Technology against Pandemic:
Insights and Practice on Telecom Networks

White Paper

HUAWEI

CONTENTS

Introduction

01 User behavior changes led to network characteristic changes

02 ICT infrastructure upgrade driven by the outbreak

03 Teaming up with partners from numerous industries, operators utilized technologies to fight the pandemic

04 Huawei's anti-pandemic practices

05 Implications and Outlook

Introduction

At the beginning of 2020, the COVID-19 pandemic started sweeping across the globe. Countries and regions started their fight against the outbreak. To date, this fight is still a tough one impacting the well-being of all mankind on this planet. The virus knows no borders, and it impacts everyone in the world. China, after its extraordinarily tough efforts to lock down cities and even the whole country, the outbreak is finally easing. Under the tremendous pressure, we are finally seeing of victory.

Looking back at what each country, especially China, went through in their adventurous combat against the pandemic, we see major changes in how societies operate, including how individuals, households, and companies behave. Offline economic activities stagnated due to isolation, families started taking on more functions, and masks became luxuries. People's attention was drawn by the outbreak around the world, and they were deeply moved by those who

worked on the frontline, most of them did not realize groups of obscure communications engineers were working side by side with the healthcare professionals.

Our peaceful life was actually the result of the efforts by those working on the frontline. Throughout the world, ICT infrastructure became a strategic cornerstone in this fight against the COVID-19 pandemic. It not only helped with the pandemic combat, but also undertook multiple times of economic activities and even social missions.

At this particular moment, Huawei analyzed the user behavior changes during the outbreak and the operators' network traffic changes in major regions throughout the world. From a technical perspective and based on scenario-specific analyses, we are providing rational suggestions on future operator network development. We aim to help countries throughout the world to win the combat against the coronavirus and restore normal socio-economic activities as soon as possible.

Change 1: Way of life changed
from outdoors to indoors and from offline to online

Epidemic prevention and control measures like zero-touch and home isolation reduced our living and working space to indoors, and we were doing everything from home. Statistics show that over 60% of Chinese people almost didn't step out of their home during the outbreak.

Since people kept staying at home, their social life moved from offline to online, with significantly longer time spend online. For example, Chinese people spent an average of 30% more time online than usual. Our daily routines were disrupted and we had more free time to experience online content. For example, the time spent on apps for online food ordering, gaming, and videos significantly increased.

Time Spent Online (Hours)

	China	South Korea	Japan	USA	Italy	Spain	France	UK	Germany
Feb.2020	5	3.9	3.5	2.8	2.7	2.6	2.5	2.4	2.3
Growth rate	30%	7%	7%	0%	11%	5%	7%	0%	2%

Legend: 2019 — Feb.2020 — Growth rate

Source: App Annie
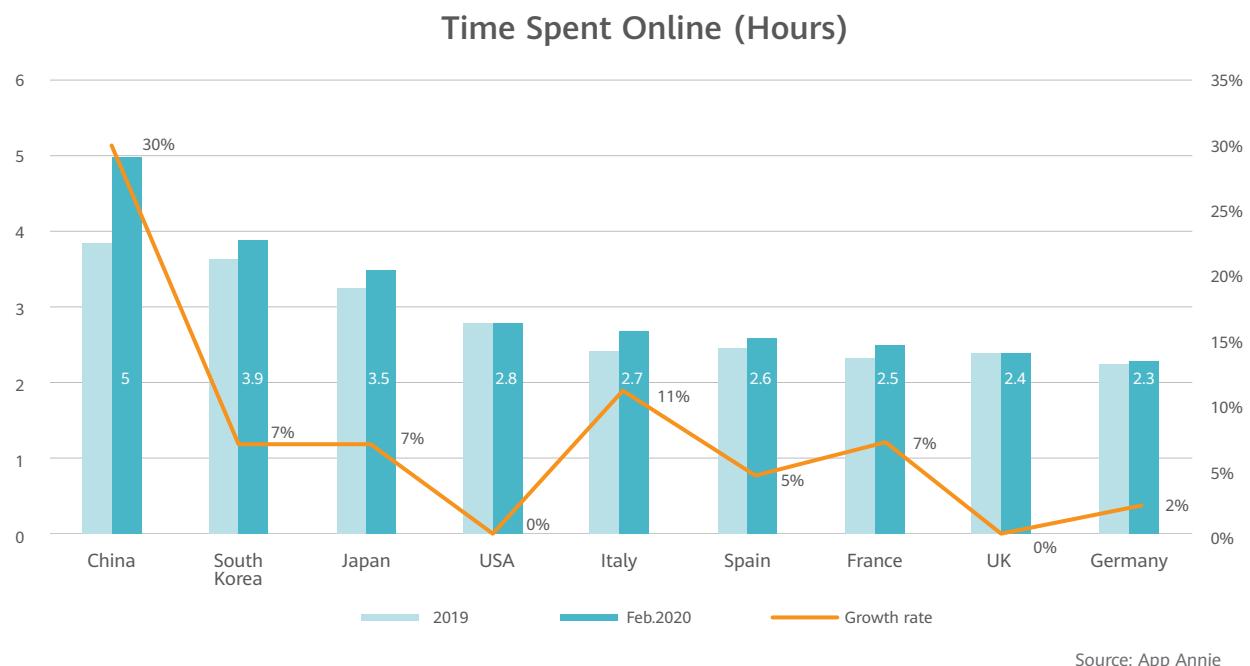
Change 2: Way of work changed
from CBDs to residences and from centralized offices to distributed workplaces

People's way of work greatly changed due to the pandemic. Our workplaces changed from CBDs to home offices, and remote video conferencing became our major way of communication and collaboration. For example, statistics show that the number of new teleworking users in China surged from 300,000 to 4 million during the outbreak.

New Teleworking Users during the Pandemic (Unit: 10,000)
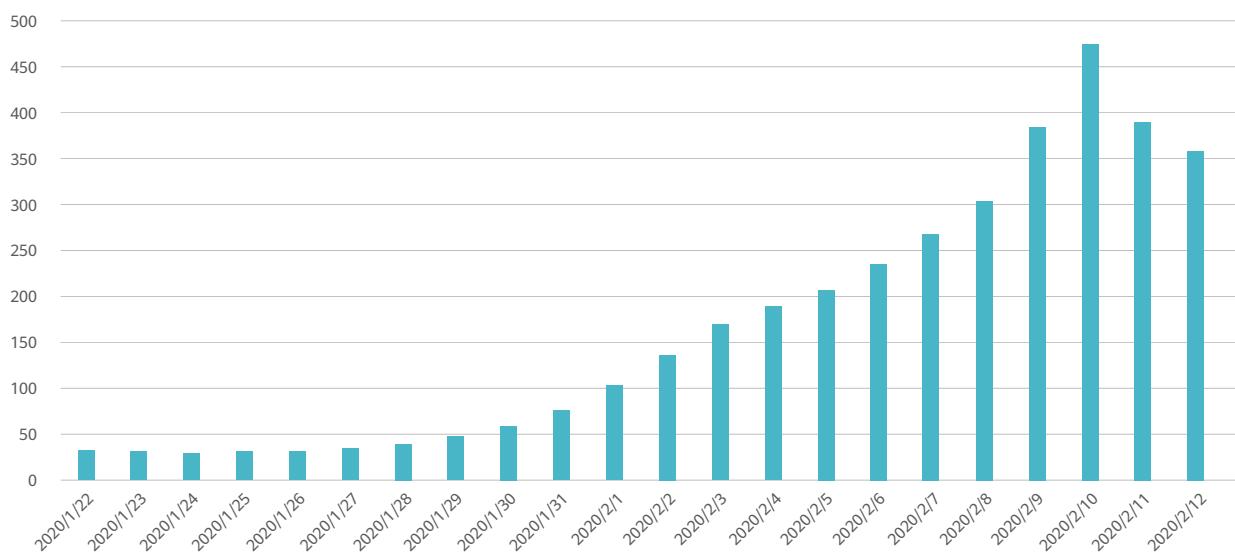
Source: MobTech, 01/22/2020–02/12/2020

Change 3: Way of education changed
learning in school to learning at home and from centralized teaching to remote teaching

In China, the Ministry of Education introduced a series of measures to continue education during school suspension due to the coronavirus. Children's homes became their new classroom, and the growth of online education erupted. For example, the average number of daily active users of apps on learning increased 8-fold during the pandemic.

Change 4: Way of public service changed
from management by man to digital governance and from contact interactions to non-contact interactions.

The "Digital China" strategy played a major role in China's fight against the coronavirus outbreak. The Chinese government effectively replaced conventional management by man with a series of digital governance tools including cloud computing, big data, and AI. This maximized management efficiency and minimized risks of virus transmission.

Communities were the frontline of joint prevention and control of COVID-19. With unified urban management and digital platforms, non-contact technologies were used to safeguard residence community gates and support strict grid management, building up a solid firewall against COVID-19. For example, conventional handwritten registration was replaced with registration through QR-code scanning, and touch-based elevator rides were replaced with touchless intelligent elevator rides.

Global uncertainty grew amid the pandemic

As of April 2020, the global outbreak of COVID-19 was still growing, and the pandemic was still not under control. Before vaccines and patent medicine become available, we still see huge uncertainties in the pandemic. At least 30 countries have declared a national emergency and taken the strictest measures such as a city lockdown. All countries have taken response measures including blocking traffic, suspending schools, and shutting down commercial spaces.

01

User behavior changes led to network characteristic changes

As ICT infrastructure, communication networks are considered to be an information superhighway. As the ways of our life, work, and public service changed, network characteristics have also remarkably changed.

►► 1.1 Network traffic changes

With users spending long periods of time online for living and working during the COVID-19 outbreak, characteristics of global network traffic have remarkably changed.

▶ **Data traffic surged**

· According to data of China's Ministry of Industry and Information Technology, mobile Internet traffic increased 36.4% compared with last year.

· According to a Spanish operator, during the outbreak, their IP network traffic increased by 40%, wireless Internet service by 25%, and wireless voice service by 50%.

· According to Telecom Italia, their fixed network traffic increased by 70%, with online gaming contributing the most increases.

· Vodafone Germany said their data traffic increased by 50%

▶ **No off-peak hours**

Typically a network's busy hours are from 8:00 pm to 10:00 pm. However, online classes and teleworking occurred in the daytime and entertainment happened in the nighttime. This changed the network model, leaving no off−peak hours.

Network Busy Hour Before Pandemic

Traffic

20:00 22:00 Time

Network Busy Hour During Pandemic

Traffic

09:00 22:00 Time
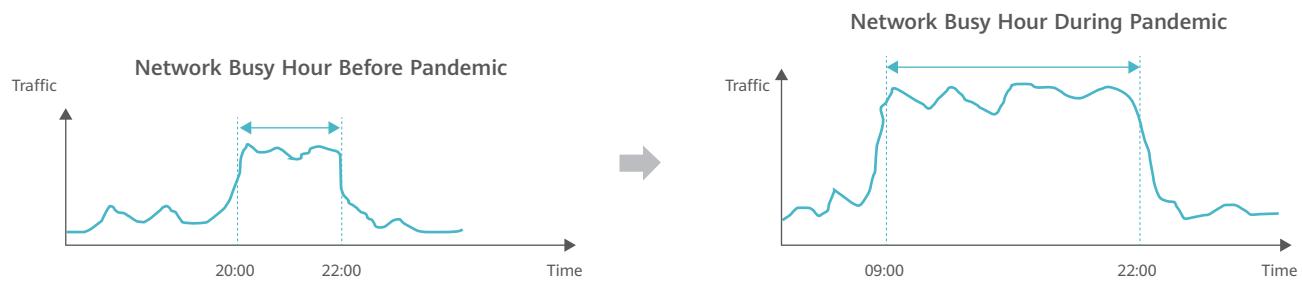
▶ **Residential areas became new hot spots of network traffic.**

Traffic Geography Distribution Change

Before Pandemic

35%

45%

55%

65%

● Rural Traffic

● Urban Traffic

After Pandemic
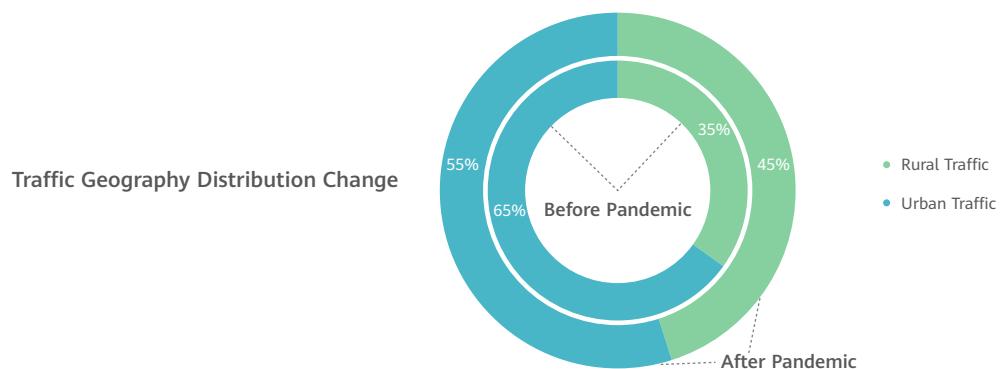
►► 1.2 User experience changes

Everyone has the right to education. Online education during the pandemic has led to a surge in demand for network coverage and bandwidth. Take interactive videos for example, live streaming classes pose much higher network requirements. To deliver good user experience, each classroom needs to be supported by high-quality and stable network bandwidth of up to 20–50Mbps exclusively. Large online classes taking place at the same time keep the network running at full capacity, and can cause bad online experiences like videos freezing, audio lagging, and long buffering times. The freezing rate (stuttering for 1 minute/class) of VIPKID's online courses was 19%, and the Internet received the most user complaints.

Course Type	Experience Error Criteria
One-on-one tutoring	• Freezes: Stutters cumulatively last up to 1 minute per class • Dropped connection: Stutters cumulatively last up to 3 minutes per class
Group tutoring	• Freezes: Stutters cumulatively last up to 1 minute per class • Dropped connection: Stutters cumulatively last up to 3 minutes per class
Live streaming	• Stutter instance quality: (0 times: excellent; 0–2 times: good; 2–8 times: not bad; > 8 times: poor) • Stutter rate quality: (0 times: excellent; 0–5%: good; 5%–8%: not bad; 8%–12%: poor)
VR	• Black edge quality: (0 times: excellent; 0–2 times: good; 2–5 times: not bad; > 5 times: poor) • Stutter instance quality: (0 times: excellent; 0–2 times: good; 2–8 times: not bad; > 8 times: poor) • Stutter rate quality: (0 times: excellent; 0–5%: good; 5%–8%: not bad; 8%–12%: poor)

Source: *White Paper on Home Wi-Fi Network Technology for Online Education,* Huawei & VIPKID

》**02**

ICT infrastructure
upgrade driven by
the outbreak

Individuals, families, as well as businesses from various industries have been greatly affected by COVID-19, posing higher requirements for ICT infrastructure. Countries have also come to realize the importance of digital transformation, and are working with telecom operators to develop policies to support the fight against the pandemic.

►► 2.1 Industries: Going digital to strengthen "immunity"

Industries hit by the pandemic, including catering, tourism, retail, transportation, manufacturing, healthcare, public services, media, and entertainment, are calling for the use of more advanced ICT and digital technologies to respond to the aftermath of the pandemic.

New requirements posed by the healthcare industry: Fully connected, contactless, online, and remote

The healthcare industry urgently needs to deliver online medical consultation and treatment services, to alleviate the pressure of hospital treatment and reduce the risk of cross infection. Hospitals are bringing in 5G robots to help with policy promotion, the offering of medical advice, disinfection and sterilization, delivery, and nursing, etc. to reduce the burden on healthcare workers. This can also reduce direct contact and the risk of infection for healthcare workers.

Health Code

2020.4.5 15:30 Updated

Name： xxx
Address： xxx
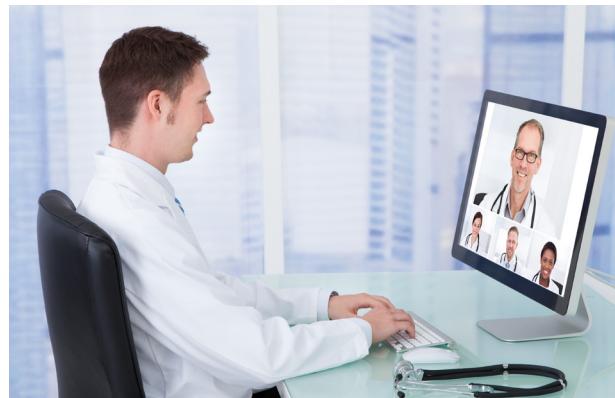
New requirements for public services: big data, full coverage, and intelligent

It's imperative that regulators use new technologies to better promote and conduct epidemic prevention and control, including deploying 5G smart robots for patrolling squares, 5G drones for promoting COVID-19 related knowledge within communities, AI thermal imaging for body temperature measurement in stations, airports, and other densely populated areas, and big data for travel history and close contact tracing, and personnel access control systems based on QR codes for shopping malls, communities, parks.

New requirements for education/entertainment: Large bandwidth, high concurrency, and low latency

COVID-19 has forced elementary and secondary schools nationwide to move their courses online, and office workers to work from home. When a large number of users access the network and the cloud simultaneously for video conferencing, attending online courses, watching videos, online gaming, home fitness, and other home entertainment, problems such as freezes and large delays can occur. To deliver a satisfactory user experience, it's important to expand the capacity of cloud video platforms to adapt to user needs in high-concurrency scenarios, and home broadband and mobile broadband for multi-user, high-traffic, and low-latency scenarios.

New requirements for catering: Contactless, platform, and cloud-based distribution

In China, all kinds of gathers including New Year's Eve dinner parties, wedding receptions, and other activities were almost cancelled, and restaurants were closed temporarily due to the coronavirus outbreak. As a result, catering companies are looking to move online and offer takeaway and delivery services. They aim to deliver contactless catering services by building an online platform that support online food ordering, cloud-based food delivery management, and mobile payment.

▶▶ 2.2 Policy support: National ICT infrastructure upgrade

The coronavirus outbreak has created many challenges to individuals, families, industries, and public services. As a result, governments and regulators across the world have issued a number of policies to facilitate the upgrade of ICT infrastructure.

China: Various policies are issued to promote the integration of ICT in healthcare and education

The state has issued a number of policies to promote the application of "big data + grid", "Internet + medical healthcare", and "artificial intelligence" to make high-quality medical consultation services easily accessible, such as online health assessments, guidance, education, as well as re-examination of patients with chronic illness, and psychological counseling, etc. The state also issued policies to encourage investment in 5G smart health systems for

deal with major public health emergencies, and accelerate the deployment of 5G to support early warning for epidemics, pre-hospital aid, remote real-time consultation, remote surgery, wireless monitoring, mobile ward-round, etc. These policies include:

- *Recent Work Plan for COVID-19 Prevention and Control*, State Council

- *Notice on Strengthening Information Systems to Support COVID-19 Prevention and Control*, National Health Commission

- *Fully Leveraging Artificial Intelligence to Fight COVID-19*, Ministry of Industry and Information Technology (MIIT)

- *Notice on Organizing Efforts to Implement New Infrastructure Projects (Broadband Network and 5G) in 2020*, National Development and Reform Commission and MIIT

Europe: Promoting network upgrade to satisfy the requirements for huge network traffic during the pandemic

EU's Body of European Regulators for Electronic Communications (BEREC) granted operators the authority to exercise traffic control (exempt from net neutrality rules temporarily) amid the outbreak. Members states have also proposed relevant control measures to deal with the crisis, such as optimizing operators' networks, encouraging Internet usage during off-peak hours, and service prioritization.

- Italian regulatory AGCOM issued an emergency decree, requiring operators to improve their networks to support the fight against COVID-19

- The German federal government granted operators the authority to exercise traffic control, prioritize video conferencing, and reduce OTT and video bit rates.

- UK's communications regulator Ofcom issued a proposal to "help broadband users stay connected".

- Switzerland looks to shutting down Netflix's streaming services

Users were advised to access the Internet during off-peak hours as Internet traffic in Spain increased by 40%The French Telecoms Federation calls, to avoid saturation, to a "digital responsibility".

South Korea: Offering multiple incentives to offset the impact of COVID-19 and revitalize the national economy

- Increasing investment in 5G by 50% in the H1 of 2020 to 4 trillion won.

- Telecom operators will continue to expand network coverage on roads and at train stations, shopping malls, and subways.

- Manufacturers will continue to launch low- and mid-pricing 5G smartphones and expand 5G service coverage.

GSMA: Calling on various countries to facilitate the upgrade of communication networks with spectrum policies

- United States: The Federal Communications Commission has released available spectrum in the 600 MHz band and 1.7‒2.2 GHz bands to provide additional coverage and capacity respectively.

- Ireland: Temporarily releasing extra radio spectrum in the 700 MHz and 2.6 GHz bands to provide additional capacity and liberalizing the use of 2.1 GHz so that it can be used for 4G and other
- technologies, rather than just for 3G.

- Jordan: Releasing available spectrum in the Sub‒1 GHz and FWA spectrum bands to MNOs on a short‒term basis.

- Saudi Arabia: Releasing available spectrum in the 700MHz band to MNOs on a short‒term basis.

- Panama: The regulator will grant temporary spectrum licenses to MNOs for additional capacity upon request.

- Brazil: An agreement between MNOs and regulator Anatel in Brazil confirms that the agency will take any regulatory action necessary, including with spectrum, to make sure all services remain intact.

▶▶ 2.3 Operators on the move: Upgrading networks for anti-epidemic efforts

▸ 2.3.1 Chinese operators

Communications support: The three major Chinese operators rapidly built 3G, 4G, and 5G base stations for the Huoshenshan and Leishenshan hospitals in order to offer gigabit network coverage. In areas severely stricken by the pandemic, operators did not suspend services because of unpaid fees, and they even temporarily resumed services for accounts with insufficient funds. This let users use or change their telecom services without going outside. Operators in some regions proactively communicated with healthcare authorities and provided discounts for medical workers who went to Wuhan help fight the pandemic. They also sent nearly 30 billion text messages to the general public about epidemic prevention and controls, and offered individuals SMS inquiry service about travelling. These three operators successfully maintained telecom network stability nationwide, especially in Hubei province.

Big data analysis: Through telecom big data analysis, operators provided information about people's travels and sent alerts ahead of time. These operators also worked together to preliminarily analyze where people went across the country and gave warnings about those who had been in close contact with COVID-19 patients.

▶ 2.3.2 Global operators

Five measures Vodafone took to strengthen network assurance

- Ensured network service quality.

- Provided network assurance for key government functions.

- Improved the spread of public announcements during the outbreaks.

- Encouraged "work from home" and provided support for small and micro businesses.

- Strengthened government's management and controls in the epidemic-stricken areas.

Four measures MTN CEO released:

- To reduce the spread of virus, requested employees to work from home and perform self-quarantine, etc.

- To protect employees' safety, started working remotely and banned international business travel.

- To ensure connectivity, provided network assurance in terms of hardware, software, spare parts, human resources, and other aspects.

- MTN played a role in solving social difficulties by providing free networks for universities and lowering the transaction fees of mobile money to reduce cash transactions.

03

Teaming up with partners from numerous industries, operators utilized technologies to fight the pandemic

Operators built and operated ICT infrastructure. Faced with the epidemic outbreaks, they worked with partners from numerous industries to overcome various difficulties. Operators met demand in various scenarios by making full use of technologies such as 5G, cloud, AI, and big data. They also practiced the principle of "tech for good" by letting ICT network infrastructure play its strategic role.

►► 3.1 Public services

The general public wanted access to visible, credible, and controlled information: People panicked since the virus couldn't be seen or touched, which was coupled with overwhelming information on the internet. They wanted authoritative, real, and credible information about the epidemic and learn about the right way to stay safe.

Authorities, on the other hand, wanted to stop rumors and panicking: As the epidemic exerted a significant impact on all aspects of society, it posed great challenges to authorities. They needed to coordinate their efforts to combat the virus, while openly sharing information with the public through updates on relevant policies and announcements so that people wouldn't believe and spread rumors or panic.

Measure 1: Using 5G drones

Drones connected to operators' 5G networks were used to combat the virus by patrolling streets, sharing information about the anti-epidemic efforts, disinfecting streets and buildings, and transporting urgent goods like medicine.

- **Broadcast:** Local police patrolled streets and communicated with people remotely by using drones in order to promote epidemic prevention information and instructions.

- **Disinfection:** Drones were used to disinfect hospitals and areas nearby. It was more efficient than disinfecting manually and reduced cross infection risks.

- **Assisting the police:** After work and production resumed, an increasing number of people returned by car. Traffic police hung registration QR codes from flying drones, and used them to remind drivers to register in advance. This saved time for drivers, doubled traffic efficiency, and avoided congestion on highways outside cities.

- **Transport:** Ferry services and other transport methods were suspended during the outbreak, so drones were used to send medicine and samples for first aid and daily necessities among other things. Air transport routes using drones could reduce distanced travel from 100 km to 2 km.

Measure 2: Checking temperatures and mask wearing with AI

Avoiding physical contact, the AI thermal temperature detection system provided automatic body temperature checks, with deviations of less than 0.3℃. The system alerts automatically whenever someone's body temperature is higher than 37.3℃, and can check 46,000 people per hour. This system addressed problems of traditional thermometers, temperature guns, and ear thermometers, which can easily lead to cross infection and are only for one person at a time. An AI thermal temperature detection system was deployed to quickly screen people's body temperature in crowded public spaces such as schools, airports, docks, stations, hospitals, and shopping malls. Operators' telecom big data analysis systems could quickly identify those who were closely connected to coronavirus patients and where they had been, which helped effectively control the spread of the epidemic.

An AI facial recognition algorithm was used to identify people who weren't wearing masks in public. Utilizing operators' ubiquitous wireless network coverage, this system was quickly deployed in key transportation hubs like railway stations, airports, and bus stations, as well as in other crowded public spaces such as shopping malls, office buildings, schools, and communities. It helped reduce public safety risks, uphold the law, and lower infection risks.

Measure 3: NB-IoT magnetic electronic door seal for people in home isolation

NB-IoT supports extensive coverage and low power consumption. NB-IoT magnetic electronic door seal provided real-time management of isolated personnel and sent alerts when they entered or left home. Powered by a range of algorithms, it collected information through front-end door and window sensors and recorded their whereabouts. Abnormalities such as people entering and exiting and other statistical data were uploaded to the back-end management platform through the NB-IoT network; this provided real-time warnings and overviews of where isolated individuals were.

Measure 4: 30 day travel history

As companies gradually resumed work, employers and community neighborhood committees wanted to learn about where returned people had been to ensure public safety. It was no longer sufficient to register people manually, and also people may lie about where they had been. To help users quickly prove their recent travels and assist governments in verifying this information, the three major Chinese operators launched a free travel history inquiry service (for example, if you have China Mobile, you can find this out by sending CXMYD#2550 to 10086). This service is based on operators' big data capabilities and information security is ensured.

Short Message

CYMYD#2550

Dear 136****9609 user, your mobile phone visited the following cities in the past 14 days: Dongguan, Shenzhen, Guangzhou.......

Measure 5: Inquiries about nearby outbreaks and targeted hospitals

Community epidemic control was an important step in preventing the spread of the virus for people returning to work. Baidu Maps offers its users a service to quickly learn about outbreaks in their cities and neighborhoods. Using the ubiquitous network offered by operators, users can learn about nearby outbreaks, fever outpatients, and targeted hospitals for COVID-19 in real-time.
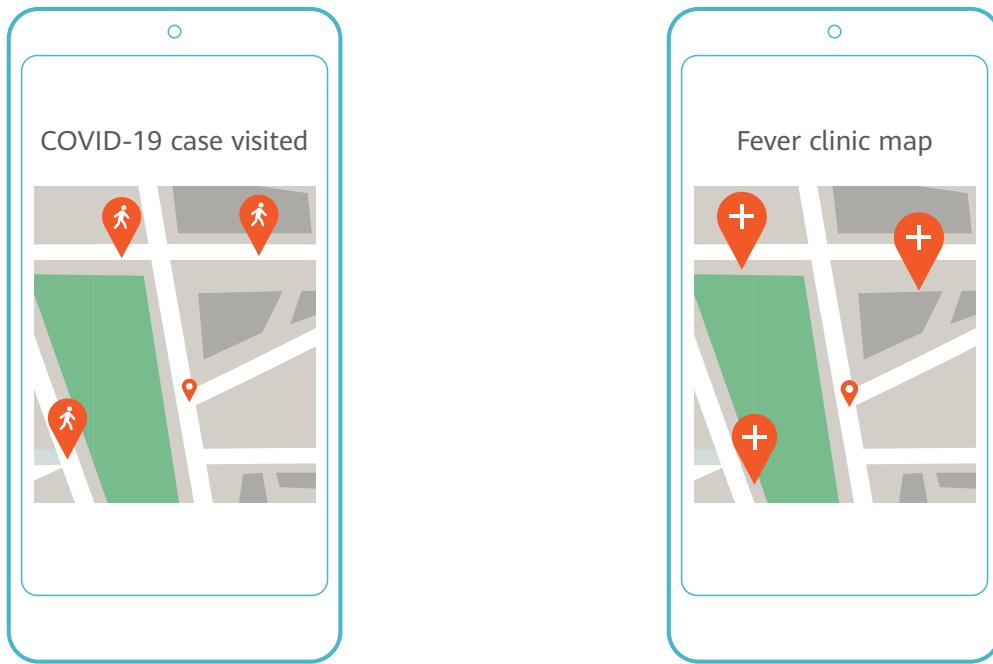
Measure 6: Big data helps users see if they are closely connected to a COVID-19 patient

There is increasing demand for big data given recent developments and the need to prevent the disease from spreading. To meet such demands, E-government Office of the General Office of the State Council launched the Close Contact Identification app. This app analyzes whether the user has been in close contact to a COVID-19 patient by using big data analyses of travel history and public transit records, including the high-speed train departure time.

▶▶ 3.2 Hospitals

The Chinese city of Wuhan was the first to marshal a citywide approach to battling COVID-19, which triggered contingency plans across all sectors, especially for public security and services. A series of steps – screening, isolation, detection, and joint prevention and control – were taken to protect lives, maintain social order, and ensure orderly production. Contactless services and telecommuting made their way into people's lives almost overnight. The capacity of the entire healthcare system was put to the test in terms of early detection, precise prevention and control, treatment efficiency, combating the virus, and resuming production.

Huawei joined operators and many healthcare partners in this battle. As key technologies underpinning the digital infrastructure, 5G, cloud, and AI have been further integrated with the healthcare industry. This has helped speed up digital transformation, contain the spread of the virus, share medical resources, reduce contact transmission risks, and improve the efficiency of treatments.

▶ 3.2.1   5G-powered digital channels quickly built up in hospitals

5G has played an important role in the fight against the pandemic with its ultra-large capacity, ultra-high bandwidth, ultra-low latency, and fast service provisioning. The gigabit-capable networks built for hospitals and a myriad of 5G-powered healthcare services have created a quality digital channel. This channel is used to connect doctors with patients, affected areas with the rest of society, and hospitals across physical and administrative boundaries. As a result, physical contact was minimized, and there were huge improvements to information sharing and treatment efficiency.

Huoshenshan Hospital opened on time with gigabit-capable networks:

On January 23, 2020, Wuhan decided to build Huoshenshan Hospital by referring to the Xiaotangshan model from the early 2000s. On January 24, 2020 (Chinese New Year's Eve), all hands were on deck to start onsite engineering construction. It was the beginning of an intense and protracted race against time to centrally treat COVID-19 patients and contain the spread of the virus.

To reduce the workload of onsite fiber deployment and shorten the project duration, Huawei worked with Hubei local operators to provide network coverage for the hospital with both 5G and optical fiber. The first 5G base station for Huoshenshan Hospital was put up in only 36 hours and went live on January 25. Using the stable gigabit-capable network, basic data services and various medical services were commissioned and put to use onsite. This helped ensure that the construction of the 1,000-bed Huoshenshan Hospital of 33,900 square meters, was finished by February 2 as scheduled. At 9:00 on the morning of February 4, the hospital admitted its first batch of COVID-19 patients, and the next day, Leishenshan Hospital was also in operation.

Figure 1: 5G network
construction for Huoshenshan Hospital

Figure 2: 5G + Wi−Fi network
construction for Leishenshan Hospital

5G live streaming of the hospitals' construction rallied confidence in battling COVID-19:

Early in the morning of January 27, China Telecom received a request to launch a continuous live streaming service for cctv.com which would live broadcast the construction of the two new hospitals in Wuhan through its "COVID-19 Live" program. The goal was to update interested people in both China and the rest of the world on the developments of COVID-19 in Wuhan.

This live broadcast had strict requirements on bandwidth and online live broadcast technologies. China Telecom finally adopted the "5G + optical fiber" dual gigabit network solution and mobilized video cloud resources across the nation. The live broadcast started at 8:00 p.m. on July 27. The non-stop live broadcast was not only in 2D but also included

4K, 360-degree VR streaming of the construction of Leishenshan Hospital, which gave netizens an immersive experience of China's strength in construction. Featuring HD images and stable connections, the live broadcast attracted nearly 100 million concurrent viewers at its peak and was dubbed "the most impressive online supervision on construction work". This live broadcast showed the world China's speed and the inspired experience that 5G brings, and rallied public confidence in fighting COVID-19.

Figure 2: Live broadcast of
Huoshenshan Hospital construction

5G, cloud, and AI enabling digital hospitals:

In addition to online live broadcast, Huoshenshan Hospital and Leishenshan Hospital were provided with gigabit network coverage with 5G. The networks can support concurrent communication for up to 25,000 users and enable a series of digital and intelligent medical services such as remote expert consultation and video conferencing across hospitals at different levels, remote B-scans, AI-assisted CT analysis, unmanned delivery, unmanned disinfection, and mobile detection vehicles. This greatly improved diagnosis and treatment rates, reduced contact transmission, aided in the shortage of frontline medical staff, and eased their crushing workloads.

▶ 3.2.2 5G-enabled remote collaboration improving resource sharing, diagnoses, and treatments:

Isolation turns out to be the most effective and important prevention and control method to contain the fast spreading coronavirus. Medical workers facing many patients also needed to adjust how they gave diagnoses and treatments in order to reduce contact and avoid infection. The quick spread of the virus brought many challenges to affected areas such as shortages of medical experts, unbalanced distribution of skills, and resource allocation difficulties. It became imperative to have medical experts work together closely to improve efficiency and reduce the workload of medical staff.

Operators and healthcare partners quickly responded to the challenges above and provided multiple solutions for 5G-based remote collaboration. For example, 5G remote consultation was provided by integrating an HD videoconferencing system with CT diagnosis. This solution allowed medical experts in different locations to read scans remotely and make diagnoses in real time.

On January 31, Huawei worked with China Telecom to deploy and commission the first remote consultation network for Huoshenshan Hospital (Figure 3), and launch a 5G remote consultation service in the Wuhan Union Hospital. With this service, the hospital was able to provide remote consultation services to patients in different parts of the hospital, as well as to patients in Peking Union Medical College Hospital, Beijing Chaoyang Hospital, and Wuhan Cancer Hospital. Massive amounts of data and ultra-HD images were transmitted over high-speed 5G networks and a medical image cloud. Medical experts in different locations were then able to share patient information in real time. For example, they could remotely label CT scans, have discussions, and make diagnoses remotely (Figure 4).

Figure 3: Commissioning the first remote
consultation platform in Houshenshan Hospital
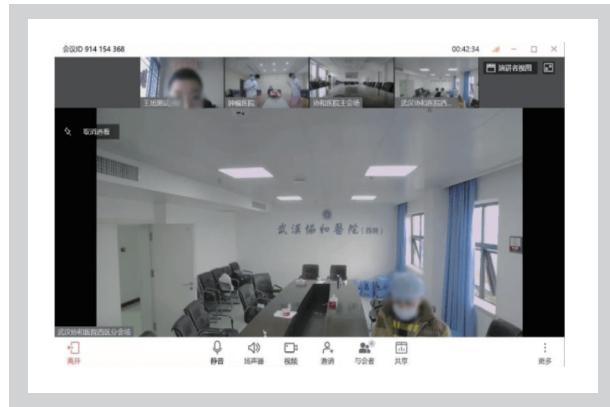
Figure 4: Commissioning the first remote
consultation platform in Wuhan Union Hospital

On January XX, four hospitals in different cities engaged in the 5G remote CT screening: Leishenshan Hospital (Wuhan), Beijing Tsinghua Changgung Hospital (Beijing), Zhongshan Hospital Affiliated to Fudan University (Shanghai), and The First Affiliated Hospital of Sun Yat-sen University (Guangzhou) (Figures 5 & 6).
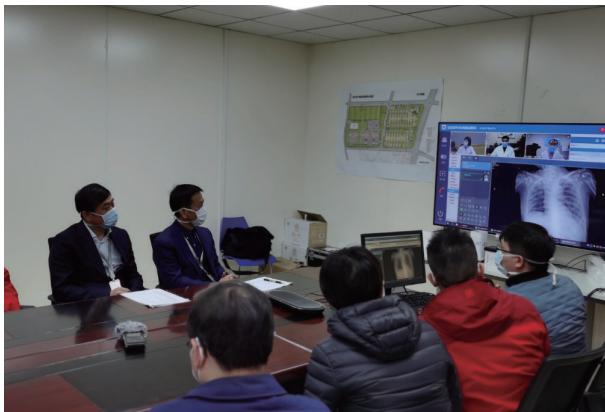
Figure 5: Remote consultation by four experts

Figure 6: Reading CT scan remotely

Since the start of the outbreak, about 1,000 hospitals in China have adopted the remote consultation solution enabled by 5G, WeLink (videoconferencing), and CT systems. Thanks to 5G's large bandwidth (UL/DL: 30 Mbit/s) and low latency, the solution let experts in different locations have stable video conferences and view HD CT scans transmitted over high-speed networks (average CT scan: 200 MB to 1 GB) in real time. This way, they could work together to improve the efficiency of screening diseases. Powered by cloud and AI, CT results can be delivered in seconds.

With 5G remote consultation, experts could gather anytime from anywhere to avoid contact and save more lives.

In addition, the 5G remote assistance solution helped nurses monitor dozens of patients remotely and simultaneously, provide psychological counseling for patients, and allow families to visit remotely. This solution plays an important role in each phase of diagnosis and treatment, avoids cross infection, reduces the workload of medical staff, and improves treatment efficiency.

Figure 6: One-on-one
remote psychological counseling

Figure 7: Remote monitoring
and visit of patients in isolation

▶ 3.2.3　5G remote B-scans for contactless, mobile diagnosis and treatment:

The span of the outbreak (Chinese provinces, cities, villages, etc.) and the measures taken to limit people's mobility and gatherings meant that medical resources were unevenly distributed among hospitals. When there weren't enough local experts, challenges arose regarding identifying, confirming, and treating COVID-19 patients in time. This solution let experts remotely operate the medical monitoring system over a 5G network to check or even operate on patients. This kind of contactless and mobile diagnosis and treatment made things much more efficient.

As shown in Figure 8, on February 18, Peng Chengzhong, deputy director of the Remote Ultrasound Medical Center of Zhejiang Provincial People's Hospital remotely controlled a robotic arm that could perform ultrasounds. Over 700 km away, Peng did B-scans through 5G networks for COVID-19 patients in a makeshift hospital converted from the Wuhan Huangpi Gymnasium.

Figure 8 Remote B-scan

▶ 3.2.4　5G-enabled unmanned disinfection, delivery, and temperature checks:

According to quarantine policies, the less human contact, the better. So how can we be sure that supplies are delivered securely and on time? 5G unmanned vehicles prove to be an excellent solution to help prevent and control the spread of the virus.

They can be used to spray disinfectants, perform medical tests, distribute supplies, and take temperatures through facial scanning. They can also work as broadcast stations in order to provide real-time news on COVID-19 prevention and control.

With the large bandwidth available with 5G networks (uplink rate of 50 Mbit/s), the cameras on the unmanned vehicles can upload road condition images in real time, making remote driving a reality. The ultra-low latency of 5G ensures that unmanned vehicles can avoid obstacles in real time and run any time of the day.

5G-powered unmanned vehicles can deliver medical and daily necessity supplies to isolated areas and masks to citizens. These vehicles can also reduce the possibility of human-to-human contact and minimize the risk of infection. They are making a major contribution to the prevention and control of the pandemic.

An unmanned vehicle is distributing supplies to a community in Wuhan

An unmanned vehicle is delivering hot meals to Beijing Haidian Hospital

An unmanned vehicle is delivering masks at the Bird's Nest in Beijing

In Wuhan's Leishenshan Hospital – a makeshift hospital built to treat COVID-19 patients, unmanned vehicles are used to distribute medical instruments and materials. The vehicles have a long range of 100 km. This means that they can work for a whole day without charging, reducing contact and saving labor costs.

An unmanned vehicle in the Leishenshan Hospital

An unmanned vehicle is distributing supplies to wards in the Leishenshan Hospital

With infrared sensors built in, robots can measure temperature and disinfect in environments with high risks and work for a long time, replacing medical workers and reducing their risk of infection.

A robot is performing a disinfection in the hall of Wuhan Union Hospital

A robot is performing a disinfection in the hall of Wuhan Union Hospital

Though COVID-19 is now under control in China, 5G and other digital infrastructure will continue to be deeply integrated with the healthcare industry. As the relevant laws and regulations are maturing, these infrastructure will play an increasingly important role in helping people stay healthy and respond to health events.

▶▶ 3.3 Homes

The pandemic has profoundly changed the way the entire society works. The most significant change is that people are isolated at home to minimize travel. As a result, homes are taking more functions. In addition to meeting routine needs, homes also become classrooms, offices, places of entertainment, and even part of hospitals. These changes have redefined the functions of homes while bringing more complex services that will profoundly change the traffic model of fixed networks in a short time.

▶ 3.3.1 During the outbreak, network traffic at home is increasing significantly, and user experience is undermined.

The pandemic has resulted in a material change in many business models. Contactless connection services are emerging rapidly, and businesses are going online. This will continue to be the trend for a long time to come. This trend will change the traffic model of home networks.

(1) Change 1: The traffic generated by services like online education and telecommuting is mainly aggregated on metropolitan area networks (MANs). As a result, data flowing in the MANs surges. In a region in China, for example, the traffic increases by more than 30%. In some densely populated regions, the traffic increases by more than 100%. **In March 2020, the network data switching volume across Italy increased by two thirds, and the total fixed network traffic nearly doubled.**

(2) Change 2: Most services of Internet applications pass through content distribution networks (CDNs). As a result, the traffic generated by these networks is seeing a sharp rise. In addition, the traffic remains at the peak for a longer period and the interval between peak hours and off-peak hours decreases significantly.

Network Traffic changing status

APPs/Internet

OTT Region

Region CDN

OTT
Backbone

OTT Region

Region CDN

Operator Backbone

Increasing

increasing
DC

Increasing

Increasing

Increasing

Increasing

CDN

CR

Increasing

BRAS

CR

BRAS

CDN

OLT

OLT

Metro

Metro
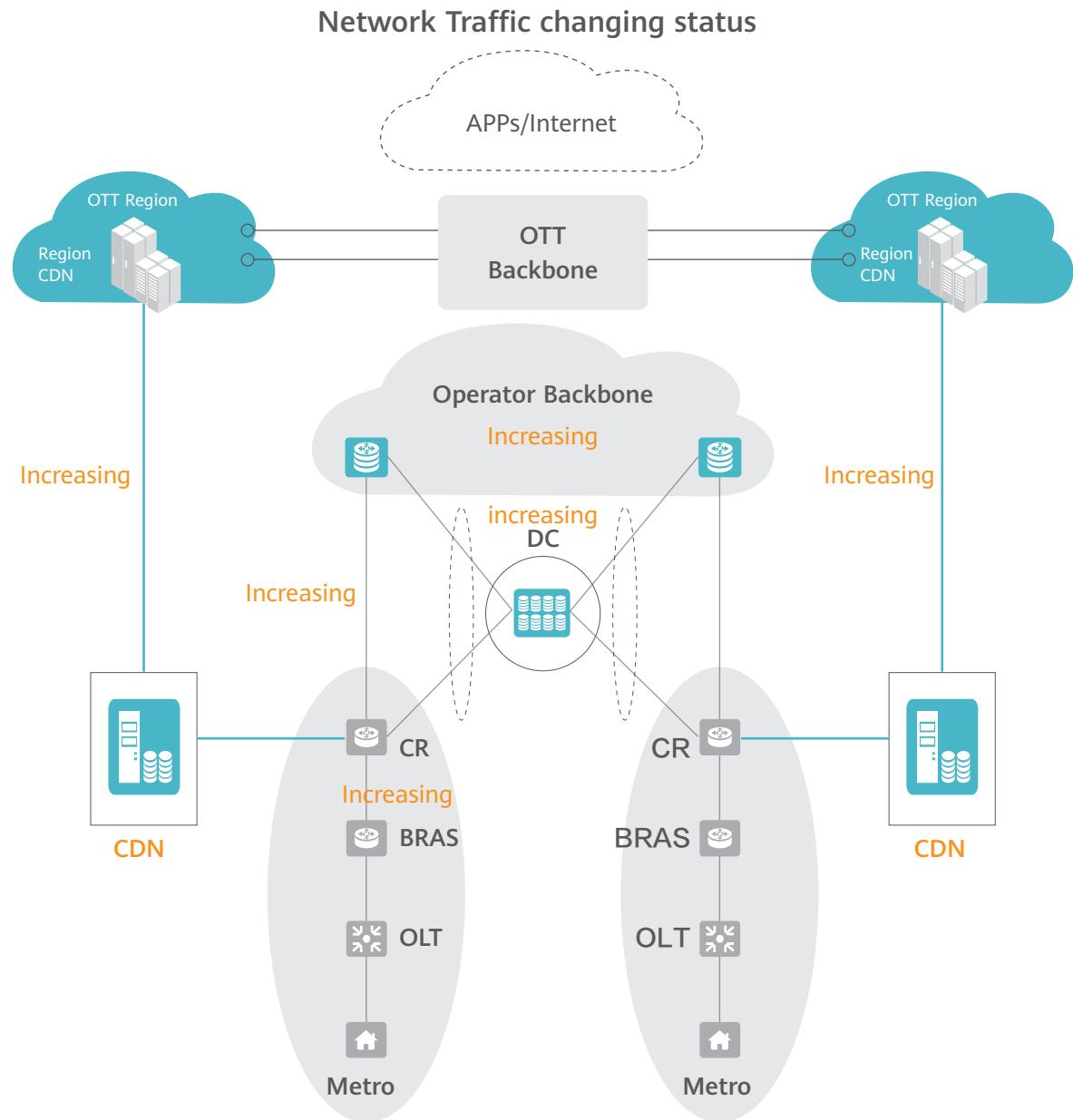
(3) Change 3: During the pandemic, home Wi-Fi networks become the main bearer networks. In Europe, for example, the traffic generated by home Wi-Fi networks is increasing by more than 80%, and more than three devices are concurrently connected to Wi-Fi networks at each home. Therefore, these networks need to coverage a wider area at home and remain busy for a longer period of time. Home users remain online for more than 10 hours every day.

The surge in home network traffic has undermined user experience, especially in regions without access to FTTx. Users have raised very specific requirements for the SLAs of services like online education and telecommuting.

- Take a city in China as an example. The packet loss rate of an online education app is nearly 10% during peak hours (from 20:00 to 22:00), greatly undermining user experience. This is also the case with telecommuting applications. For example, the packet loss rate of a video conferencing application exceeded 2% during peak hours.
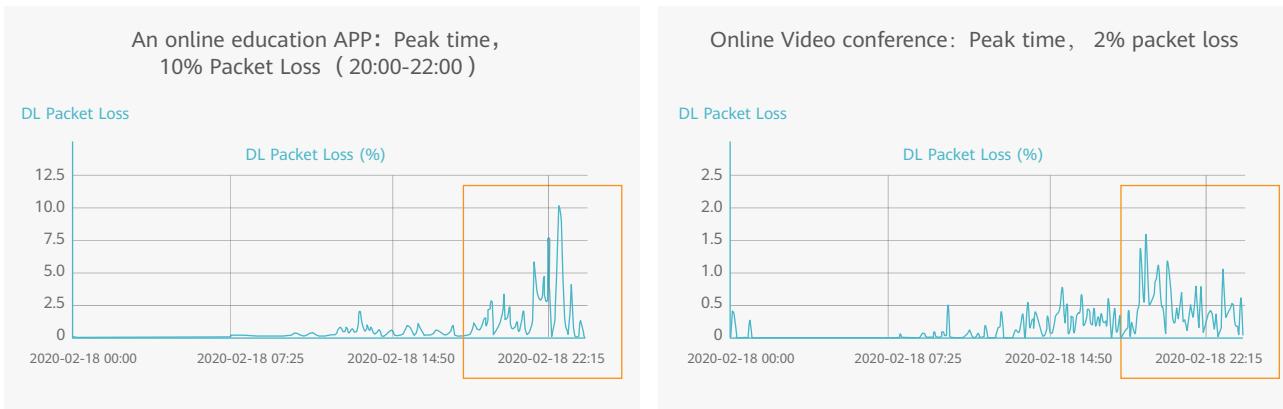

- During the pandemic, more than 70% of user complaints are related to home Wi-Fi, making it the weakest link. The main reasons include interference, limited coverage, and lack of SLAs for key services. According to an article published by the UK regulator Ofcom, microwave ovens can reduce Wi-Fi signals, so users are recommended not to use the microwave when they are making video calls, watching HD videos or doing something important online. Cordless phones, baby monitors, halogen lamps, dimmer switches, stereos and computer speakers, TVs and monitors can all affect Wi-Fi.
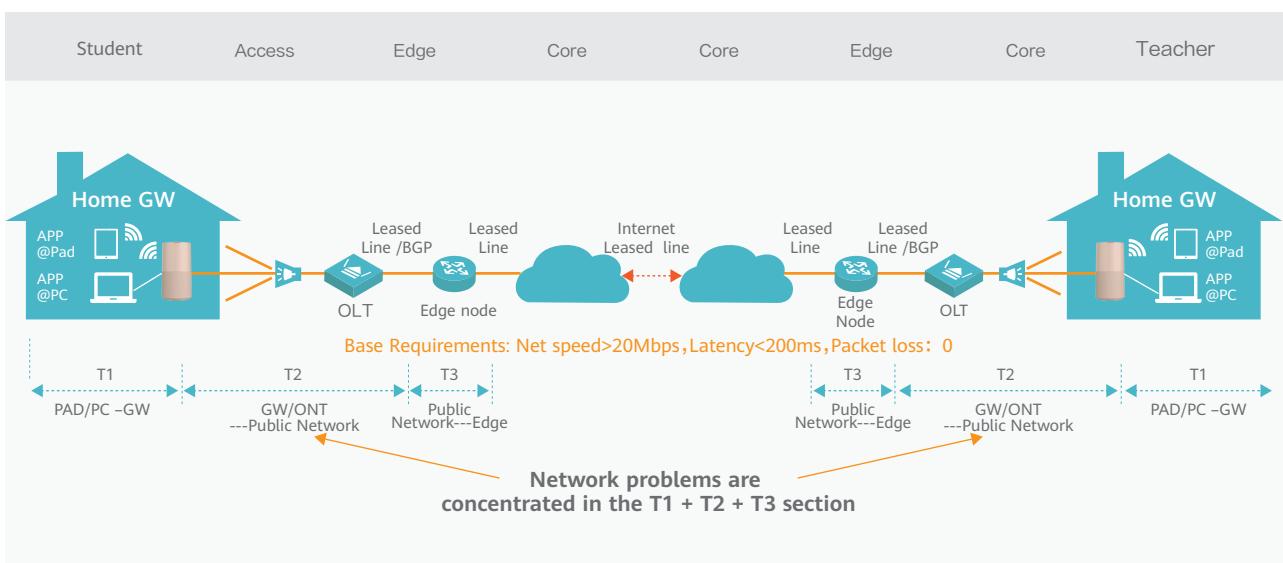
▶ ## 3.3.2 Operators are working with their partners to improve network quality and home service experience

- **Deploying new technologies to improve user experience**

(1) Improving home Wi-Fi network coverage: Due to the poor Wi-Fi coverage, users are having a bad ultra-broadband service experience. In addition, operators do not have effective ways to operate and maintain home Wi-Fi networks. To address these problems, Huawei has launched an innovative home network solution, which can work with any media like Ethernet cables and wireless to remove connection barriers. The 1+N home network is built on Huawei's high-performance home gateways. Through intelligent synchronization and seamless roaming, every corner at home can be seamlessly covered with 100 Mbit/s and 300 Mbit/s Wi-Fi networks. This solution helps operators improve user experience and operational efficiency.

Home WiFi network	High efficient networking APP

New business

Villa — Hotel

Apartment

Engineer APP

Order Auto Collection
Multi-point Sampling
Wi-Fi networking
Wi-Fi simulation
Channel Optimization
Acceptance

Fast Networking
Smart modeling

Experience Assurance
Wi-Fi Simulation

Fast Acceptance
On-key Assessment
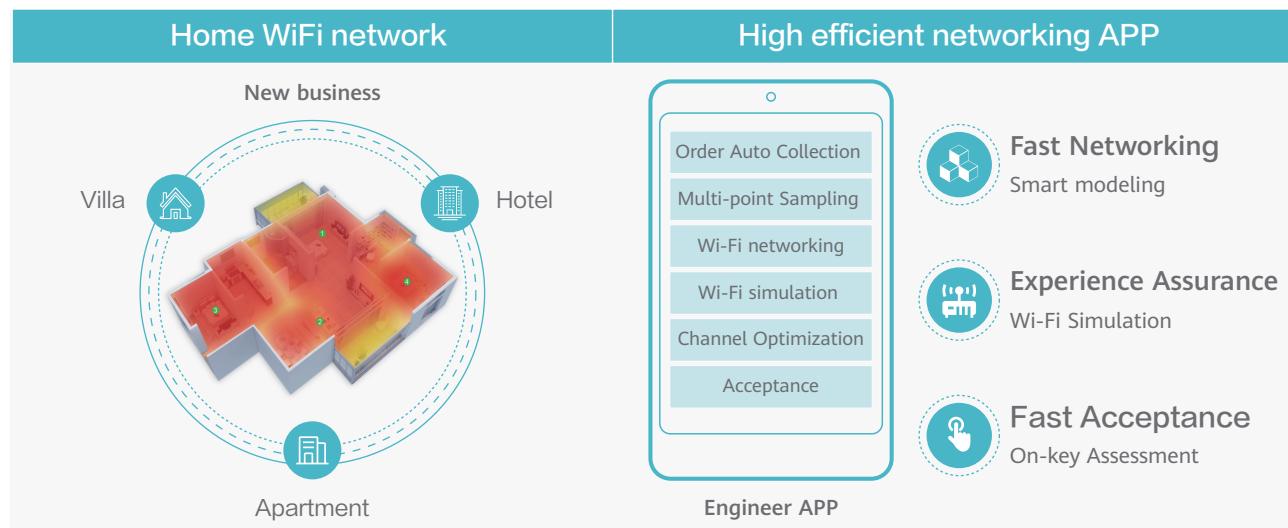
(2) Higher Wi-Fi speeds for higher-priority services Huawei's innovative technologies can intelligently identify VR, video, and gaming services. Based on that, operators can provide dedicated channels for online education and gaming services, and guarantee a high QoS. This can ensure that VR video, live broadcast, and gaming are running smoothly without any freezing.
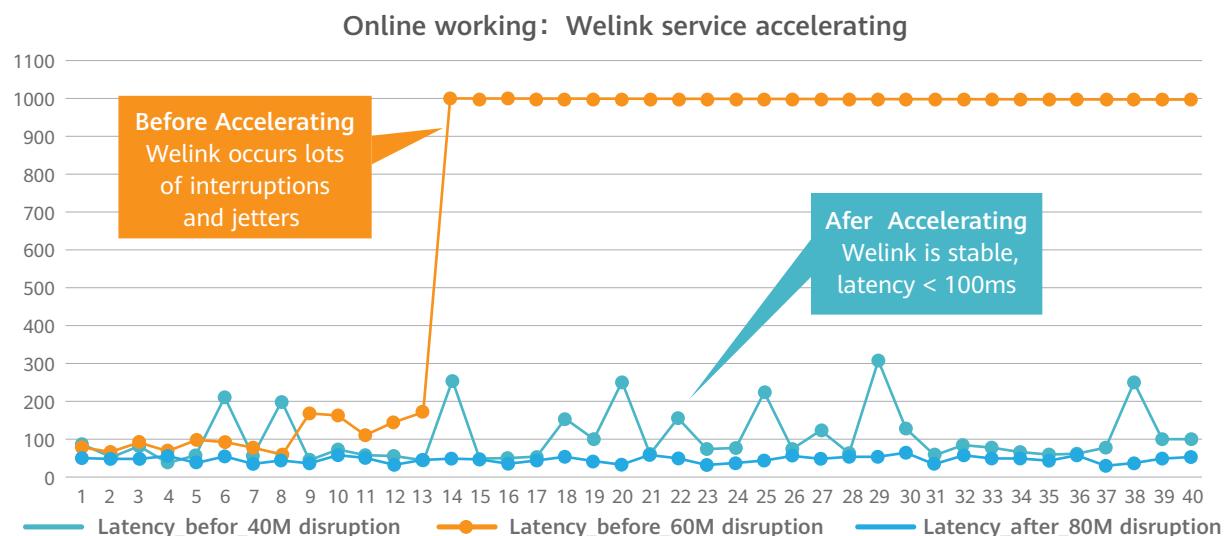
Online working：Welink service accelerating

Before Accelerating
Welink occurs lots of interruptions and jetters

Afer Accelerating
Welink is stable, latency < 100ms

— Latency_befor_40M disruption　　—●— Latency_before_60M disruption　　— Latency_after_80M disruption

(3) Network topologies and Wi-Fi performance are visualized, making remote O&M a reality. Users can perform network detection and troubleshooting at home.

— Cloud-based O&M: Smart gateway and access point management, plug-in installation, home network topology visualization, Wi-Fi optimization, channel switching, and batch terminal operations

— O&M by the installation and maintenance app (SDK enabled): remote access management for installation and maintenance app users, Wi-Fi quality evaluation, speed test, one-click Wi-Fi quality detection, Wi-Fi channel optimization, and Wi-Fi setting

— Mobile app management (SDK enabled): home network topology visualization, home network configuration, Wi-Fi strength mode selection, transmit power adjustment, blacklisted device management, protection against unauthorized access, and setting of guest networks

• Acceleration of home network speeds for free during the pandemic: China's three major operators have launched free network speed acceleration services in each province during the pandemic, and pushed targeted services for online education and telecommuting.

China Telecom	Zhejiang Mobile	Jiangxi Unicom
• 200Mbps Upgrade for free • Golden membership for 3 months • 6T family public cloud service	• Fixed BB for education 200Mbps upgrade for free	• 5G +IPTV for online education

• **Providing more applications for home users**

• Providing targeted video service packages: China Telecom is providing four free video/gaming apps for all users, which have been used for 3.74 billion times and 4 billion hours. China Unicom is offering 10 data-free video games to users in Hubei and 229,000 data packages have been distributed. China Mobile's Migu Video live broadcast the construction of the Huoshenshan Hospital and Leishanshan Hospital over 5G networks, attracting more than 500 million views.

- Launching several online education platforms: By the end of March 2020, China Telecom's cloud-based live classroom service had served 1.01 million students from 319 universities. China Unicom had provided 10 million free courses that had covered 47 million users. China Mobile's online distance education service has covered 60.7 million people, with a total of 104,700 classes opened.

▶▶ 3.4 Enterprise scenario

As countries around the world have launched different anti-pandemic policies and measures, such as the "nationwide or municipal lockdown", most companies have to resort to telecommuting. So operators and their industry partners are using technologies to help companies with telecommuting and resume production.

- Collaborative assurance for telecommuting

Operators are committed to supporting companies with telecommuting

During the critical period of pandemic fight in China, operators opened their "cloud conference" services for free to meet companies' needs for online working and teleconferencing. By March 2020, the number of new users of China Telecom's e-Surfing Cloud conference had reached 858,000, and the total number of conferences held had reached 718,100; China Unicom's total registered users had reached 104,000, and it had provided services for 15,900 companies and institutions; China Mobile's cloud videoconferencing system had covered 31,000 companies and 4.532 million users.

In Thailand, local telecom operators have promised to provide government agencies and SOEs with free Internet connections for three months and offer private companies network packages based on their bandwidth requirements.

Huawei provides full support

The telecommuting platforms represented by WeLink provide companies with a full range of services, including video conferencing, online clock-in/out, online marketing, and cloud-based contract signing, providing full support for companies to resume production. To fight the pandemic, Huawei announced to open its smart work platform HUAWEI CLOUD WeLink for free. According to statistics, the number of daily meetings and newly registered companies of HUAWEI CLOUD WeLink increased by 100% and 50% respectively within the several months since its opening to the public. Especially during the Spring Festival, hundreds of thousands of companies started to use the platform, with millions of daily active users and 50-fold increase in service traffic.

Internet companies provide full support

During the pandemic outbreak and spreading, Internet companies have actively expanded ICT infrastructure capabilities and provided more cloud hosts. For example, an Internet company have deployed additional 10,000 cloud servers within two hours.

- **Joint efforts by operators and industry partners to ensure work resumption of companies**

When the situation settles down, work resumption becomes a top concern. The problem is, as the pandemic severity and prevention efficiency vary from place to place, when workers coming from different places return to work, there is a high risk of cross infection. Therefore, ensuring employee security has become the biggest pain point for all companies that are about to resume production.

Operators in China have actively carried out information-based pandemic prevention and launched multiple customized information services, such as the thermal imaging system for body temperature measurement, cloud conferencing, and a "calling card" that shows the caller's identity when you receive a phone call. The thermal imaging system for body temperature measurement has multiple advantages, such as "no-contact, long-distance, large-area, and quick detection of body temperature". The thermal imaging camera is used to measure the forehead temperature of workers returning to work, so that body temperatures can be quickly detected in the crowd, and the anti-pandemic management personnel can promptly know the workers' body temperature when they reach the work site. This system has greatly reduced the anti-pandemic workload during the production resumption period. It has not only saved the time of manual temperature measurement, but also reduced personnel contact, which further lowers the pandemic spread risk, and builds the first line of protection for large-scale production resumption.
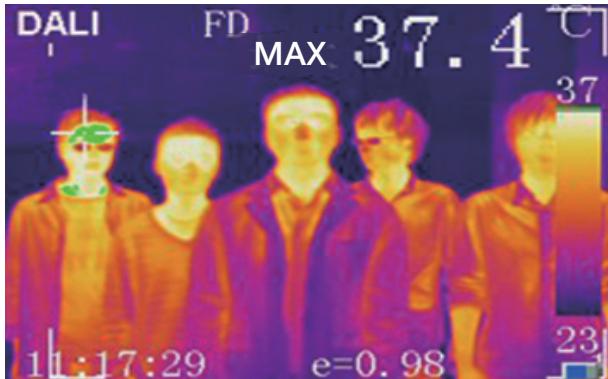
Operators in China have provided an innovative public service of "checking roaming destinations". Users can send SMS messages to check their travel schedules within 15 days or 30 days. This service solves the problem that many people cannot prove their travel schedules or return to their residences or work places.

The "intelligent voice-based pandemic survey system" jointly developed by HUAWEI CLOUD and Yizhi Intelligent Technology has been highly championed by operators. It can identify susceptible people in real time, improving the efficiency and accuracy of pandemic survey.

The "intelligent voice-based pandemic survey system" mainly applies to the following four scenarios:

(1) Pandemic notification: Point-to-point quick call to promote pandemic prevention and control knowledge.

(2) Local residents check: Help government agencies, companies, and schools quickly collect information.

(3) Checking people's traveling record: Survey the physical conditions of returned personnel in batches and automatically generate statistical reports.

(4) Patient tracking: Regularly track the physical conditions of those with symptoms.

04

Huawei's anti-pandemic practices

In the current situation, we must protect ourselves before making contributions to the anti-pandemic work. So for Huawei, it must first ensure the safety of all Huawei employees. Since the pandemic outbreak, Huawei has taken a series of measures to effectively ensure the health and safety of its employees. On that basis, we have also actively responded and exerted to meet the needs of customers and governments around the world as they fight the pandemic.

Currently, Huawei has fully resumed its production in China, and restored its capability to supply customers and partners worldwide. Currently, Huawei is doing all it can to help partners fight the pandemic and ensure production as much as possible.

▶▶ 4.1 Different policies at different stages

Since January 23 when Wuhan was officially announced to be locked down, Huawei has developed and implemented different anti-pandemic policies within Huawei based on different stages of the situation, and it has set up an emergency response team for overall management.

- Stage 1: During the Spring Festival holiday, as "each place was fighting its own battle", Huawei suspended employees traveling from or to Wuhan, tracked the traveling record of each employee, and reported exceptions in a timely manner.

- Stage 2: When work resumption was postponed, Huawei employees worldwide were required to clock in/out on line every day to track their health status. Employees were permitted to work at home and collaborate through WeLink.

- Stage 3: Two major measures during the early work resumption period: 1. Find out anyone who has pandemic spreading risks through effective identification and mandatory control; 2. Block the transmission path through personal protection, indoor ventilation and sterilization, and minimum contact or communication.

- Stage 4: Things got worse quickly outside China, while people started to resume work in China. Outside China, Huawei has released the national pandemic prevention solution package and implements it by force in highly risky countries; Within China, Huawei takes appropriate risk-control measures based on the situations in different places.

▶▶ 4.2 Huawei also uses digital methods to dynamically monitor the pandemic situation and proactively prevent and control the risks.

(1) Measure 1: Ask employees to clock in and report health status through WeLink before 12:00 every day. Check employee health information and travel record and generate a list of employees requiring special attention. The health dashboard is updated in real time to better protect employees.

(2) Measure 2: Identify risky employees and limit their access permission to the campus: Specify the criteria for

identifying risky employees, develop a **list of risky employees** and a **health dashboard**, and update them every day. For in-house employees, categorize them by their risk levels and limit their access permission to the campus. For external personnel (contract workers, logistics service suppliers, and visitors, etc.), check and verify their identity and health status one by one before giving them an admission pass or certificate.

(3) Measure 3: Communicate and work with the isolated or risky personnel through WeLink. During the pandemic outbreak and spreading period, WeLink was used to support real-time communication, teleconferencing, office collaboration, and cloud-based document management for Huawei employees worldwide. So their work efficiency was not significantly affected. According to statistics, WeLink has supported more than 10,000 meetings every day since January 25, and it supported 50,000 meetings on January 31 alone. On the first day when Huawei resumed work, WeLink helped 190,000 Huawei employees host 40,000 video conferences and 10,000 cross-country conferences, supporting the normal operation of Huawei's business.
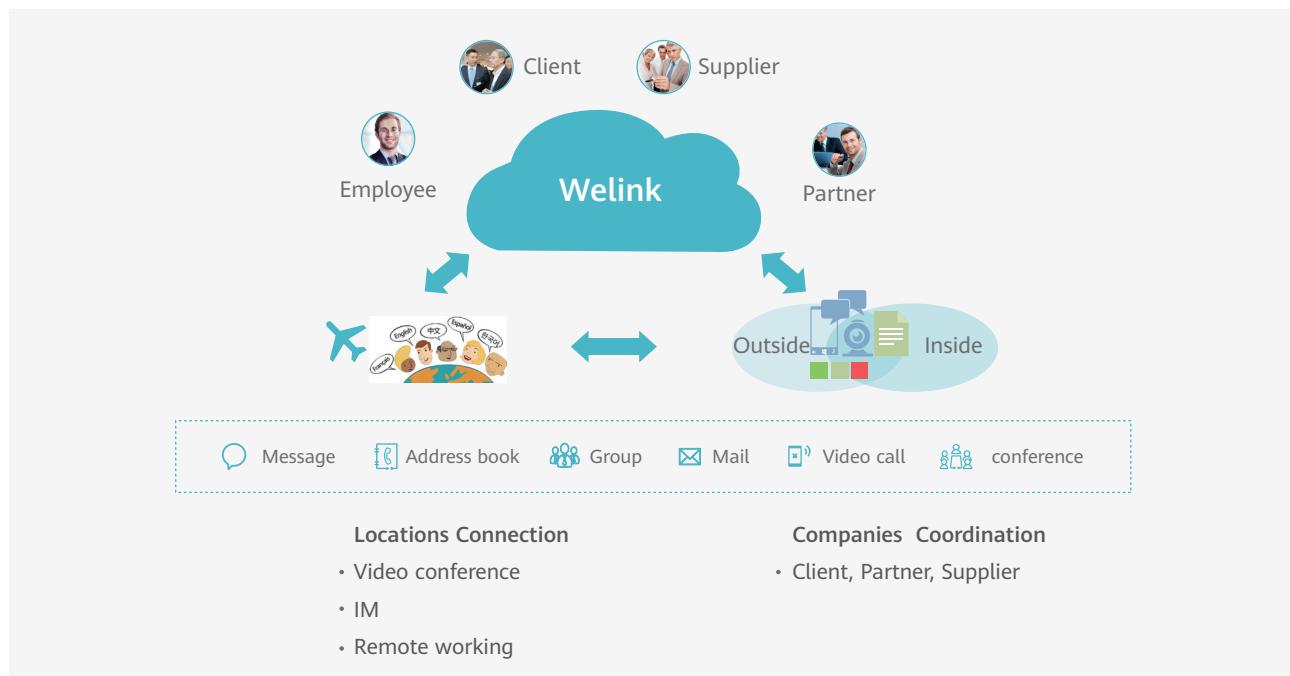
# ▶▶ 4.3 Digital campus: Campus management after resuming work

Huawei's campuses are spread across more than 170 countries and regions. To manage more than 4 million connected objects in these campuses, Huawei has connected 24 sub-systems of campuses and streamlined their data to establish a unified digital operation center worldwide. The Huawei smart campus solution lets the company build a fully connected digital campus with one set of ICT infrastructure, one digital enablement platform, and one intelligent operation center. During the COVID-19 outbreak, Huawei developed a pandemic prevention and management solution as seen in the picture below.

Huawei anti-pandemic solutions

anti-pandemic APP

Body temperature detection	Check in control	Mask detection	Gathering detection	Check out detection
Health claim	Anti-pandemic knowledge	Online test	Welink	......
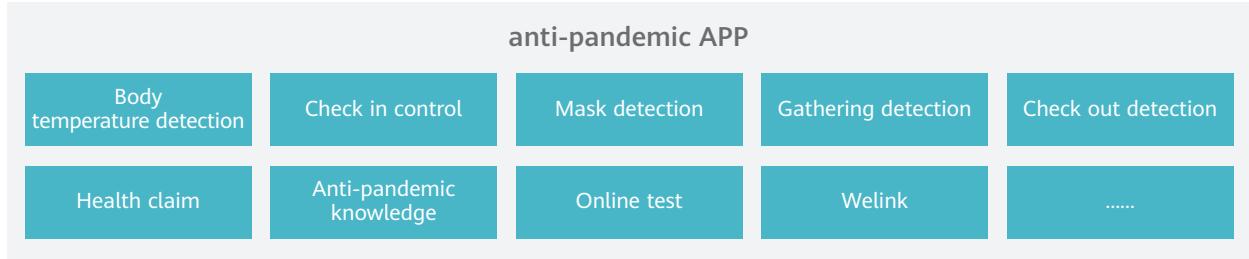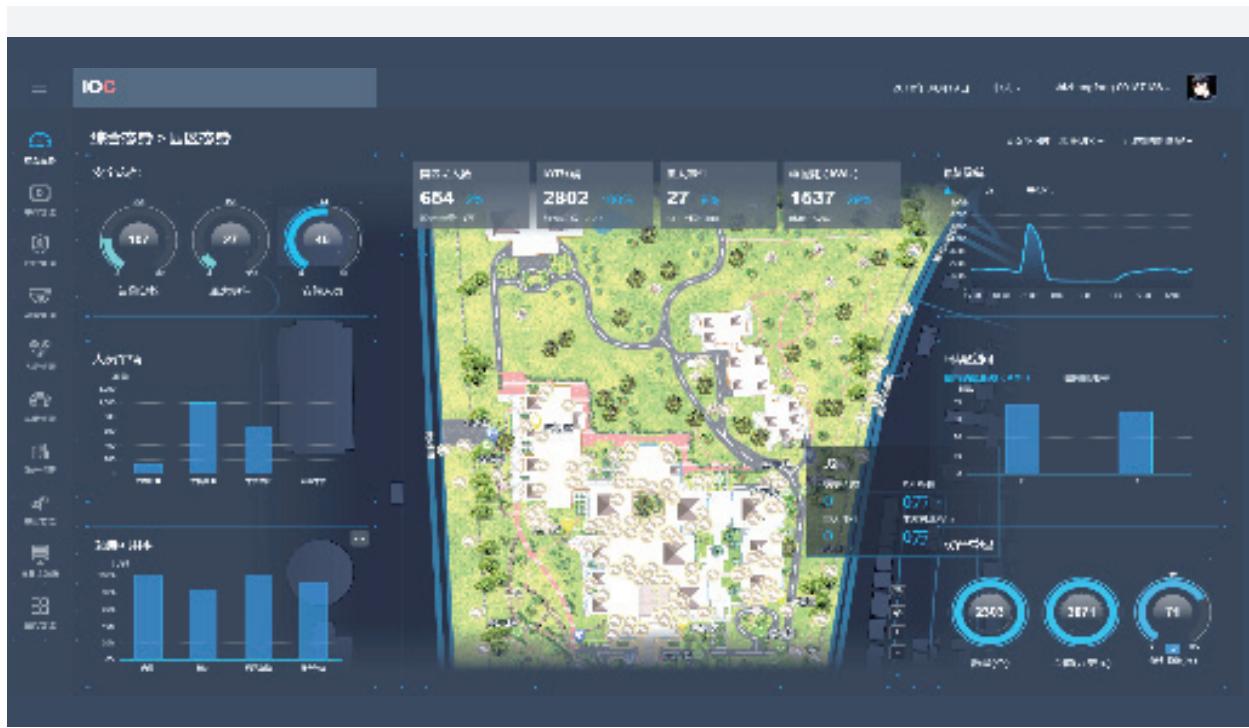
5G + AI + Cloud

The details of the solution are as follows:

- Monitor the campus comprehensively to mitigate risks. Specific measures include:

— Lining up for inspection: Stay at least **1 meter** from each other when in line. Verify permission to enter the campus (employee ID card, text message, and permit). **Generate alarms for high-risk personnel.**

— Body temperature check: Set checkpoints at the entrance and check people's temperature with a **contactless infrared thermometer**. Personnel with an abnormal temperature are not allowed to enter. Their information is to be recorded, and they will be sent home for further observation.

— Abnormality alerts: Have alarms for whenever an abnormality is detected, such as **personnel not wearing masks**, campus **gatherings**, and **off-duty** key personnel.
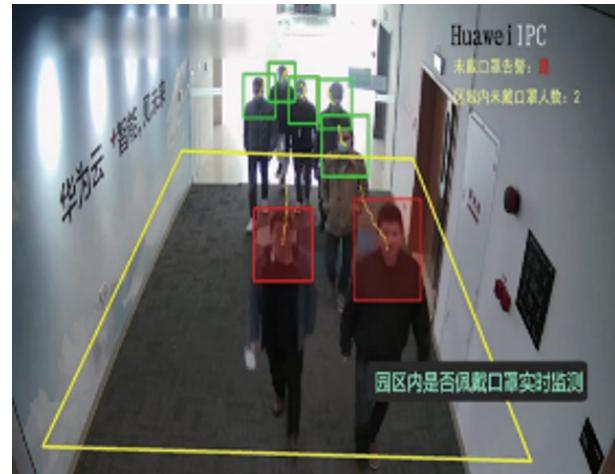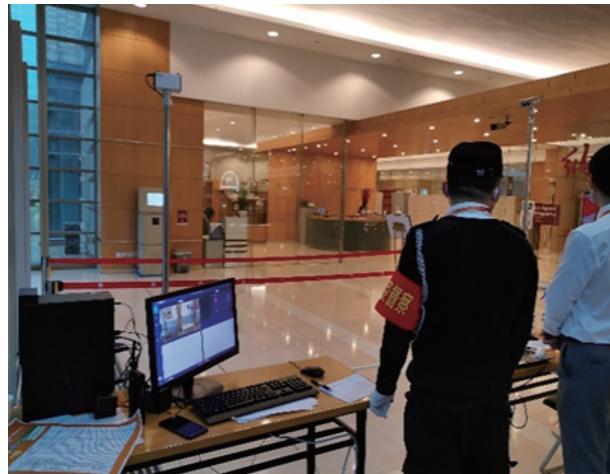
05

Implications and Outlook

Several leaders of countries and international organizations have said that the world is facing its most challenging crisis since World War II. The coronavirus pandemic will have a far greater impact than the 2008 financial crisis, and how far-reaching its impact is has yet to be determined. We can draw on the current trend of this pandemic from the perspective of ICT infrastructure and make a few implications.

1. ICT infrastructure is not only the foundation of the digital world, but when applying digital technologies, is also the cornerstone to fighting the pandemic.

First, ICT infrastructure has played an important role in the fight against the pandemic. Digital technologies such as big data, AI, and cloud computing supported by ICT networks are crucial in monitoring and analyzing the pandemic, backtracking the virus, preventing and controlling the pandemic, treating patients, and allocating resources. In addition to assisting the fight against the pandemic, these digital technologies have also been applied in other areas, such as helping businesses tackle their problems and safeguarding normal social activities.

Second, digital technologies supported by ICT infrastructure are helping social activity continue during the pandemic. One of the biggest characteristics of the pandemic is that it affects offline economic activities because of the measures such as "stay at home" and "social distancing". Massive amount of social and economic activities have gone online. Businesses closed their doors and students stayed home from school, but networks put people back to work and school, which lead to surging demand for online office and learning applications. The pandemic has suspended many offline activities, but people are living it up online. Taking China as an example, data from QuestMobile finds that daily network usage has gone from 5 billion hours to 5.76 billion hours since January 23. The number of daily active users and average daily usage have both reached record highs.
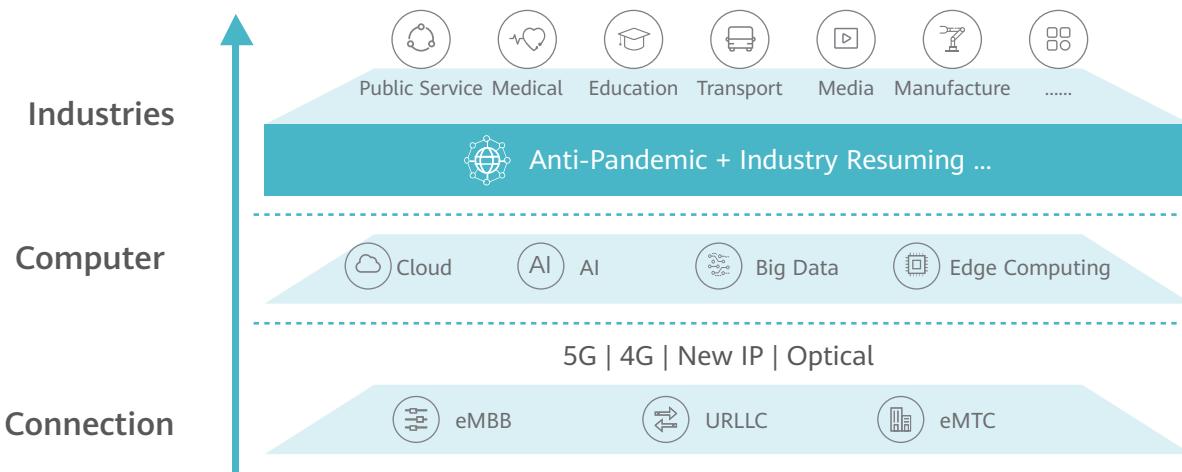
2. Moderate redundancy is the key to network resilience and flexibility. Keeping a moderate level of network redundancy is still vital for addressing the traffic surge caused by the pandemic and is necessary for normal social activity.

The ongoing pandemic has been an unprecedented shock to ICT networks worldwide, whose traffic models have undergone significant changes as a result. The changes can be summarized as resulting in traffic surges, transferring hotspots, concurrent traffic spikes, and heavier traffic periods. Though these changes impact networks worldwide will not be discussed in detail, China's networks have handled heavy traffic flow and remained stable. One reason being

that China has been accelerating 5G deployment and has built the world's fastest 4G networks with widespread coverage. Another reason is that China has seen an FTTH penetration rate of over 90%, and more than 80% of Chinese households have broadband speeds of 100 Mbit/s.

Moderately advanced and redundant ICT infrastructure has ensured the stability of China's networks during the pandemic. This serves as a reference for other countries around the world to develop their ICT infrastructure solutions to cope with the pandemic.

3. Governments and regulators could help by releasing policies and measures that facilitate rapid expansion and upgrading of ICT infrastructure. They should also implement necessary access policies, meet resource requirements, and put out incentivized measures to ensure the deployment of ICT networks.

The pandemic is like a war, time is of the essence. Governments and regulators should proactively release policies that facilitate the rapid deployment of ICT infrastructure. These policies may cover the following:

- Reserve and distribute temporary and emergent spectrums. For example, Gulf Cooperation Council (GCC) countries and the US have used temporary spectrums to meet the emergency requirements for network capacity during the pandemic.

- Reduce spectrum wholesale prices and issue more spectrums to encourage operators to quickly deploy networks with wider coverage.

- Implement policies to support site acquisition like encouraging co-constructing and sharing infrastructure, and allow operators to use more site resources.

- Temporarily lower taxes on ICT infrastructure during the pandemic.

- Positively guide the public opinion to help people build a correct understanding of emerging high-tech such as 5G and AI, and eliminate prejudices.

4. Global operators could benefit from evaluating the far-reaching impact of the pandemic and proactively plan and deploy network evolution in the future from a strategic perspective.

The pandemic is accelerating the digitization of thousands of industries. Its impact on networks also allows global operators to consider and plan future-oriented network evolution from a new perspective. We propose the following network evolution suggestions:

- **Ultra-broadband network:** Deploy 5G and gigabit optical networks for new connections and help establish the foundation for a connected, digital world. 5G and gigabit optical networks provide high-performance and widespread broadband services for individuals, families, and enterprises, and they support ubiquitous connections for everyone's work and personal lives. They also help in the digital transformation of traditional industries for a more robust digital economy.

- **Simplified network:** Simplifying network architecture, devices, and deployment can accelerate the expansion, upgrades, and deployment of networks such as 5G. We should learn from this coronavirus pandemic and improve the performance of the existing ICT infrastructure to address any possible future risks more effectively.

- **Intelligent network:** This pandemic has posed new requirements on network O&M efficiency and methods. Operators should apply new technologies such as AI in telecom networks. This can further improve the automation and intelligence of networks, bring intelligent troubleshooting and contactless O&M, and further accelerate the delivery of new services.

The warm spring is coming with longer daytime and blossomed flowers. The coronavirus pandemic is not over yet, but people have already reflected on the pandemic. Huawei has always been in pursuit of excellent technological innovations as we believe that science and technology are the ladder of human progress, the key to overcoming difficulties, as well as the foundation of technological excellence. ICT technologies play a key role in our fight against the COVID-19 outbreak. The invisible light and electricity signals flowing through the cables above and below us has established a digital channel for saving lives and maintained the basic operations of the whole society. China's ICT infrastructure has become more advanced with the application of 5G networks, large-scale data centers, and other ICT technologies. They will continue to use this advantage as much as possible to contribute to economic development.

"With a backward glance at the windswept place, I carry on, in spite of wind, rain or shine." Huawei firmly believes that with the technical strengths of ICT networks, we will beat the pandemic, embrace a better future, and finally build a fully connected, intelligent world.

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