plan or videos into 3D with a strong visual impact.

Zhao Tianqi believes that the labor-intensiveness of the current film and television production industry is causing a huge diparity with advanced forms of film and television communication. AI-based production of film and television is a realistic demand, and AI will definitely spark a new revolution in the film and television industry.

PROPELLING VARIETY SHOWS

Since its debut in 2017, the variety show "The Rap of China" has increased the popularity of hip-hop culture in China. In addition to the attraction of many star judges, the variety show had already drawn wide attention before it was released: It was China's first variety show to use artificial intelligence in operations and production.

Executive producer Chen Wei explained that many AI technologies have been used in producing and marketing the program including producer selection and show editing.

For example, when choosing a producer, they used an AI matching system, which considered popularity, professionalism, music expertise and fan feedback to single out Gloria Tang with a match rate as high as 90 percent.

As for the show's production, over a hundred cameras were operating on set and managed by an AI system that drastically cut the workload of editors.

Additionally, the show adopted an "only him/her" function, which, through facial recognition technology, enabled users to watch only their favorite people,

greatly improving the user experience.

"The Rap of China" was not the first variety show to use any sort of AI. But in previous shows, AI often played an on-screen role as a guest like the Little V and Little Du robots in "Mask Singer" and "Super Brain." But no matter the role AI technology plays, it is changing the way TV program is made. "AI might lead to a revolution in variety shows," admits Dr. Min Wanli, chief scientist of Alibaba Cloud and AI.

Analysts have determined that AI will cause four major trends in variety shows. First, experience is "king." Traditionally, when content was "king," variety shows with excellent content were popular with viewers. Thanks to the rapid development of AI and VR technologies accelerated by 5G, variety shows that give viewers an "immersive" feeling have become a mainstream. Audiences pay more attention to the overall experience than the content on the screen.

Secondly, the power of advertising can be strengthened. Variety shows have always been battlefields for advertisers. After the entry of AI, production costs are dropping but advertising revenues are certainly not. On the contrary, AI enables advertising clients to sponsor certain variety shows in a more vertical way and can even "tailor" a variety show to their own brand for better advertising effects.

For instance, in "Who's the Keyman," a wildly popular variety show on Hunan Satellite TV, China's leading entertainment channel, sponsor Viomi Smart Home arranged the settings featuring the performance of a smart home, allowing Viomi to reap huge advertising revenues.

Thirdly, AI will take a leading role. Presently, AI remains at a technological level and an image based on AI still cannot play a key role in a variety show. However, few doubt that AI could one day become the central figure in a variety show.

With the development of AI technology and the internet, AI stars combining the novelty of technology and "personal" charisma will certainly emerge and draw many fans. A variety show with AI stars would not be completely surprising.

Fourthly, humans are integrating with AI. As AI technology develops, more people see AI as more than a tool and understand how it could merge with human expertise. The integration of human and AI could play a bigger role in producing variety shows.

AI can mass produce variety, but it needs further learning to understand complicated feedback. And human power can help AI make programs that align closer to mainstream social values. AI can also build a new type of entertainment platform featuring automatic production and a steep cut in human labor.

With the help of 5G, AI has become irresistible to television producers and is sure to motivate new reforms of the sector.

September 26, 2018: Powered by big data and AI technologies, four robots play a 2-2 football game at a "5G Experience Park" set up by China's telecoms company Huawei. VCG

SMOOTHER GAMING

The word "eat chicken" is used throughout the Chinese internet thanks to the game "Jesus Survival: Great Escape." The phrase has become synonymous with a player's first place in the game. Before the game was acquired

by Tencent, one of China's largest Internet service providers, the phenomenon of "plug-in" cheating was serious because the servers were all outside the country. The game would frequently lag at night, leaving users with a less-than-ideal experience.

After it acquired exclusive operation rights to the game, Tencent Cloud officially released Supermind intelligent network products which use AI technology to protect the gaming experience and network security.

If games lag often, it generally represents a network failure. When a traditional network fails, engineers must explore every link of the network. Programmers must check hundreds of line warnings to find relevant information and then carefully check the specific computer room and host. This set of processes takes at least half an hour.

Thanks to AI technology, Tencent Cloud's Supermind intelligent network products offer high performance, global interconnection and intelligent features, which can fully eliminate game hiccups.

To improve performance, the Tencent Cloud server has optimized and upgraded the physical network and uses the intelligent network card SDN module to separate the network action layer (Fastpath) and the policy layer (Slowpath), which increased the network bandwidth throughput of Tencent cloud host more than three times over.

In terms of global interconnection, Tencent Cloud deployed 36 availability zone nodes in more than 21 geographical regions around the world, providing users with nearly 100 global BGP access and TB-level total export bandwidth capabilities and helping them achieve better internet connection.

April 5, 2019: People play rock, paper, scissors with a robot at a 5G experience station in Hangzhou, the first of its kind in China. Thanks to low latency of 5G and AI computing, robot can guess its opponents' gestures and make judgement in a very short time. As of now, nobody has beaten it. VCG

For intelligent performance, through AI technology, Tencent Cloud Supermind intelligent network can find the most reasonable route through tens of thousands of lines for intelligent planning. With the help of AI positioning, route planning time was shortened to less than five minutes, and processing time of game credentials was reduced by 75%.

AI technology also provides functions such as AI mode disassembly and comprehensive information protection for Tencent Cloud and realizes intelligent closed loops from network design to operation management to security monitoring.

In addition to ensuring the smooth operation of games on the cloud platform, AI technology is also used in game production. For example, game makers such as EA and SONY have been working on AI game engines, neural network development and AI operating systems to develop "AI + games."

Whether in network architecture or game production, AI in the 5G era will bring more new changes to gaming. These changes will give players a better gaming experience and the entire game industry new development ideas. The continuous integration of "AI + games" will certainly promote the flourishing development of the entire industry.

The author is the chairman and president of SAVABOON Intelligent Technology (Qingdao) Limited Company. His study focuses on AI technology, Internet of Things technology and solution. In April 2019, Post and Telecom Press published his book Artificial Intelligence: Practices of Future Business Scenario. This article is an excerpt from the book reprinted with permission.

OPPO's Pioneering 5G Phone

By **Li Zhuoxi**

OPPO's grand 5G plan has unfolded with the launch of the OPPO Reno 5G handset.

In the 5G era, many industrial chains will evolve as new ones emerge, exerting a tremendous impact on social life, communication and entertainment. More importantly, it will accelerate the digital transformation of all of society at a speed beyond imagination.

With the increasingly fast development of 5G concepts, most consumers are more concerned about how soon they can use a 5G mobile phone.

In fact, many phone manufacturers have been working hard for years to prepare for the landing of 5G smartphones. The OPPO Reno 5G version, one of the first 5G models to hit the global market, could possibly be the first 5G smartphone readily available for consumer use.

So far, OPPO has officially announced beta testing and the first batch of 5G users, which has greatly accelerated the process of making 5G accessible in China.

The first beta group of 5G users were given OPPO's smartphone Reno 5G for free and provided first-hand experience with a 5G network in covered areas through Oppo's cooperation with telecom operators including China Mobile's Beijing branch, China Unicom's Shanghai unit and China Telecom's Shenzhen branch. Feedback from users will help the company better understand and harness the superfast technology.

This is the first beta testing campaign of its kind in China as well as the free network access provided by a hardware manufacturer in cooperation with all three major telecom operators.

WHAT'S NEW WITH 5G PHONES?

The low-hanging fruit of the 5G smartphone has been drooping long enough. What will be most exciting compared to today's phones? How will they provide a glimpse into the future?

For ordinary users, the most intuitive advantage of 5G technology will be unparalleled fast network speed. From 120K/s to 600K/s in the 3G era and 1.5M/s to 10M/s in the 4G era to Gb-level transmission speed in the 5G era, 5G has data capacity 100 times of that of 4G, which means that its network speed is dozens of times faster.

So how fast will 5G downloading be? In a field test of the Reno 5G smartphone, the maximum download speed reached as fast as 1049 Mbps, about 7.9 times faster than a 4G smartphone in the same conditions, which means that it would take only a few seconds to download a 1080P high-definition movie. In addition, when watching an online video, you can arbitrarily drag the timeline with zero waiting or loading time to enjoy seamless playing,

which has been hard to achieve in the 4G era.

According to some authoritative R&D institutions in China, in addition to fast speed, 5G mobile phones will also feature low latency and ubiquitous access to the network.

Ubiquitous access to the network could solve many problems commonly experienced in signal blind spots such as elevators, restrooms, underground garages, subways and other places. The offline situation caused by poor network signal will be rare in the 5G era. Low latency can also avoid the severe consequences of slow signal transmission, late network response and delay of system instructions.

These features of 5G mobile phones are attractive for sure. However, only improved network speed and smoother user experience does not make 5G "the future." The wide application scope of 5G is the real story.

According to OPPO, various future usage scenarios are possible for 5G phones including 3D VR video calls, AR shopping, virtual reality interconnection, ultra-fast downloads, multi-cloud games, 360-degree panoramic live broadcasting and group selfies in different places.

HOW DIFFICULT WILL THE 5G LAUNCH BE?

With hopes of seizing first-mover advantage in the global 5G battle, many mobile phone manufacturers have made big investment, but the journey has not been easy.

From 3G, 4G to 5G, each frog-leap development of technology has taken a decade, and each leap involves three levels of participants:

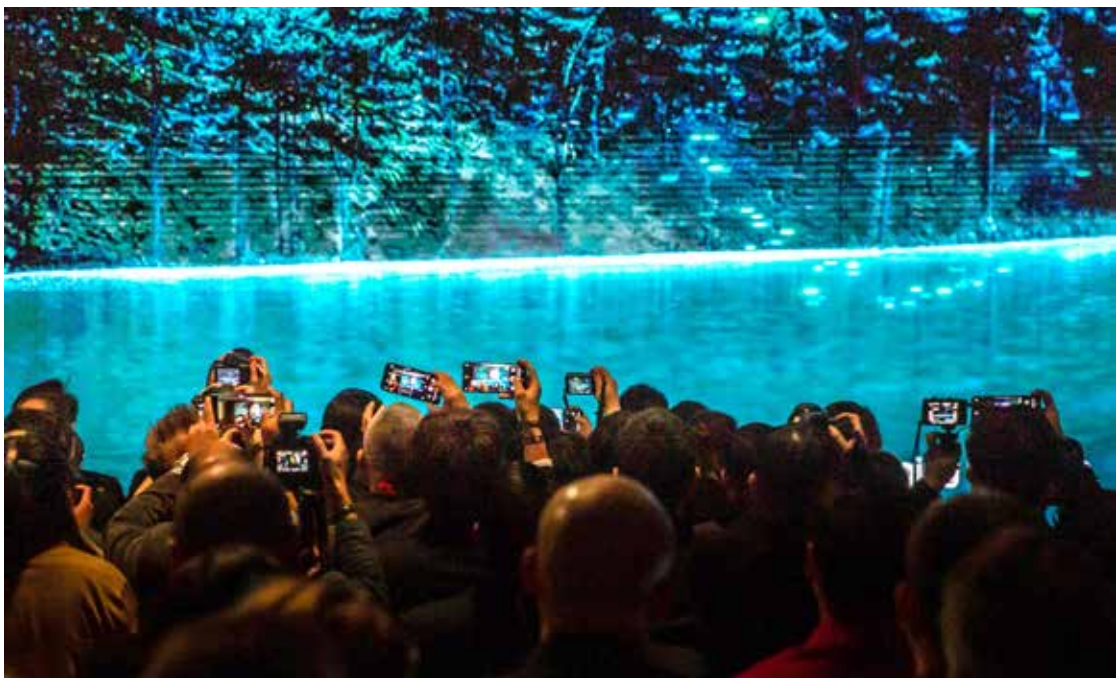
The first level is ground-breakers acquiring standard essential patents.

The second involves solution providers and verifiers of network construction, such as telecom operators and mobile service providers.

The third features 5G-based mobile phone vendors such as OPPO and 5G application service providers such as various related apps.

OPPO has remained deeply engaged and continued making significant contributions throughout all the three phases for 5G.

In fact, OPPO mapped



February 23, 2019: At OPPO Innovation Event 2019 held before the MWC exhibition in Barcelona, Spain, the brand introduced its 10x hybrid optical zoom technology and unveiled its first 5G smartphone OPPO Reno. VCG

out forward-looking 5G deployment plans soon after establishment of the 5G standard. In 2015, it organized a 5G communication standards team. Along with other global operators and cooperation partners, OPPO began 5G research and development work just after the establishment of 5G standard.

During this time, OPPO also participated in the third stage of formulation work on technical specifications for China's IMT-2020 5G standards as the only terminal manufacturer. So far, OPPO has submitted more than 2,600 technical proposals to the 3rd Generation Partnership Project (3GPP), a standards organization that develops protocols for mobile telephony, obtained more than 2,000 groups of 5G patents, and actively participated in the promotion work of 3GPP Release 16.

As 5G standards settle, competition on hardware has begun. With little experience of 5G terminal skills to be used for reference, OPPO deeply explored many technologies from day one. The differences between 5G and 4G models are far more numerous than meets the eye—the appearance is different, but also internal hardware components and the overall design of the device.

Producing a 5G mobile phone is far more complicated than just swapping out a chip on a 4G unit. The overall design requires tremendous differences.

The first is the antenna. Traditional 4G mobile phones have only 3 to 6 antennas, but 5G phones have 10 or more. How to fit these antennas in the narrow space of a mobile phone has been the top problem for designers.

Also, how to install a bigger 5G module into the phone but keep it light and thin has been another challenge. Because development of the 5G phone remains at an early stage, it still needs to support 2G, 3G and 4G networks as well as Wi-Fi, Bluetooth, GPS and other technologies.

With the simultaneous operation of many networks, preventing interference between different signals has remained a problem for mobile phone engineers alongside the challenge of electromagnetic design compatibility.

At the end of the day, it is impossible to make a qualified 5G mobile phone only by stacking hardware.

A series of 5G hardware problems required the OPPO technical team to withstand the pressure of the "depopulated zone" and make concerted efforts based on the technological achievements of the era to make breakthroughs.

At OPPO's Innovation Event 2019 in Barcelona, the brand presented its first 5G smartphone to consumers around the world and announced that they had solved many related challenges including antenna design, baseband, radio frequency and power consumption, and building a complete 5G mobile communications system.

The possibilities are endless for future 5G phones considering myriad usage scenarios such as 3D VR video calls, AR shopping, virtual reality interconnection, ultra-fast downloads, multi-cloud games, 360-degree panoramic live broadcasting and group selfies in different places.

In addition to hardware research and development, 5G phone manufacturers also need to work closely with telecom operators to promote the commercial landing of 5G phones so that the users can get the phone as soon as possible.

In fact, OPPO has been actively conducting joint commissioning and testing with the three major operators. Since March this year, OPPO has made 5G field tests with several base station equipment manufacturers in the environment of the Unicom 5G network. It has established cooperation with China Mobile and ZTE and signed a formal contract

with China Telecom in April. OPPO has never rested in its mission of 5G commercialization promotion.

In the domestic Chinese market, OPPO has already officially launched the 5G Spark Plan and established a good communication channel with users through which it hopes to better understand the users' feelings and actual needs to improve future 5G models.

In the overseas market, OPPO Reno 5G version successfully passed 5G CE tests conducted by Sporton International Inc., a global inspection services authority, and was awarded a 5G CE certificate by CTC advanced GmbH, obtaining entry into mature high-end 5G phone global markets including Europe.

From launching a terminal device to innovating applications and testing networks with operators, a complete 5G experience is on the horizon.

A BET ON THE FUTURE

Despite the massive investment and fierce competition, the future of 5G mobile phones looks like a good bet.

If you look at the entire development of the mobile phone industry, you will see that updates of communication technology have hugely affected the competition patterns of the industry.

To some extent, 3G technology solved "human-to-human" communication problems while 4G made "human-to-information" interaction smoother. The improvement of communication technology has accelerated the transition of mobile phones from functional machines to smart machines.

This is also the reason 5G technology has been so eagerly anticipated: It could completely reset competition patterns of the mobile phone industry.

People have witnessed sometime vicious competition in Chinese smartphone market. Last year, many phone brands such as Hammer, Jinli and Meitou abruptly vanished from the market shortly after ranking among the best-selling brands.

Meanwhile, according to January 2019 data from Sino Market Research on mobile phone sales, Apple and Xiaomi did not rank in the top four in China. And ZTE, Nubia and TCL, which had once maintained impressive shares of the market, continued to lose ground.

Development of the 5G communication network will almost certainly cause the mobile phone industry to "reshuffle." Therefore, ensuring that 5G deployment remains soberly and orderly amid the chaos of reshuffling will test the wisdom and vision of all manufacturers.

Competition for 5G technical skills and landing speed has already been replaced by the race to pioneer overall layout and deep development of 5G.

As early as September 2018, Shen Yiren, vice-president of Oppo, presented a vision that 5G terminal devices will not be limited to mobile phones—various devices will be developed upon the needs of users. He believes OPPO has more and better ideas about the future 5G terminal devices.

Instead of faster 4G, 5G is more like a technological milestone. Not only will it cut the delay between network and equipment, but also greatly improve data transmission capabilities.

Various functions stacking together could support automated driving, artificial intelligence and machine-to-machine communication, and soon it could totally change the operation of families, hospitals and factories and everywhere else, ultimately integrating all things for the benefit of mankind.

From "interconnection of all things" to "integration of all things," the boundaries of human capability would be expanded again, and the diverse demands of people finding themselves in increasingly complicated situations would be met.

A revolutionary change is also a qualitative change that occurs when many comprehensive technologies developed to the same point.

OPPO's grand 5G plan has unfolded with the launch of OPPO Reno 5G version. Application scenarios and market acceptance of 5G mobile phones still need more exploration, and many key points about the technology are still being questioned by business insiders. However, amid the fierce competition for the future, OPPO has clearly set its sights on seizing the opportunity!

The 5G Future of Logistics

By **Fang Yu**

5G solutions are set to drive logistics towards the logical trend of automation and unmanned operations.

Technology is changing the logistics industry drastically. Will such changes align with expectations for development of the industry? Perhaps the answers will arrive with the 5G era.

Chinese e-commerce giant Suning's intelligent "cloud warehouse" in the Nanjing Yuhua Logistics Base is a good place to start. Dubbed the largest smart logistics base in Asia, it boasts an unmanned warehouse equipped with automatic guided vehicles (AGVs), unmanned dump trucks, automatic terminal delivery vehicles and even drones. The full-process unmanned logistics "army" created by Suning has become the backbone of intelligent logistics, supporting the implementation of comprehensive smart logistics solutions.

Benefiting from intelligent logistics solutions, Suning has achieved unmanned operation throughout the process from commodity pickup and checkout to delivery, significantly improving logistics efficiency.

MAN OR NO MAN

Many who visit this cloud warehouse—where modern, intelligent logistics equipment operate smoothly and complementarily and form a complete warehousing and distributing system—start asking: Will completely unmanned, automatic logistics become a reality soon?

Luan Xuefeng, vice president of the Suning Logistics Research Institute, said that unmanned logistics doesn't eliminate the need for manpower. Currently, Suning's cloud warehouse can store more than a million stock keeping units (SKUs). Even so, two kinds of commodities are unsuitable to be handled with automatic equipment: highly nonstandard furniture and fresh food. So 100-percent automation in retail warehousing and logistics would be unrealistic. Suning focuses on liberating manpower by placing employees in the non-work logistics process. For instance, the utilization of visual inventory technology can maximize the working efficiency of every person. Suning equips its warehouses in cities like Nanjing, Shanghai, Guangzhou and Shenzhen with 5G, artificial intelligence and other cutting-edge technologies, making them smarter and more flexible, automatic and efficient.

From another perspective, the obsession with automation reflects visions emanating from the current generation of logistics workers. In particular, the rapid development of both offline retail and e-commerce in China has enabled the country's current logistics system to leverage its demographic dividends to the maximum. To achieve future development, the current logistics pattern

must be transformed.

Unmanned logistics represents an inevitable result of changes in social structure. The shift opens a door for the arrival of Chinese AGVs.

CHINESE "REINDEER"

In early 2017, a video depicting AGV logistics robots at work went viral on the internet, inspiring more to notice the development of cutting-edge logistics technologies.

The most famous AGV is Amazon's Kiva, which is nicknamed "Amazon reindeer." The day it was unveiled, the star robot aroused global attention as a revolutionary piece of automatic logistics equipment. However, its disadvantage was also obvious: Its hefty price tag made the cost hard to justify for most logistics companies.

In China, increasing numbers of equipment manufacturers are now concentrating on developing AGV logistics robots. Chinese "reindeer" are expected to cut costs and bring about substantive changes to the logistics industry. With the help of 5G technology, the dream of developing affordable but high-quality Chinese "reindeer" will come true.

Currently, each AGV has its own "brain" (chip), with an average price of 80,000 yuan. In future, with the maturity of 5G technology, AGVs will be able to achieve intensive unified management. A "central brain" may control hundreds of AGVs. That means future AGVs will have no chips. This would drastically cut the price of an AGV robot to 20,000 yuan, significantly cutting costs for purchasers.

At present, Suning's Shanghai warehouse is equipped with 270 AGV robots, which are five times faster than human sorters and can achieve picking and sorting accuracy of 99.99 percent. An AGV can replace 10 human workers. They could cut staff in a warehouse from 70 to five.

THE FUTURE OF SOCIALIZED LOGISTICS

Yang Daqing, a researcher at China Society of Logistics, believes that 5G will change the logistics industry in at least three aspects: First, smart logistics equipment and facilities will become the norm. Widespread popularity of unmanned vehicles, drones and logistics robots will free humans from low-end labor. Second, humans will strengthen interconnectivity and interaction with vehicles, cargo and warehouses. The application of technologies such as the Internet of Things and artificial intelligence will make vehicles, cargo and warehouses smarter and enhance their efficiency in communicating and interacting with humans. Third, services will become dynamic, transparent and intelligent. Take supply chain financial services as an example: In the past, logistics companies could only raise funds from banks through warehouse receipt hypothecation. In the 5G era, they will be able to apply for loans from banks with bills of high-value-added commodities in transit as collateral.

May 29, 2018: Logistics warehousing line at Suning's logistics base in Nanjing, Jiangsu Province. VCG

Automation and unmanned operation have become an inevitable trend in the development of logistics. This is because China's demographic structure cannot afford the previous labor-intensive development mode of the logistics industry. But at the same time, the logistics divisions of many retail enterprises are shifting from cost-oriented to efficiency-oriented, which presents higher requirements for automation and unmanned operation. Logistics divisions of some retailers have gradually evolved into socialized logistics companies. This testifies to another kind of value change.

In this context, Suning Logistics needs to continue serving as a test field for exploring integration of logistics technology, changing minds and finding forward-looking solutions. But as a business, it needs to consider the input-output ratio. Advancements in 5G technology will definitely benefit logistics companies like it. It is well aware that application of 5G will significantly cut the cost of AGV-equipped intelligent warehouses over the next five years.

The author is a senior media professional.

Solutions for 5G Security

By **Yang Zhiqiang, Peng Jin and Su Li**

The adoption of new technologies in 5G architecture and the openness of the 5G ecosystem pose new threats to data security.

The large-scale popularization of mobile communications networks in China began with 2G, which have become significant infrastructure of information society after development through the 3G and 4G eras. Individual users are still primarily served by 4G networks. In the impending 5G era, mobile networks will no longer be confined to person-to-person communications but expand to the Internet of Things (IoT).

The 5G network will be capable of achieving data transmission at 1Gbps, latency as low as one millisecond, and a million concurrent connections per square kilometer, supporting transmission of massive amounts of data and reliable interaction of key data between devices. With the sharp increase in the volume of transmitted data and the boom in information applications, public awareness of the value of data is growing accordingly. Data security and privacy protection have gradually become issues of common concern among individual users, corporate users and even governments.

STRICTER SECURITY STANDARDS

Security is a prerequisite for the operation and service of communication networks. Alongside technological progress, the popularization of the internet and the increase in cyber threats and attacks, the security design of communications networks has constantly improved from generation to generation. To ensure safe communications, accurate transmission of data and effective protection of users' information, an enhanced version of 4G security standards was formulated during the creation of 5G Phase I (2016-2018) international security standards by the 3rd Generation Partnership Project (3GPP). This security system offers the following:

Better wireless data transmission protection. 5G adopts algorithms such as AES, SNOW 3G and ZUC that have proven very safe in the 4G era to protect data confidentiality and integrity. Moreover, 5G strengthens the protection of data integrity to better meet the demand of the IoT.

Safer user authentication system. Compared to 4G, 5G features an upgraded authentication and secret key agreement, which can better prevent roaming fraud. In addition, 5G adopts the Extensible Authentication Protocol (EAP) to support more authentication algorithms, so that application scenarios such as the IoT and the industrial internet can find a suitable authentication algorithm.

More flexible inter-network data security mechanism. Alongside data transmission security within one network, 5G also provides the Security Edge Protection Proxy (SEPP) to protect network signaling

data (control commands in communications networks, which may result in subscriber information leakage if tampered by malicious attackers) between different operators.

More rigorous user privacy protection. The 5G network uses digital certificates and a public key cryptographic algorithm to protect subscriber permanent identifiers (SUPI), which ensures data security in two ways: For starters, when subscribers use air interfaces (wireless communication links between cell phones and base stations) to transmit data, their SUPI will be automatically encrypted, so attackers cannot obtain SUPI even if they acquire data about air interfaces. The other is that the encrypted value changes every time a subscriber logs in, so attackers are unable to track any designated subscriber even if they constantly monitor relevant air interfaces.

RISKS AND SOLUTIONS

The security of 5G networks is upgraded and enhanced compared to its predecessors, but the introduction of new technologies and the openness of the 5G ecosystem pose new threats to data security.

First, the 5G core network adopts virtualization technology and is built on the cloud. The cloud-based infrastructure, as well as its network capacity-building, supply chain, secondary development and management mode, differs from traditional networks. The physical boundaries between former networks and systems disappear, access control goes deeper from ports to inside the system, and further decoupling between hardware and software makes the supply chain more complicated. The adoption of open source software makes system faults and exploitable security risks more visible.

September 26, 2018: China International Postal and Telecommunications Exhibition is held at China National Convention Center, Beijing. About 400 exhibitors display their latest research result. This picture shows China Telecom's mobile safe officing. VCG

Second, 5G needs to achieve isolation of data slices with differentiated demands for security on the same physical infrastructure to prevent data leakage between different slices. To this end, it needs to guarantee high-standard data slice security while optimizing cost efficiency.

Furthermore, Mobile Edge Computing (MEC), a hot application for 5G, can provide cloud storage and cloud computing services for users and enhance user experience with lower latency. The environment for MEC is more complicated, variable and decentralized. Compared with core networks of mobile operators and cloud computing centers, MEC needs to accomplish trustworthy computing tasks in a comparatively untrusted environment. From the perspective of network deployment, 5G should ensure data passing through border gateways is free of unauthorized external access. This requires the 5G network to have a perfect security mechanism and management mechanism.

5G is more than just a network, but a system. It connects terminals and equipment from a wide array of suppliers, connects massive amounts of users, and connects vertical industries. From the perspective of security, 5G has a very complicated trust model. During its long life cycle, 5G will face attacks that may continue evolving. For example, practical quantum computers are expected to emerge in the 5G era. Their supercomputing ability will enable them to crack existing encryption algorithms. To prevent quantum computers from threatening the security of the 5G network, the secret key algorithms of 5G were upgraded from 128-bit to 256-bit to enhance security through increasing password length. Moreover, we need to research all sorts of anti-quantum algorithms targeting asymmetric key reinstallation attacks.

Data security is only part of the 5G's overall data ecosystem. It needs joint efforts of all stakeholders, including equipment manufacturers, network operators, service providers, regulators and users to enhance 5G security and data security at large.

Co-author Yang Zhiqiang is vice president of the China Mobile Research Institute (CMRI). Co-author Peng Jin is director of the Security Research Division of CMRI. Co-author Su Li is chief researcher at the Security Research Division of CMRI.

The 5G Data Security Dilemma

By **Shashank Reddy**

Without stringent data protection measures and legal safeguards to protect the privacy and rights of individuals, the potential drawbacks of 5G could outweigh any possible gains.

5G (or "5th Generation"), the latest generation of mobile communication, is slated to begin replacing existing 4G networks in 2020. In the run-up to its launch, the benefits of 5G and its potential transformative powers have been repeatedly highlighted in popular media. Principally, 5G will enable the transfer of large amounts of data at significantly higher speeds and with lower loss levels than current networks. But the most interesting aspect of 5G is its ability to allow a host of devices and systems to 'communicate' with each other. This in turn will boost several nascent technologies and industries including the Internet of Things (IoT), driverless cars and smart cities.

The sheer volume of data that the 5G networks could potentially transfer is many magnitudes greater than at present. Most of the transferred data is envisioned not to hail from personal cell phones but take the form of increasingly sophisticated data arising from an entire gamut of sectors ranging from healthcare and logistics to automobiles and Virtual Reality. This scenario, however, raises the question of whether the world is prepared to safeguard and govern such vast amounts of data. The flip side of increasingly large data transfers is the increased possibility of data breaches and invasion of privacy, issues that have become increasingly problematic in countries around the world. The resulting unprecedented data wave will require establishment of safeguards both at a technical level and through governmental policies.

5G SECURITY ISSUES

Precisely what makes 5G so attractive over previous mobile communication networks is how different it is. The architecture of the network relies more on disaggregated virtual networks, and a significant portion of any 5G network relies on cloud storage to function optimally. This feature makes 5G ostensibly faster than previous networks. However, several studies have shown that while 5G networks may be faster, they are not necessarily more secure. A recent Huawei White Paper pointed out that 5G will

September 17, 2018: 2018 China Cybersecurity Week opens in Chengdu, Sichuan Province. VCG

essentially be service-oriented and that its primary use will be the creation and integration of service industries. With increasing global focus on the need for digital privacy and security, it has become essential to build technical safeguards within the technology itself before it becomes mainstream.

Global standards for mobile telephonic networks are determined by an organization called the 3rd Generation Partnership Project (3GPP), which has also designed standards for 5G networks. Several researchers have noted, however, that critical security features were not included in these standards. In a report on the security of 5G architecture, the government of the United Kingdom outlined four primary goals 5G networks need to meet: cross-layer security, i.e. security across various applications or layers of use of the network; end-to-end security featuring a secure connection between the end user and the core network; cross-domain security, which is applicable across 5G use-cases and industry domains; and finally, security-by-design, where security features are built in during the design phase. The standards established by 3GPP for 5G networks do not seem to provide built-in solutions to meet these goals, especially for end-to-end security and security by design.

These two specific data security goals are critical in any 5G network. End-to-end security ensures that any data remains encrypted and protected during the process of transfer between data generator and destination. This reduces the scope for data theft in the process of transfer as well as any related violation of privacy. Security-by-design, on the other hand, requires designers of the network architecture to conceive of every plausible security threat that could arise with the widespread use of the network and mitigate the potential of these threats by incorporating requisite security features within the architecture itself. The fact that the 3GPP standards do not adequately address either of these issues has significant potential negative implications because it opens the door for more adverse cyber-attacks to occur than in the

past. For example, if adequate technical safeguards are not included in the architecture of the network, it would be theoretically possible for bad actors to hack into a driverless car and control it from afar. Similarly, lack of necessary end-to-end encryption could enable relatively easy theft of the data and identities of individuals.

Such required technical safeguards cannot be set at the national level because that would lead to wide technical discrepancies between various 5G networks. It is necessary for 3GPP to take the lead in establishing technical safeguards. While current 5G standards fall short of incorporating these safeguards, we have seen positive indications that 3GPP has begun working with other organizations to plug holes in its technical standards.

December 1, 2018: The first Real World CTF 2018 Finals are held in Zhengzhou. 100 contestants from 20 top cyber security teams around the world compete in the finals. VCG

DATA GOVERNANCE

The considerable challenges brought by 5G demand robust governmental responses in the form of data protection and privacy laws. The regulatory challenges posed by 5G do not differ substantially from existing regulatory and policy issues related to digital privacy and data protection. What will be different in the 5G era is greater potential for violation of privacy. Now, Europe is best poised to mitigate security risks associated with a wide rollout of 5G networks. The EU General Data Protection Regulation (GDPR) is arguably the most stringent data protection and privacy framework in the world. The GDPR explicitly states that data protection must be designed alongside the development of products and services and that privacy settings on any product must be set on high by default. The Regulation also contains strong responsibility and accountability provisions that put the onus on the data controller to safeguard individuals' data.

China unveiled its own data privacy regulation in 2018 titled "Personal Information Security Specifications." The Specifications share many similarities with the GDPR including the right to full erasure of personal data and specific requirements for notification of data breaches and cross-border transfers. The Specifications, however, are not law, so they are not yet legally binding. Furthermore, the document falls under the wider rubric of the Cybersecurity Law of 2017, a significantly more comprehensive framework that covers all aspects of information and communication technology. In China, data protection is seen from the prism of national security as opposed to an important independent issue.

India, where the mobile telephonic revolution is still underway, lacks an effective data security regime. While some concrete steps have been taken in the recent past including the recognition of the Right to Privacy by the Supreme Court and the formulation of a draft Data Protection Bill, these still fall far short of what would be required to adequately safeguard against the possible dangers posed by 5G. Indian telecom companies are gearing for a nationwide rollout within the next couple of years. However, the country has been silent on possible data security challenges

posed by 5G and its implications for the Indian context specifically.

The United States lacks a unified national data protection law. Instead, a patchwork of various legislation governs data privacy across different sectors. The Family Educational Rights and Privacy Act, for example, protects school health records, while the Children's Online Privacy Protection Act protects the data of children under the age of thirteen. Different state laws, with differing standards, requirements, and enforcement mechanisms add to the confusion. This renders the US woefully underprepared to handle the data protection needs of the 5G era.

Clearly, most of the world's governments are not yet ready to handle the data security challenges of 5G. In fact, frighteningly few policy-related conversations are occurring in countries poised to be struck by such challenges.

The situation is unfortunate. A widely accepted policy cliché is that government regulations tend to follow technological innovations. The case of 5G had potential to be the exception. This is arguably one of the few times that governments can foresee the emergence of the technology and have time to establish policies before the technology becomes widely adopted. Most of the world's governments, however, have not taken advantage of this window of opportunity. There is still time, considering that the first widespread rollout of 5G networks will not happen until 2020. It is also vital to building global consensus on data protection norms in the age of 5G, especially in the realm of data transfer across borders. But such consensus seems increasingly unlikely in the context of trends towards nationalization of digital space.

INTERNATIONAL COOPERATION DEMAND

5G has the potential to lift human society into a new era of technological capabilities. However, the most prominent use-cases of 5G and the sheer quantity of data that will consequently be created make the issue of data protection and privacy more pressing than ever. Applications like the Internet of Things may make life more convenient, but they also open doors for more malevolent cyber-attacks. In such a scenario, there is a need to ensure adequate safeguards for individuals' data and privacy in the technical design of the 5G networks. Today, it appears that such safeguards have not been incorporated as required, although the standards-setting organization 3GPP has assured that it will be done. At the same time, governments around the world need to be more cognizant of the possible dangers hiding behind a widespread 5G rollout without optimum legal safeguards to protect the privacy and rights of individuals. To comprehensively engage in the policy challenges of such new technologies, it is also necessary for governments and regulators around the world to cooperate to develop inter-operable privacy requirements. Without such protections, the potential drawbacks of 5G could outweigh any possible gains.

October 18, 2018: A forum on cyber security under the 2018 Digital Economy Summit is held in Zhengzhou, Henan Province. VCG

The author is a Master of Arts in Law and Diplomacy candidate at The Fletcher School. He has served as a research analyst at Carnegie India.

Prospects for China's ICT Industry and Mobile Economy

Edited By **Hu Zhoumeng**
Designed By **Andrey Maleev**

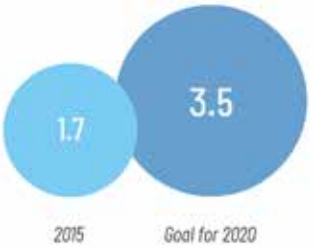
Along with the fast development of technologies such as the mobile internet, 5G, cloud computing, big data and the Internet of Things (IoT), the scope of the information and communication technologies (ICT) sector has constantly expanded, from traditional telecommunications and internet services to new realms such as the IoT.

The rise of the ICT industry has fostered a huge mobile service market in China. By the end of 2018, China's mobile internet users had amounted to nearly 1.2 billion, four times the number of North America, of which 97 percent came from the Chinese mainland. At present, China has formed an extensive and diversified mobile ecosystem that lays a solid foundation for its digitalization strategy and exerts far-reaching influence on consumers, enterprises and even the whole of society.

ICT INDUSTRY DEVELOPMENT PLAN

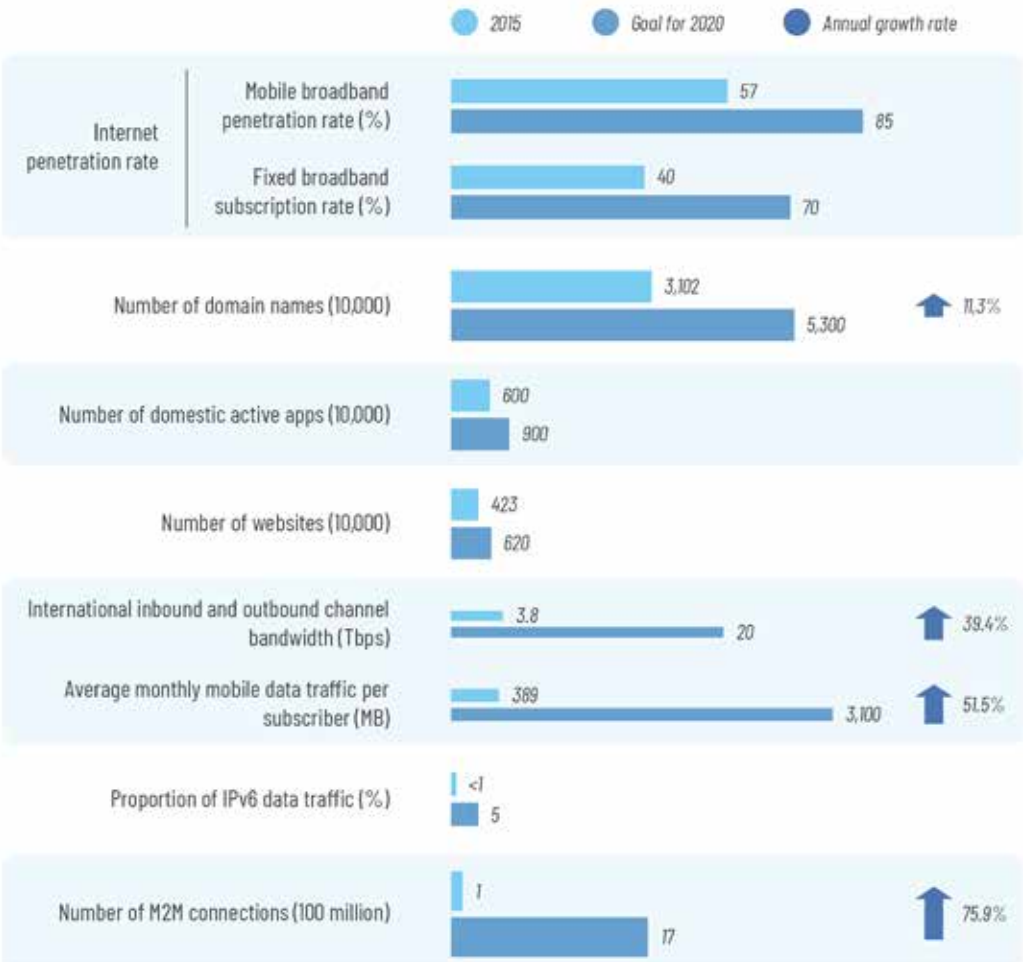
Size of the Industry

Revenue of the ICT industry (trillion yuan)



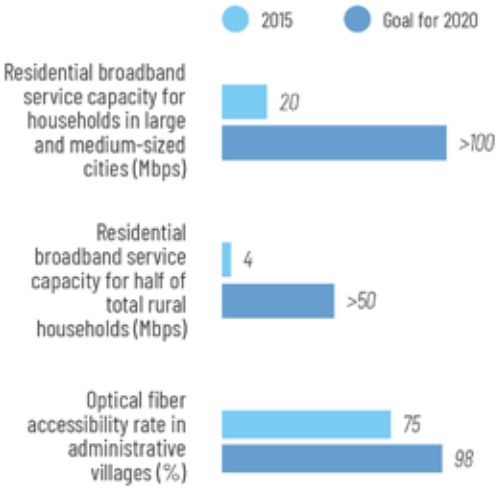
Cumulative investment in ICT infrastructure (trillion yuan)

Development Level

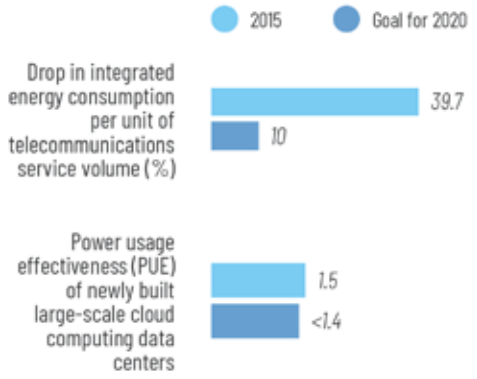


Note: The Internet Protocol Version 6 (IPv6) is the most recent version of the Internet Protocol (IP), designed as the successor of the current Internet Protocol Version 4 (IPv4). M2M refers to Machine-To-Machine communication.

Service Capacity



Green Development



5G DEVELOPMENT

Technical Research and Development

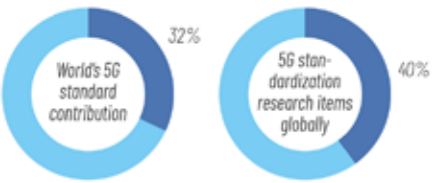
China launched the research and development of 5G technology in January 2016. So far, the first and second phases of the project have been completed, and the third phase of 5G system tests is ongoing.

Chinese telecommunications equipment giants Huawei, ZTE and Datang have all completed NSA (non-standalone) tests, and the third phase of SA (standalone) tests has been partially started.

The trial construction of 5G networks will be gradually carried out in major Chinese cities.

Standards Formulation

As of March 2018, China occupied 32% of the world's 5G standard contribution, and led about 40% of the 5G standardization research items globally.



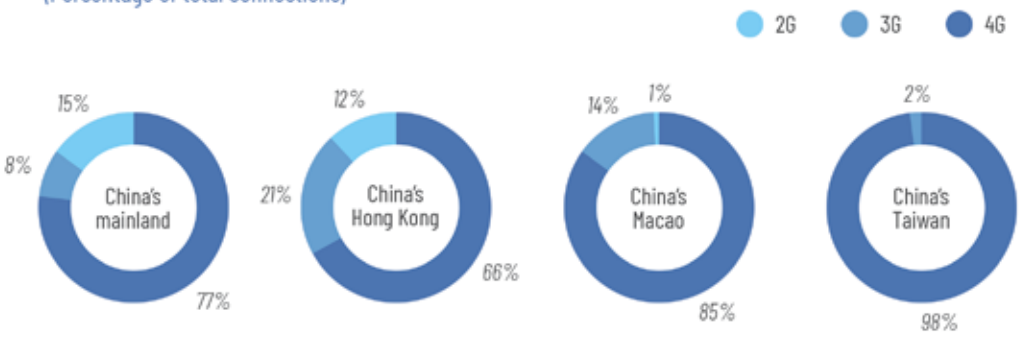
Currently, a unified global 5G standard is still under formulation. Relevant research, academic and industrial institutions of China are actively participating in key projects of international standards-developing organizations such as the International Telecommunication Union (ITU) and the 3rd Generation Partnership Project (3GPP).

Industrialization

In December 2018, the Ministry of Industry and Information Technology of China awarded 5G spectrum to the country's three major mobile operators. It will consecutively formulate and promulgate plans for spectrum utilization for the IoT and the Internet of Cars. The research and development of 5G chips have also been launched, and such chip manufacturers as Huawei, MediaTek and Unisoc have unveiled relevant roadmaps. China's major mobile operators have collaborated with terminal manufacturers to carry out 5G research and development, and some Chinese cell phone makers have already developed 5G NSA pre-commercialized prototype terminals.

MOBILE ECONOMY

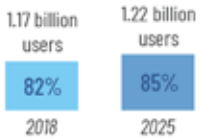
Distribution of Telecommunication Technology
(Percentage of total connections)



Note: Percentages may not total 100 due to rounding.

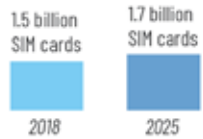
Size of the Mobile Market

In 2018, the number of mobile users in China reached 1.17 billion, and the figure is estimated to hit 1.22 billion in 2025, with the penetration rate rising from 82 to 85 percent.



On average, each Chinese mobile user owns 1.3 SIM cards.

By the end of 2018, a total of 1.5 billion SIM cards had been activated, and the figure is expected to reach 1.7 billion in 2025.



By the end of 2018, the number of active smartphones exceeded a billion in China, with a penetration rate of 69 percent. It is estimated that the number of active smartphones in the country will surpass 1.4 billion in 2025, with the penetration rate rising to 88 percent.

By 2025, China's 4G penetration rate will reach 72 percent, and 5G subscribers will hit 460 million, accounting for 28 percent of the country's total. Meanwhile, the number of China's active 5G devices will surpass the combined volume of North America and Europe, ranking first in the world.

Social and Economic Impacts

In 2018, China's mobile ecosystem added US$280 billion in value to the country's economy, of which infrastructure suppliers contributed US$5 billion, mobile operators US$130 billion, equipment manufacturers US$90 billion, retailers and distributors US$10 billion, and content, app and service providers US$40 billion.

In 2018, China's mobile operators and expanding mobile ecosystem directly provided nearly 3 million jobs and indirectly created 5.5 million jobs.

In 2018, the mobile ecosystem contributed US$84 billion of tax revenues for the Chinese government.

Sources:

The Plan for the Development of the ICT Industry (2016-2020) released by the Ministry of Industry and Information Technology of China

The Mobile Economy China 2019 released by GSMA

The 43rd China Statistical Report on Internet Development released by China Internet Network Information Center

Digital Detox: Unplugging From Social Media

Concept by **China-India Dialogue**

A Fortnight of Freedom

Sukrit Koul
Age: 22
Occupation: Copywriter
Birth place: New Delhi
Current city of residence: New Delhi

To find that many of my insecurities and issues were directly or indirectly related to my social media use was definitely a revelation and something which I have made a point of working on.

The term "detox" has traditionally been used in the context of fitness, with people avoiding junk food, and abstaining from smoking and alcohol. However, lately, more and more people have been associating detoxes with mental health as well, where they take a break from using social media platforms. This kind of "digital detox" is important because social media can get far too overwhelming for anybody after a certain point.

I too attempted a social media detox recently, with the intent to stay away from Twitter, Facebook, Instagram and Whatsapp for a month.

A little background to this story: I have been diagnosed with post-traumatic stress disorder (PTSD) and attention deficit hyperactivity disorder (ADHD) and have displayed traits of a borderline personality disorder (BPD), which can make social media quite a minefield to navigate, especially if I see anything that may trigger a panic episode. Up to a week before I went offline, I had started to find myself being more and more irritable. I had no patience with people, and then later, I'd crave their company. I was sleeping late and waking up early which made my sleep schedule go for a toss. I was constantly glued to my phone to the point of being completely unaware of

my surroundings. This started having a negative impact on my relationships with my colleagues, family and friends.

Finally, the day arrived. On the subway ride home from work, I deactivated my Twitter, Facebook and Instagram accounts, and uninstalled Whatsapp. I informed a couple of close friends about this and nobody else.

The impact this detox had on me was brilliant. The first couple of days were trying. Whenever I'd find myself with some free time at work, I'd always start to reach for my phone out of habit, but then would remind myself not to do so. I'd keep my phone's data and WiFi off, and only use it for music or answering important calls. By the fourth day, I had started keeping a book in my bag, hoping to rekindle my lost love for reading. By the time the first week ended, I was relatively much more stable mentally than before the detox. I was able to deal with stressful situations without flying into a panic. I felt much less bothered by trivial annoyances. Whenever I was outraged about something, I didn't turn to social media to distract myself, as I had earlier. Instead, I tried to face the issue that was bothering me head-on, and work out a solution for it. By the time the second week rolled around, I was feeling much better, thanks to having been able to catch up on sleep instead of browsing Instagram or Facebook. I started to meditate and did some light exercise as well.

To find that many of my insecurities and issues were directly or indirectly related to my social media use was definitely a revelation and something which I have made a point of working on.

Before the detox, I was the stereotypical caricature of a young adult glued to his phone and laptop the entire day, whether for work or for killing time. Over the course of the detox, I cut down on my phone usage and dug out my old iPod and used that for music instead. I also picked up my camera and started to brush up on my photography skills. The second week ended with me spending much less time on my phone and laptop and more time with my camera and iPod.

This fortnight had a positive impact on my relationships with friends, and with my dad. I spent some time with him and we went out for a movie, something we had last done in 2016. I also got the opportunity to try doing some exercises my therapist had suggested to help me overcome my social anxiety.

I really wanted to continue my detox for a while more, but in an impulsively made decision, I logged back online. And now, while I still engage in silly banter on social media, I have found myself applying what I learned during the detox period more and more with respect to how I consume social media. It was indeed challenging, but I would really want to try it again for a longer period of time, and really encourage everybody to give it a go at least once.

Everything in Moderation

Swai Bandekar
Age: 22
Occupation: Writer
Birth place: Nadiad
Current city of residence: Vadodara

I was torn between wanting to take a break and wanting to know what was happening on social media.

I first embarked on a digital detox around this time last year, when I was moving to a new city. The move had been a spontaneous decision. When the opportunity to join my company's Vadodara branch came by, I had instantly said yes.

The idea seemed thrilling at first. But barely a month after moving to the much bigger city of Vadodara from Nadiad, my excitement was replaced by loneliness, anxiety, and the stress of an unfamiliar environment. In Nadiad, I had had a circle of friends that was an important support system. Moving away meant losing out on this as well. And the flood of social media updates reminded me of this daily. I was anxious and depressed. Finally, one day, I went straight to my mom and cried and cried. She held me tight and told me to try a digital detox, start meditation and pen my thoughts down in a journal every day.

Even though my mum doesn't use her phone for much other than following my posts on Instagram, Twitter, and for watching YouTube videos, she knew I had gotten addicted to my new iPhone. I needed a break.

When I told my close friends that I was doing a digital detox, everyone told me it was impossible. One friend suggested "locking" all my apps and asking someone else to set the password so that I couldn't access them. "I don't need it!" I told him, with a great deal of overconfidence.

Finally, detox-day arrived. I uninstalled all my apps. Initially, I had to restrain myself with the greatest of efforts to not reinstall Instagram, and see what my friends were posting. It lasted five days.

Over the next few days, I ended up reinstalling, then re-uninstalling and then re-reinstalling apps, grappling with intense FOMO (Fear of Missing Out). I was torn between wanting to take a break and wanting to know what was happening on social media.

Finally I decided I couldn't do it. I ended up going back to my life of swiping left and right, uploading pretty pictures on Instagram, and tweeting the usual nonsense. The anxiety kept coming back. And then one day, in the bathroom of my office, I broke down. That's when I knew I had to do something concrete.

I booked an appointment with a therapist. She was non-judgmental, and suggested I stop using my phone and focus on doing what I love. I had been an ardent reader in school. Drawing and cooking used to be my passions. I did some research about where I could buy books at affordable rates. Then I went and bought 12 of them. I uninstalled all the apps on my phone, again.

The digital detox had now begun for real. A week went by without my checking Facebook or Instagram. I was instead reading *Tools of Titans* by Tim Ferriss. I finished it within a week. I consider that my biggest achievement yet – getting back to reading had taken a lot of effort as my mind was now used to being constantly distracted. I began spending more time with my family, especially my little nephews and my mother. Because of this detox, I was able to get to know them so much better, and it brought us closer.

By the end of a month and a half, I had given up the phone, I was productive at work, exploring the city all by myself, trying out new foods, and many other things. I started chatting with strangers and actually made a new friend from Switzerland who was visiting my city.

It has now been three months since my digital detox. I have gained control of myself and stopped myself from being constantly hooked onto social media.

"Everything In moderation" has been the most important thing that I have learned on this journey. In the pursuit of chasing social media notifications, I had been missing out on so many things in real life. The digital detox not only brought me closer to my family and rediscover old hobbies, but also made me get to know my new city—and more importantly, myself—better.

Embrace, Don't Quit Social Media

Lin Qi
Age: 27
Occupation: Teacher
Birth place: Tianjin
Current city of residence: Shandong

Disconnecting from social media is not the answer. Users need to build a firm attitude and practice self-control in a rapidly changing world.

The call to "quit social media" seems to have been stirring for some time, but few people seem to have put it into practice. Although social software can lead to many negative consequences, we still cannot ignore the positive changes it has brought to our lives. As far as I'm concerned, I don't think it's necessary to deactivate social apps.

Social interaction is an important means of connecting and maintaining contact with other people and society, whether IRL or in cyberspace. WeChat Moments is a prime example. If you choose to shut it off you miss other people's sharing, recommendations, photos and gossip. Without talking to people every day, it's hard to follow the changes in people's lives. Without social media, you would have no way to know what your friends and family want to say, about the people they meet and the places they have visited. People often rely on hobbies to find friends and build intimacy through understanding. Closing this window quietly cuts off a channel for further relations with others.

If you're not worried about the isolation without social software, consider its convenience. We can make new friends at home and chat with people whenever and wherever we want. Through a set list of contacts, we can immediately chat with family members and colleagues. We can tease old friends that might live across the globe in a WeChat group. With the advantages of the internet, social software has opened doors to new worlds. The environment around us is so large that we would never be able to shake hands with everyone and look into their eyes throughout our lives, but social software facilitates greater possibilities.

To be fair, I once considered taking a break from social media, but before I made up my mind, I saw a forum post on the subject. The original poster said that he had changed his new mobile phone but couldn't find his prior contacts, so he took the opportunity to quit all social apps and hope relatives and friends would understand. In thread, a friend wrote, "XX has been looking for you for a long time since you uninstalled your social apps." Scrolling further down was a message of two or three hundred words from XX. "Have you ever thought about the impact of your quitting social media on us?" he wrote. "I understand that we are still close friends even if we don't maintain contact for a long time, but as you get on with your new life and make new friends, I want to be able to follow you. Please, let me connect to you."

The words touched me so much that they stay with me to this day. Previously I never believed that relationships in the virtual world were indispensable. I began to rethink the significance of social apps on reality. Like the living people standing in front of us, behind each username is a soul. Since we are not bothered by interaction with people in our daily life, why should friendship in social media become victim of a so-called "advancement of consciousness?"

The world around us is marching forward. To some extent, the emergence of social media conforms to the overall trend of human desire. It is unreasonable to focus only on the drawbacks and ignore the great things it has done. Social software is simply a tool, and what's the wisdom in giving up a tool? If we quit one app, a second and a third will emerge. Even if we quit every one of them, other useless software will find a way to occupy our space and time. Disconnecting from social media is not the answer—users should build a firm attitude and practice self-control in a rapidly changing world, stay true to ourselves and avoid getting lost in the internet.

Across Time and Space
—Tracing Zheng He 600 Years Later

By **Yang Xiaoyun**

Over 600 years ago, Ming Dynasty (1368-1644) navigator, explorer and diplomat Zheng He visited the Indian port city of Kochi. More than half a millennium later, a Chinese writer living in India visited the city again to explore the close connection between Kochi and China.

One weekend, I ventured from Delhi to Kochi Port in southern India to see Chinese fishing nets.

During his reign, Emperor Chengzu (1360-1424) of China's Ming Dynasty dispatched Zheng He, a Chinese navigator, explorer and diplomat, on an expedition seeking treasures in East Asia, the Indian subcontinent, the Arabian Peninsula and East Africa. In more than two decades, Zheng visited more than 30 countries and regions along the Western Pacific Rim and Indian Ocean. He traveled more than 70,000 nautical miles in his seven voyages, the most ambitious in the world at the time.

Zheng visited Kochi twice, and some believe he eventually died there.

Zheng He was a native of Kunming City, Yunnan Province. Each of his seven voyages set off from harbors in China's Jiangsu and Fujian provinces.

I boarded a plane in Kunming and crossed the Himalayas to arrive in New Delhi, a perfectly westward trip in the same latitude. My trip was the shortest flight between China and India available today, taking only three hours. I changed planes to fly from north to south across India. It took me another three hours from New Delhi to Kochi, which is the largest port city in southwestern India and a commercial hub, as well as a military stronghold.

Before I arrived at the beach, I could see from afar rows of the famous Chinese fishing nets. Bright blue fishing nets hung from the poles erected on a few large wooden boats. It was like a picture of simplicity and antiquity against a background of blue sky and gentle waves.

The Chinese fishing nets were of simple design; the fishing method was simple as well. A thick pole stands in the middle of the fishing boat with several big rocks tied to it with thick ropes. The nets are propped up by bamboo and wooden poles around the central pole. The fishing nets are lifted by the weight of the rocks. When the ropes are

loosened, both the central pole and fishing nets are lowered into the water. After some time, the pole is pulled up by ropes and the nets are raised to the surface with fish inside.

It is believed that Zheng He introduced Chinese fishing nets to the fishermen in Kochi some 600 years ago. In China, similar wooden boats and fishing methods were only found in Xiapu, Fujian Province. Today, Kochi fishermen demonstrate the traditional Chinese fishing method as a performance for earning money. Due to technological development, this method is no longer a competitive way of fishing.

At Kochi beach near the Chinese fishing nets, tourists will find many vendors selling snacks such as green mangoes and pineapples soaked in saltwater. Fruits are skinned, sliced into pieces and sprinkled with chili powder before being handed to customers. This is almost identical to the way vendors selling pickled radishes, papaya and olives in Dali and Kunming of China's Yunnan Province.

Looking back at history, I believe India and Yunnan must have had some connections. The two were connected on land by the ancient Silk Road. Starting from Chengdu in Sichuan Province for India, people could cross the Yunnan-Guizhou Plateau, first arriving at Dali from Xichang, then leaving China at its border with Myanmar and heading westward. The Maritime Silk Road had already long been mapped by Zheng He's fleets centuries earlier. Through the ancient Silk Road and the Maritime Silk Road, there had been exchanges of commodities, goods, and personnel for hundreds of years.

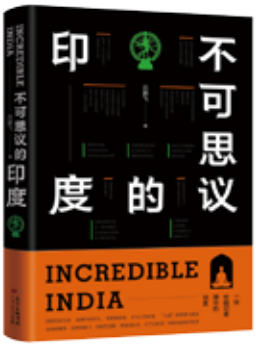
June 19, 2014: A fisherman casts a net in a lake in the suburbs of Kochi, India. VCG

In New Delhi, coriander and mint leaves are the most common ingredients, which are also loved by Yunnan locals. I also saw rice balls, a popular snack in New Delhi. It is very much like the rice balls in Dali, Yunnan Province, dipped in syrup to form colorful balls.

Kochi Fort is a small town. We rented a tuk-tuk and wandered around. We were told that there was a stone tablet next to the site of Chinese fishing nets inscribed with words about the story of how the Chinese migrated and lived here before moving inland in India. But we couldn't find the stone tablet. We saw a synagogue in town. I was told that the blue and white bricks paving the floor were from China in the 18th century. I was also told that there was once a Buddhist temple in town, but the Chinese Buddha statue in the temple was taken to the UK by the British, and the temple no long exited.

I saw an old house in town with the first floor serving as a simple shop. Its door was made of several wooden planks, half open. It was the kind of door made of long and narrow planks only seen in old towns in China's rural areas. Several attached planks make a door which are detached during the day and attached again at night. I looked up to see the windows on the second floor, which were also half open. They were in style and decoration very similar to those of ancient China, but newer because of recent renovation.

The author is a Chinese writer living in India. This article was quoted from the WeChat official account "Chindia Guru."



Incredible India

By Lv Pengfei

Guangdong People's Publishing House
August 2018

Kotnis: Forgotten Hero

By **Lv Pengfei**

Many Chinese would find it hard to believe that Kwarkanath S. Kotnis, the most revered Indian doctor in China, is hardly known in his hometown. Only when Chinese people visited the relatives of Dr. Kotnis in India did the Indian public pay any attention to the figure, which soon dissipated.

Dr. Kotnis is only known to a limited circle of people relevant to China in India: scholars or officials who conduct Chinese studies, students who study Chinese or businessmen or journalists who have been to China. Even Xuanzang is more well-known generally in India than Kotnis.

In August 2013, the naval hospital ship visited India and docked in Mumbai. I left Delhi and headed for Mumbai to conduct an interview about the ship. Mumbai is where Kotnis had previously studied. From there, he boarded a ship bound for China and never returned. Mumbai, Kotnis and Chinese doctors—these elements alone are enough to write a rich manuscript. But throughout the journey, I did not know where to start. At INHS Ashwini Hospital in Mumbai, I wrote Kotnis' English name on paper and handed it to every doctor or nurse I met, only to receive more blank head shaking.

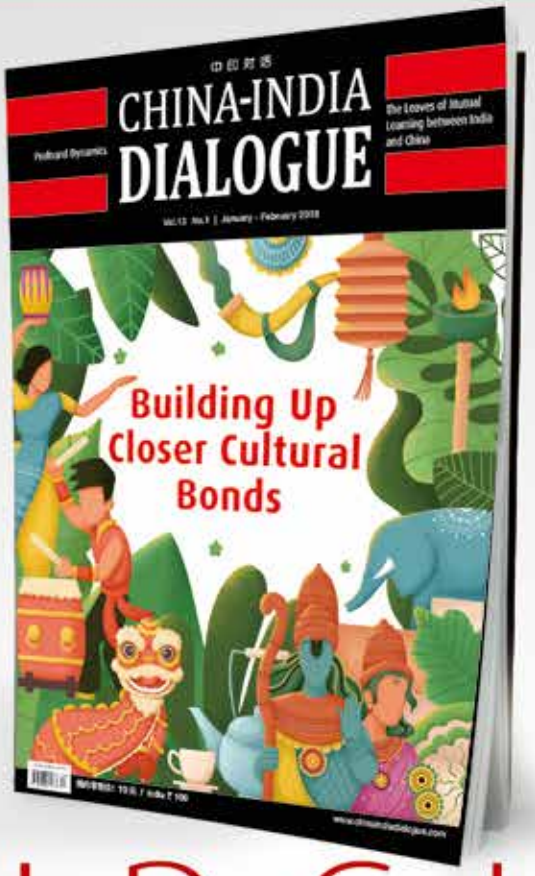
Kotnis married a Chinese girl who gave birth to a son who died of illness shortly thereafter. His wife has now passed away. Kotnis' closest relative is now his niece, Sumangala Borkar. Like her uncle, the Sumangala family members were all doctors. When I met her, her daughter was preparing to study in the United States. Sumangala runs a clinic. They told me that the clinic was named after her uncle Kotnis in commemoration of his life. They also compiled letters from Kotnis and his family before and after his visit to China into a photocopied pamphlet so others could learn about him.

Sumangala gave me a collection of letters from Kotnis, from which I witnessed his rich inner world and felt the thrill of his war life in China. In July 1938, Kotnis consulted Dr. Mehta about the medical team in China and then wrote to his father: "Dr. Mehta pointed out that there may also be a bleak side to the trip that could lead to sacrifice, interruption of studies and loss of a well-paid job. Yet I don't think the future is really bleak...." The last letter was written on October 15, 1942. He briefed his colleague Basu on the situation in the base area and said that he was considering a trip to Yan'an at the end of the year. He also expressed concern about the chaos in India and wondered how India's political situation be resolved. Less than two months later, he died of illness on December 9.

Kotnis was one of the five doctors in the Indian medical assistance team sent to China. When we commemorate Kotnis, we should not forget the other members. Basu, for instance, stayed in China longer than Kotnis and had a closer relationship with China. He eventually left China and returned to India. By then he had lived in China for five years. A former friend of Kotnis, he organized the nonprofit organization Dr. Dwarkanath Shantaram Kotnis Memorial Committee after returning home. In 1959, Basu returned to China to study acupuncture. In 1977, he established the Acupuncture Association of India, which promoted Chinese acupuncture in India. In 1986, before his death, he donated his savings of 300,000 rupees to the government of West Bengal for the development of acupuncture.

Like Kotnis, Basu has no descendants. His student Doctor Mrigendranath Gantait became the successor of his career, being devoted to continuing his missions.

The author of this book, Lv Pengfei, was a journalist of the People's Daily Indian Branch and has lived in New Delhi for three years.



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