



The Mobile Economy

China

2022



GSMA™ Intelligence

The GSMA is a global organisation unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. Our vision is to unlock the full power of connectivity so that people, industry and society thrive. Representing mobile operators and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good, Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.

We invite you to find out more at [gsma.com](https://www.gsma.com)

Follow the GSMA on Twitter: [@GSMA](https://twitter.com/GSMA)

GSMA Intelligence is the definitive source of global mobile operator data, analysis and forecasts, and publisher of authoritative industry reports and research. Our data covers every operator group, network and MVNO in every country worldwide — from Afghanistan to Zimbabwe. It is the most accurate and complete set of industry metrics available, comprising tens of millions of individual data points, updated daily.

GSMA Intelligence is relied on by leading operators, vendors, regulators, financial institutions and third-party industry players, to support strategic decision-making and long-term investment planning. The data is used as an industry reference point and is frequently cited by the media and by the industry itself.

Our team of analysts and experts produce regular thought-leading research reports across a range of industry topics.

www.gsmaintelligence.com

info@gsmaintelligence.com

Contents

Executive summary	2
1 The mobile market in numbers	10
1.1 Subscriber growth slows as market nears saturation	11
1.2 5G momentum continues to build in China	12
1.3 Smartphone adoption and data traffic continue to rise	13
1.4 Revenue growth stabilises as 5G share of capex grows	14
2 Key trends shaping the mobile industry	16
2.1 5G powers ahead	17
2.2 The metaverse: melding the digital and the physical	21
2.3 Telco of the future: 5G and the cloud to lay the groundwork for transformation	24
3 Mobile contributing to economic growth and social progress	26
3.1 Mobile's contribution to economic growth	27
3.2 Expanding the benefits of mobile internet	30
3.3 Mobile tackling social challenges	31
4 Policies to support digital advancement	36
4.1 Facilitating fast and cost-effective network rollouts	37

Executive summary



Mobile will be vital to a thriving economy post pandemic

In 2021, mobile technologies and services generated 5.6% of GDP in China, a contribution that amounted to nearly \$900 billion of economic value added.

Since the initial outbreak of Covid-19, mobile networks have been instrumental in providing the reliable connectivity needed to sustain social and economic activities. Across China, operators have harnessed their networks to support frontline healthcare efforts to curb the spread of the virus, including the use of 5G-powered remote patient diagnosis. In this sense, the pandemic has presented a testing ground for an array of 5G-enabled solutions, further demonstrating the benefits that the technology can bring to society.

Mobile also continues to make significant contributions to China's economy. In 2021, mobile technologies and services generated 5.6% of GDP in the region, a contribution that amounted to nearly \$900 billion of economic value added. The mobile ecosystem also supported approximately 6 million jobs (directly and indirectly) and made a substantial contribution to the funding of the public sector, with around \$100 billion raised through taxation.

As countries bring the pandemic under control, a top priority for governments will be to drive economic recovery, promote sustainable growth and increase resilience to future shocks. Advanced connectivity will be crucial to realising this objective, for instance by enhancing productivity and efficiency through 5G- and IoT-enabled digital transformation of industries. In mainland China, the State Council has published a blueprint for growing its digital economy, which targets digitisation of public services and governance systems, innovation in strategic technologies and self-sufficiency in areas such as semiconductors.



Smartphone adoption rising as subscriber growth wanes

By the end of 2021, over 1.2 billion people subscribed to mobile services in China, equivalent to 83% of the population. While this places China among the world's most developed mobile markets, unique subscriber growth is slowing. Nevertheless, smartphone adoption and mobile internet usage continue to grow steadily as operators focus on expanding access to digital services such as video. Increasing engagement with bandwidth-hungry applications will drive the rise in data traffic, which is set to grow by almost 3.5× by 2027.



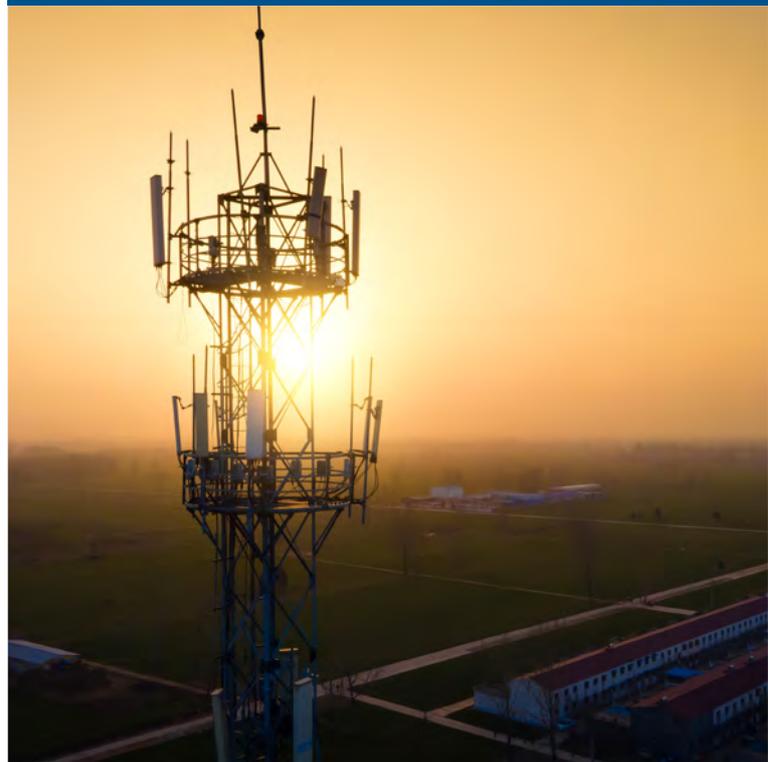
The mobile ecosystem looks to frontier technologies

The metaverse – broadly defined as myriad virtual environments blended with the real world to enable immersive user experiences – is receiving huge interest around the world. This emerging phenomenon is being explored by tech firms across China, as well as mobile operators, which could use 5G as a main pathway to engage in this space. Operators are looking to combine best-in-class telecoms networks with frontier technologies to make an impact in key sectors, including manufacturing and mining. China Mobile, China Telecom and China Unicom all unveiled new strategies in 2021, which aim to augment their computing capabilities in order to support large-scale digitisation of enterprises and the broader economy.



5G deployments and take-up increase across China

4G adoption peaked in 2020 and fell throughout 2021 as consumers increasingly switched to 5G packages. Due to the rapid take-up of 5G in China, the region is one of the global leaders in terms of 5G adoption. In 2021, China added more than 285 million 5G connections, with its share of global 5G connections equivalent to 75%. Growth in 5G adoption in the region is supported by a growing device ecosystem, an increasing number of compatible handset sales and aggressive network rollouts. Operators in mainland China have now deployed over 1.4 million 5G base stations, while network coverage in Hong Kong currently exceeds 90% of the population. As consumers signal relatively strong upgrade intentions, GSMA Intelligence expects that China will be home to 892 million 5G connections in 2025 (representing 52% adoption). Further, with 80% of smartphone users in mainland China willing to pay more for a 5G than 4G subscription, we project consistent positive core revenue growth over the coming years.



The mobile industry continues to tackle digital exclusion and social challenges

Mobile operators play a key role in efforts to achieve the UN Sustainable Development Goals (SDGs), primarily by delivering the connectivity that enables access to life-enhancing services and tools, and providing a platform for industrial transformation. As a consequence of operators' heavy network investments, more than 1.04 billion people in China now use mobile internet services. This figure is expected to increase by a further 146 million by 2025, reducing the proportion of unconnected people to 20% of the population. Meanwhile, operators are increasingly taking steps to support SDG 13: Climate Action and the global transition towards a zero-carbon economy. This includes, for example, disclosing and reducing their carbon emissions, cutting energy consumption and making investments in energy-saving solutions.



Policies look to support digital progress after Covid-19

During the Covid-19 pandemic, society has relied heavily on communications and digital technologies, which have acted as a lifeline for citizens, businesses and institutions. In a post-pandemic world, supportive investment-friendly policies will be fundamental to stimulating telecoms infrastructure build-out, which will be a central pillar of economic recovery and future crisis resilience. In mainland China, the regulator's facilitation of commercial network-sharing agreements is a case in point, as it has enabled fast base station deployments and considerable cost savings for operators. Moreover, fully realising the mobile opportunity will require forward-looking policymaking, particularly with respect to spectrum. To this end, regulators should aim to make a total of 2 GHz of mid-band spectrum available to support the growth of 5G over the 2025–2030 period.



Mobile Economy China

Unique mobile subscribers



2021-2025
CAGR: **0.6%**

2021

1.22bn

Penetration rate
(% of population)

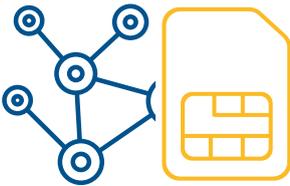
83%

2025

1.26bn

84%

SIM connections



2021-2025
CAGR: **0.7%**

2021

1.67bn

Penetration rate
(% of population)

113%

2025

1.73bn

116%

Mobile internet users



2021-2025
CAGR: **7.7%**

2021

1.04bn

Penetration rate
(% of population)

71%

2025

1.20bn

80%

Smartphone adoption

(% of total connections)

2021



77%



2025

89%

Licensed cellular IoT connections



2021

1.52bn

2025

2.30bn

4G

Connections
(excluding licensed cellular IoT)

2021

1.16bn

2025

840m

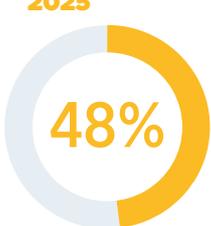


Adoption
(% of total connections)

2021



2025



5G

Connections
(excluding licensed cellular IoT)

2021

488m

2025

892m

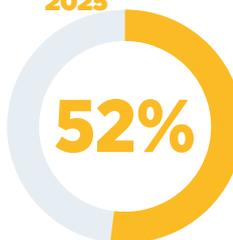


Adoption
(% of total connections)

2021



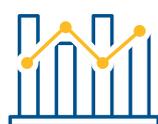
2025



Operator revenues and investment

Total revenues

2021



\$209bn

2025

\$218bn

Operator capex for 2022-2025

\$132bn

88% on 5G

Mobile industry contribution to GDP

2021



\$890bn

5.6%
of GDP

2025

\$960bn

Employment



2.6 million

jobs directly supported by
the mobile ecosystem, plus

3.5 million
supported indirectly

Public funding

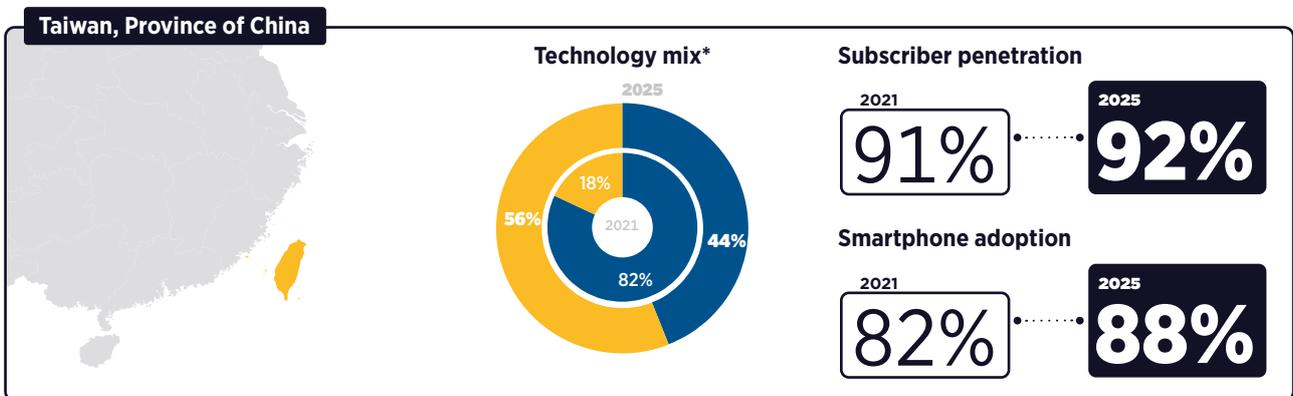
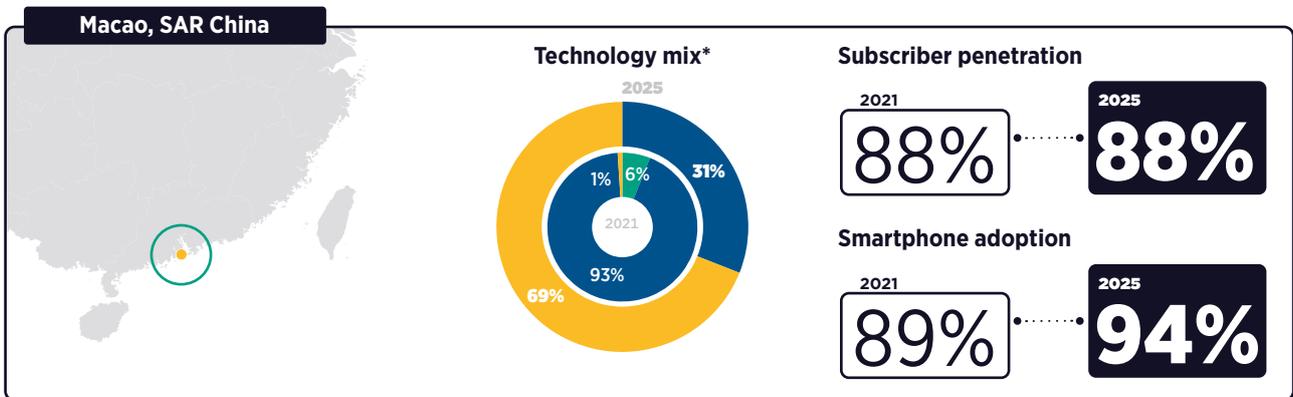
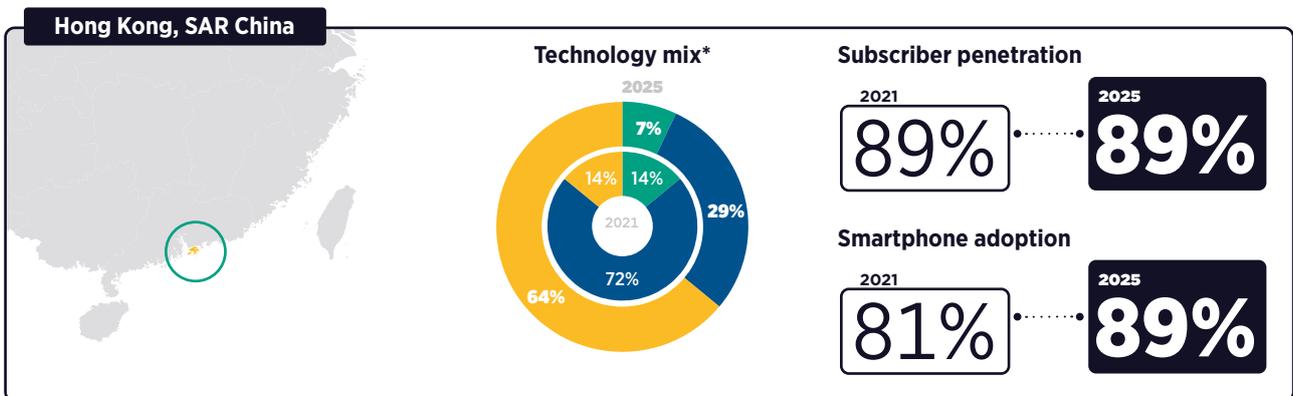
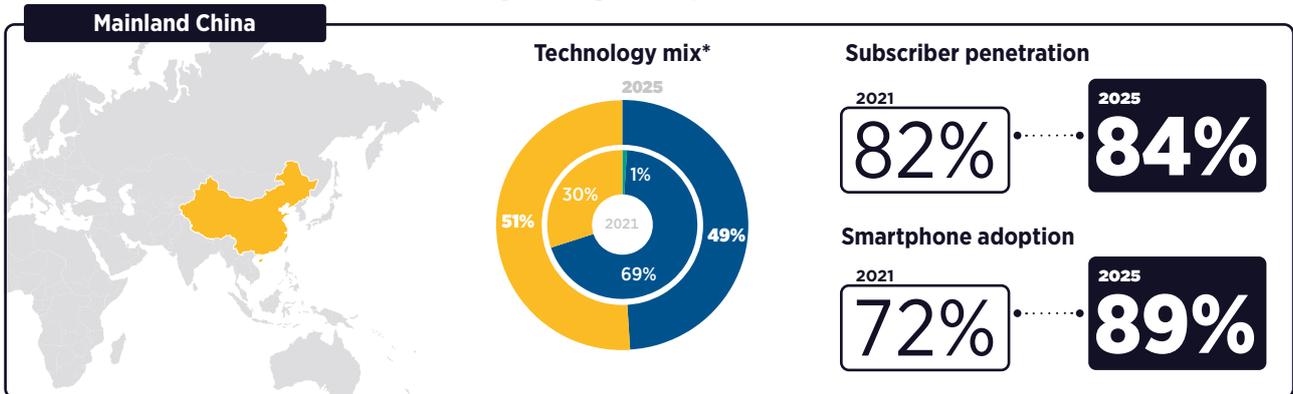


\$100bn

Mobile contribution
to public funding

(before regulatory and
spectrum fees)

● 3G ● 4G ● 5G



* Percentage of total connections



1

The mobile market in numbers



1.1 Subscriber growth slows as market nears saturation

Figure 1

Source: GSMA Intelligence

Key milestones for the mobile industry in China

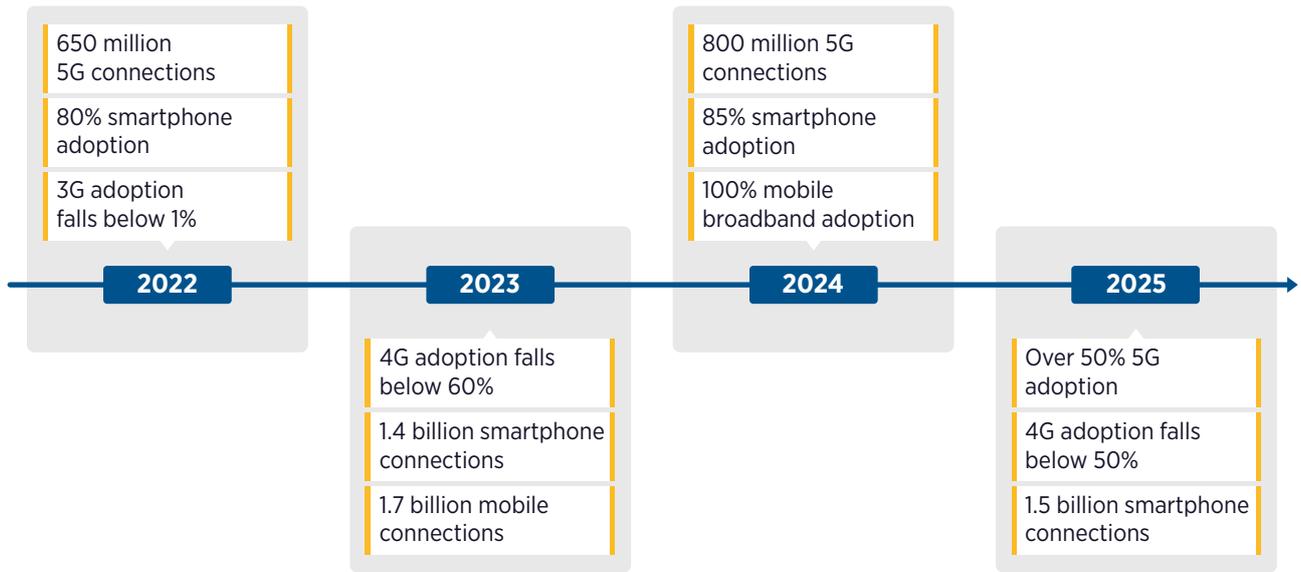
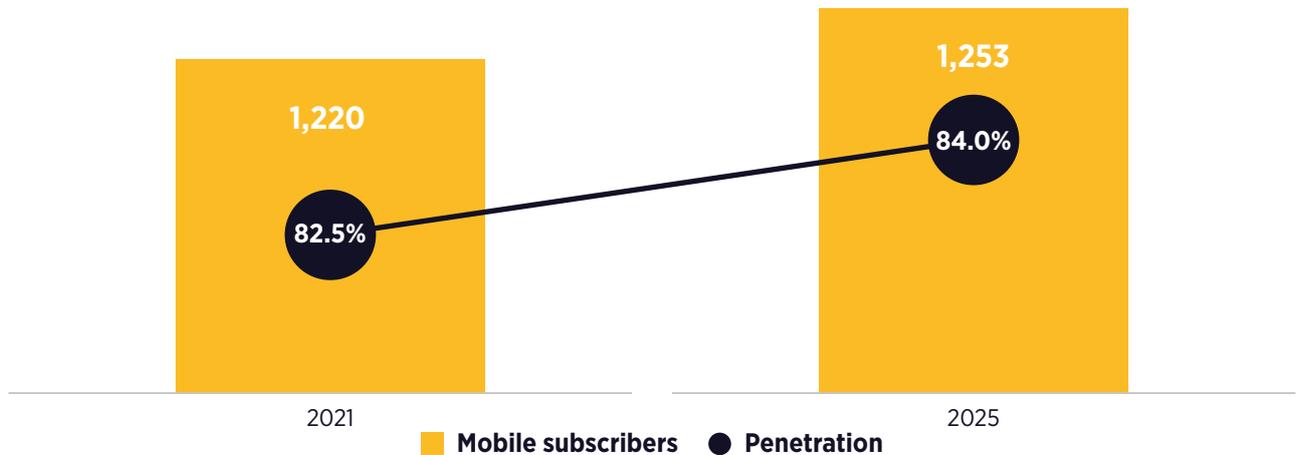


Figure 2

Source: GSMA Intelligence

There will be 33 million new mobile subscribers in China by 2025; most new subscribers will be younger people owning a phone for the first time

New mobile subscribers (million)



1.2 5G momentum continues to build in China

Figure 3

Source: GSMA Intelligence

By 2025, 5G will be the dominant mobile technology in China

Percentage of total connections (excluding licensed cellular IoT)

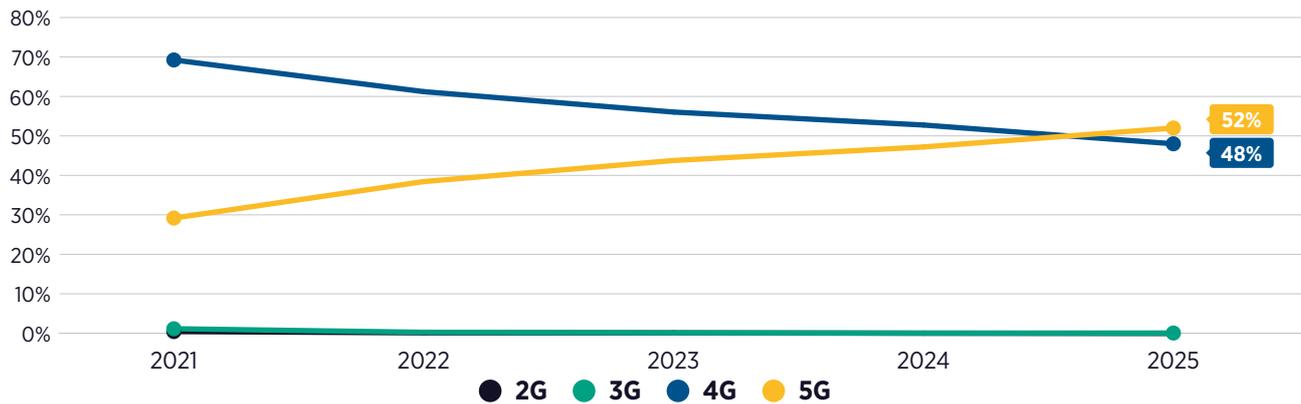
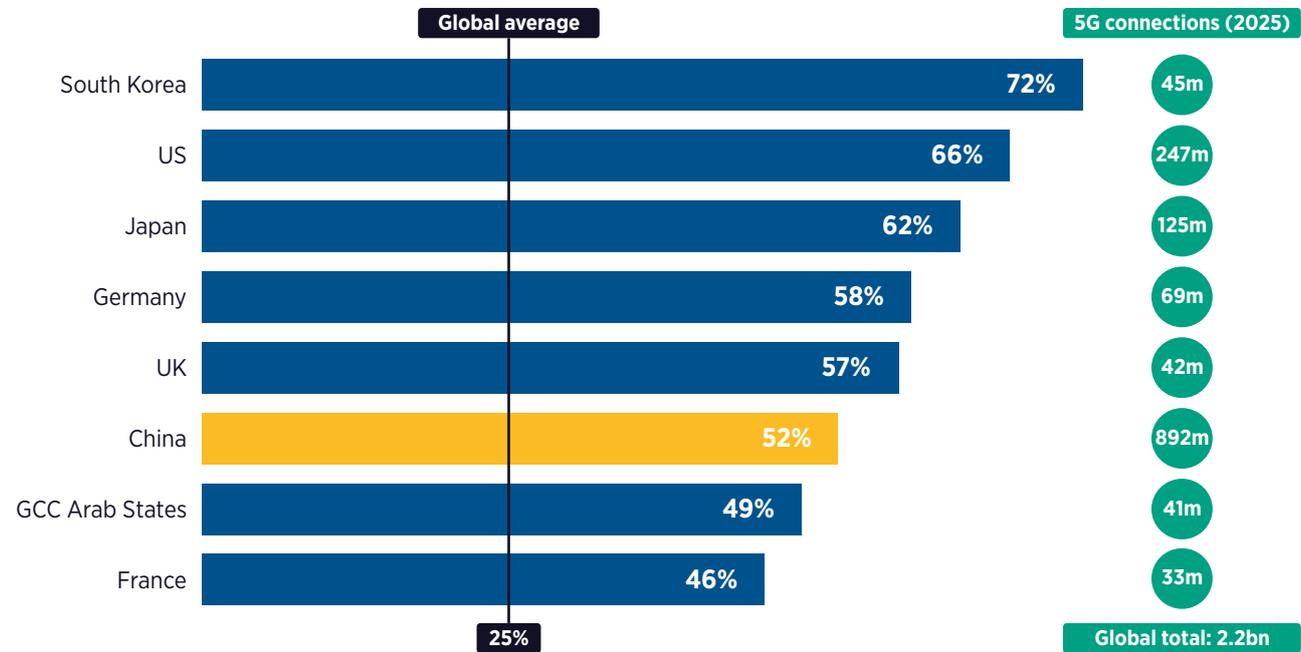


Figure 4

Source: GSMA Intelligence

China will continue to be among the leading 5G markets globally

5G adoption in 2025 (percentage of connections)



1.3 Smartphone adoption and data traffic continue to rise

Figure 5

Source: GSMA Intelligence

There will be over 1.5 billion smartphone connections in China by 2025, accounting for just under nine in 10 mobile connections

Percentage of connections in select countries (excluding licensed cellular IoT)

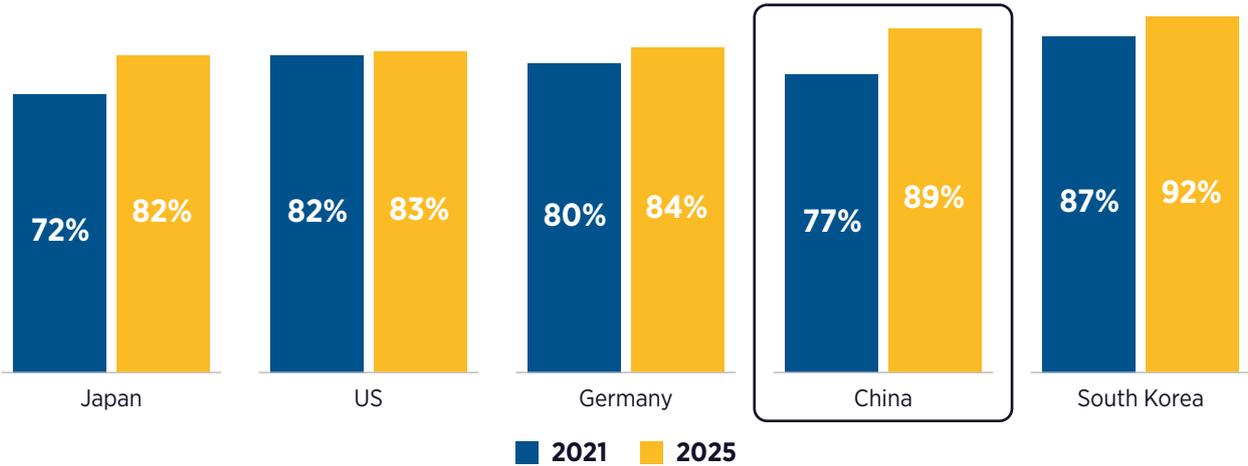


Figure 6

Source: GSMA Intelligence, based on Ericsson Mobility Report November 2021

Mobile data traffic will more than triple in most places by 2027, driven by increasing smartphone adoption and video usage

Mobile data traffic per smartphone (GB per month)



1.4 Revenue growth stabilises as 5G share of capex grows

Figure 7

Source: GSMA Intelligence

After a sharp recovery from the impacts of the pandemic in 2021, operator revenue growth in China will stabilise over the period to 2025

Mobile revenue (billion), YoY growth

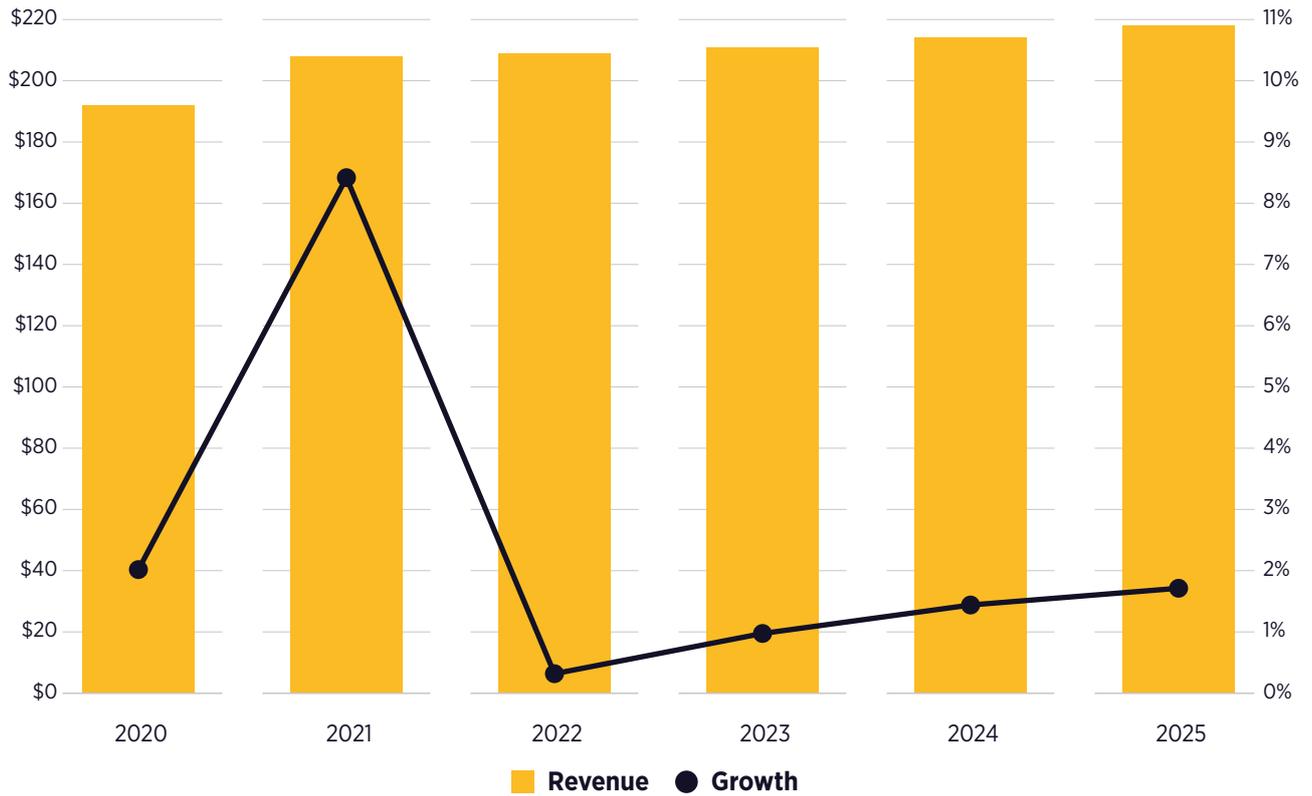
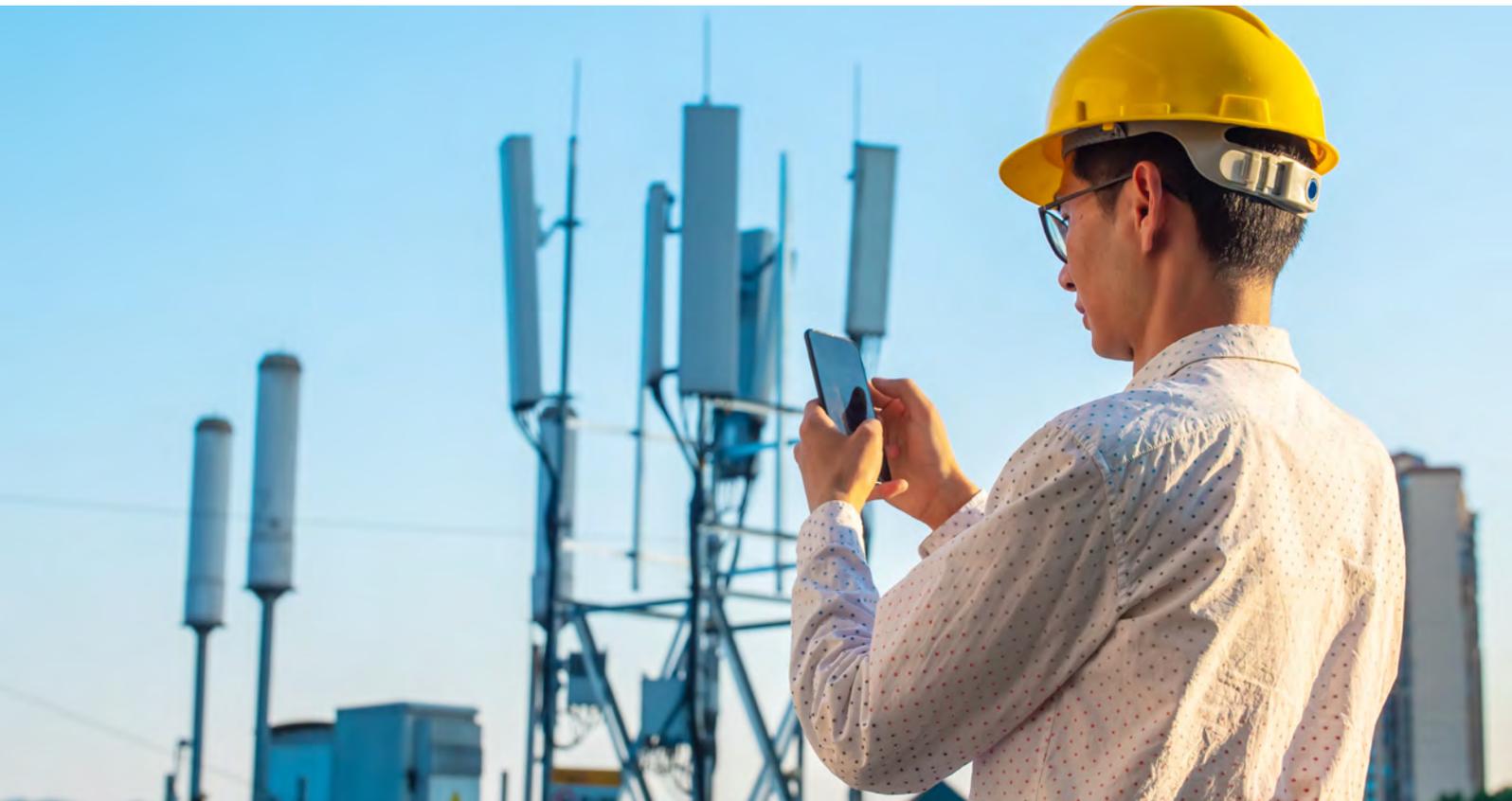
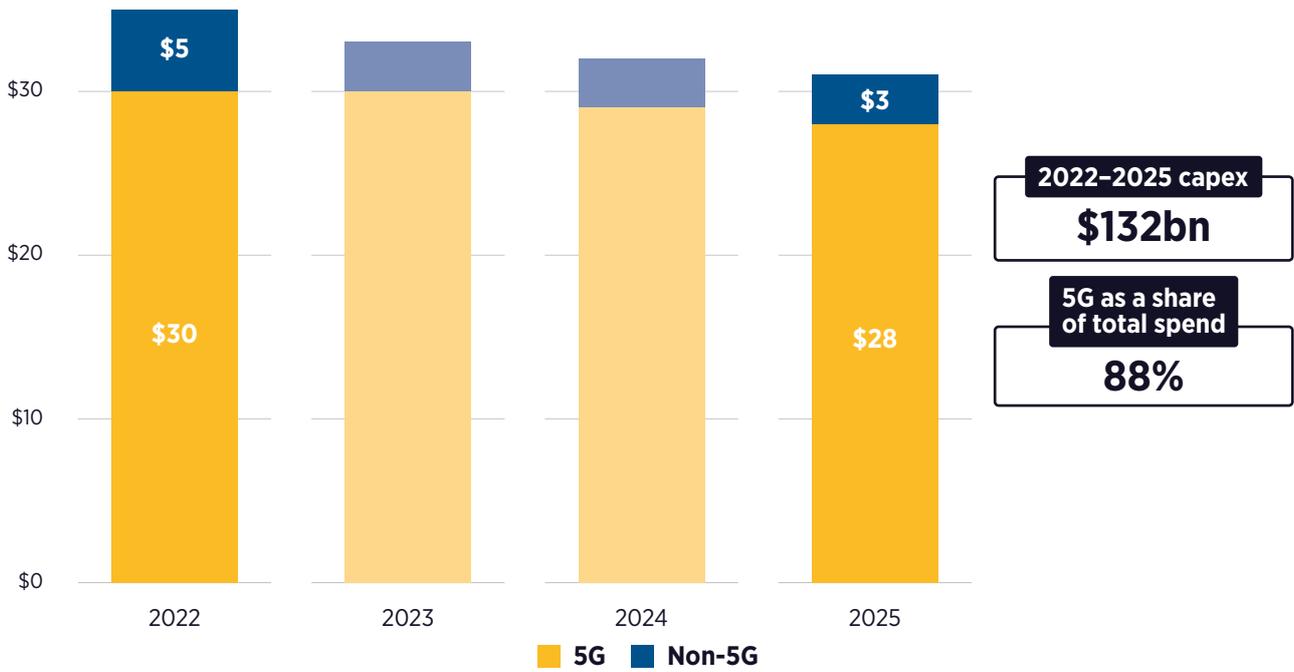


Figure 8

Source: GSMA Intelligence

Mobile operators in China will invest \$132 billion in their networks between 2022 and 2025, of which 88% will be in 5G

Capex (billion)



2

Key trends shaping the mobile industry





2.1 5G powers ahead

As 4G adoption has peaked, 5G take-up in China is gaining momentum, supporting positive top-line trends for mobile operators. Strong 5G demand in mainland China means that it represents the single largest 5G market in the world, with 5G connections (481 million) accounting for over three quarters of the global total (636 million) at the end of 2021. Further, Taiwan surpassed 5 million 5G connections by the end of 2021, equivalent to 18% adoption, and in less than 18 months since commercial networks went live. In 2025, China will continue to be among the world leaders in terms of 5G adoption, with close to 900 million 5G connections.

To make that vision a reality, operators are ramping up infrastructure deployments. In mainland China, for example, the Ministry of Industry and Information Technology (MIIT) revealed that mobile operators had deployed over 1.4 million 5G base stations by January 2022.¹ As a result, 5G coverage now extends to all prefecture-level cities, more than 98% of county-level urban areas and 80% of township-level urban areas. China Mobile plans to increase its own 5G base station count to 1 million by the end of 2022.² According to Hong Kong communications regulator OFCA, 5G coverage has exceeded 90% of the population,³ while CSL states that its network has been extended to country parks, hiking trails, cycle tracks and camping sites.

In mainland China, 5G coverage now extends to all prefecture-level cities, more than 98% of county-level urban areas and 80% of township-level urban areas.

Given the capital-intensive nature of 5G network deployment and densification (especially in high-frequency spectrum bands), Chinese operators are engaged in infrastructure-sharing arrangements, commercially negotiated to enable fast and cost-effective rollouts. In January 2021, China Mobile and China Broadcasting Network (CBN) finalised the terms of a 700 MHz network sharing and construction deal, as part of which China Mobile will provide the national broadcaster with access to its 2.6 GHz network on a paid basis until 2031. Under a supplemental agreement signed in September 2021, CBN may be able to purchase 50% of the 700 MHz equipment and assets from China Mobile based on an assessment of their market value at the time.

Under a “co-build, co-share” agreement, China Telecom and China Unicom had jointly deployed more than 400,000 5G base stations across China as of H1 2021 – a move that has helped them to save RMB80 billion (\$12.4 billion) in capex and about RMB8 billion (\$1.3 billion) in annual opex.⁴ Moreover, in Taiwan, APT and Far EasTone have deployed 5G services in the 3.5 GHz band in a multi-operator core network (MOCN) scenario.

1 “China adds 654,000 5G base stations in 2021”, Xinhua, January 2022

2 “China Mobile targets 1M 5G sites at end-2022”, Mobile World Live, February 2022

3 [5g.gov.hk/en/what-is-5g/coverage.html](https://www.5g.gov.hk/en/what-is-5g/coverage.html)

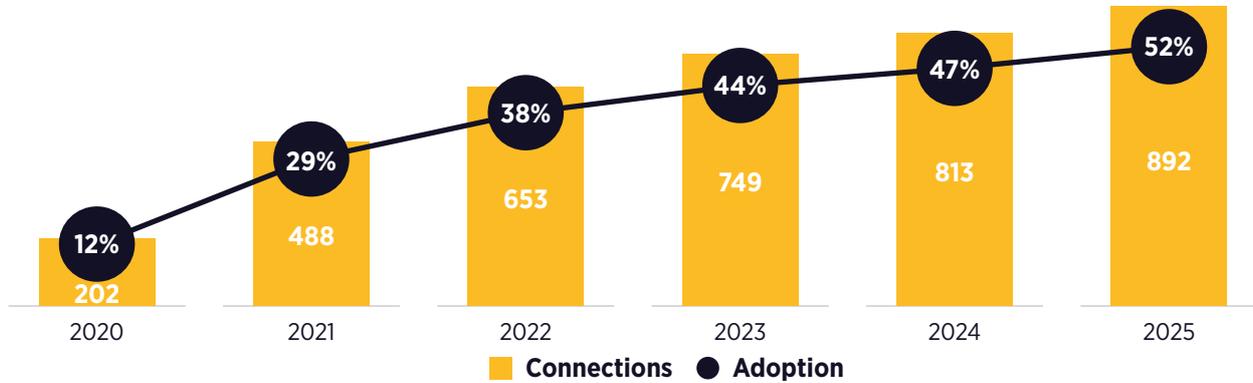
4 “China operators underline network sharing savings”, Mobile World Live, June 2021

Figure 9

Source: GSMA Intelligence

The rate of 5G connections growth will moderate over the coming years

Million, percentage of total connections



GSMA Intelligence’s latest consumer survey found that over 75% of users in China report that 5G has met or exceeded their expectations. Consumer enthusiasm for 5G, signalled by relatively strong upgrade intentions, and falling prices for compatible devices will provide further encouragement for China’s mobile industry. With 80% of smartphone users in the country willing to pay more for a 5G

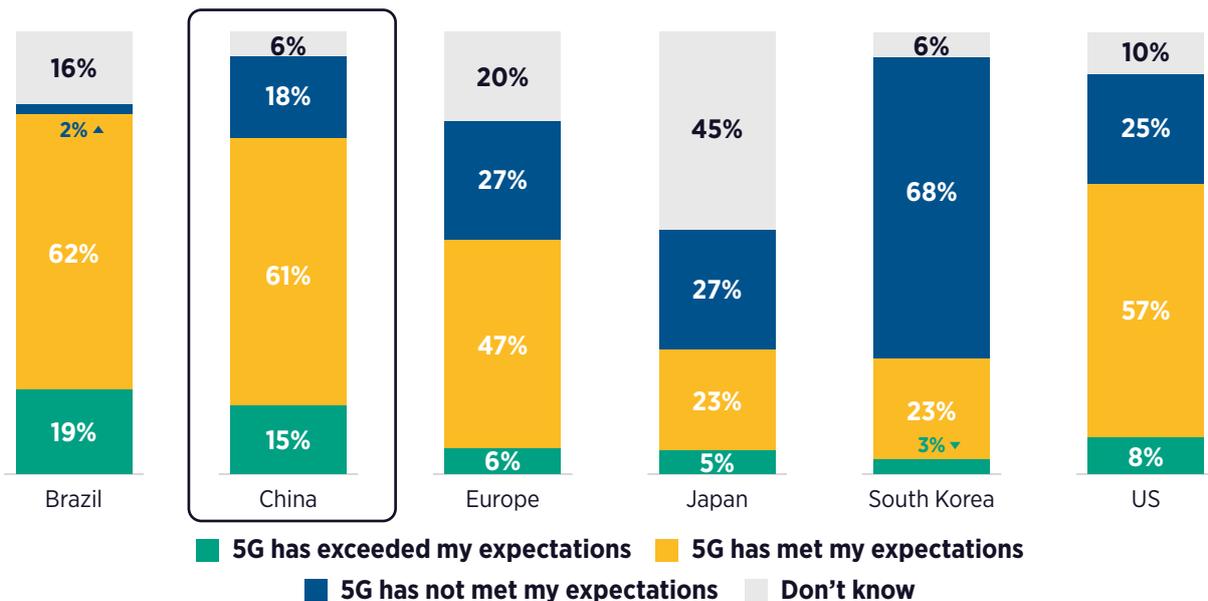
than 4G subscription,⁵ growing 5G volumes are translating into higher levels of average revenue per user (ARPU). To maximise the 5G uplift, operators will need to focus their commercial strategies on the incremental gains the technology brings and the services that benefit the most e.g. cloud gaming, e-sports and enhanced video and extended reality (XR) applications.

Figure 10

Source: GSMA Intelligence Consumers in Focus Survey 2021

Positive 5G experiences reported by Chinese consumers

Which of the following statements best describes your experience with your 5G network? (Percentage of 5G users)



⁵ How much more are consumers willing to pay for 5G?, GSMA Intelligence, 2022

5G standalone networks come to fruition

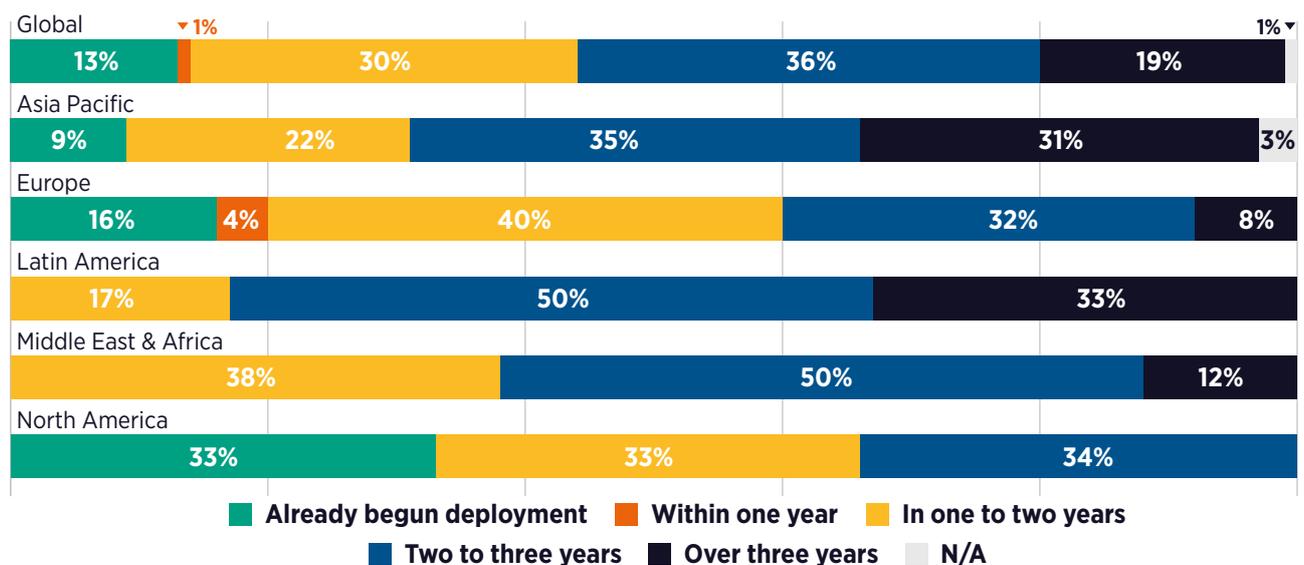
5G has driven renewed interest in the B2B (or enterprise) space, with the pandemic proving to be a further catalyst for sectoral digitisation, such as in healthcare, manufacturing and transport. China Mobile saw impressive B2B revenue growth in 2020 (24% year on year), fuelled by advancements in network, cloud and data, information & communications technology (DICT) for verticals. Since 5G is a national strategic priority, all three Chinese operators are increasingly capturing new 5G-enabled B2B opportunities, combining connectivity with artificial intelligence (AI) and cloud/edge technologies.⁶ In July 2021, the MIIT unveiled the 5G Application Set Sail Action Plan (2021–2023), which aims to advocate and encourage the use of advanced mobile connectivity in vertical industries. Devised in collaboration with nine other ministries, the plan will look to drive breakthroughs in enterprise 5G use cases while creating a new technology ecosystem.⁷

Much of the enterprise opportunity will rely on the deployment of standalone (SA) networks to benefit from 5G’s superior capabilities, such as supporting massive machine-type communications (MMTC) and ultra-reliable low-latency communications (URLLC). In mainland China, operators’ ambitious 5G rollout strategies have included commitments to SA networks, with limited trials of non-standalone (NSA). This approach has positioned Chinese operators among the frontrunners in 5G SA commercialisation, ahead of operators in many other markets. However, deployments of 5G SA will increase in other markets over the next one to two years (see Figure 11). In October 2021, Taiwan Mobile received a 5G SA system certification from the National Communications Commission, allowing it to provide advanced mobile broadband services for enterprises to embrace Industry 4.0.

Figure 11 Source: GSMA Intelligence Operators in Focus: Network Transformation Survey 2021

The enterprise opportunity has increased focus on the deployment of 5G standalone networks in leading markets

Considering your 5G network assets and strategy, when do you plan to deploy standalone 5G?
(Percentage of operators)



⁶ Operators in the enterprise market: assessing progress on B2B revenues and the impact of Covid-19, GSMA Intelligence, 2021

⁷ For more information, see: Region in Focus: China, Q3 2021, GSMA Intelligence, 2021



5G underpins smart city innovations

As the key technology for next-generation digital infrastructure, 5G is central to delivering innovative use cases for individuals, empowering vertical transformation and driving socioeconomic development. The pandemic is reshaping cities and driving interest in new technologies, including video surveillance systems, remote asset monitoring and touchless delivery. 5G can underpin these applications and others to improve city governance across public transport, logistics, emergency services, environmental protection and e-government services for citizens. By 2030, GSMA Intelligence forecasts over 550 million smart city IoT connections in Asia Pacific, a large proportion of which will be in China.

To address smart city opportunities, operators are building partnerships and ecosystems and bringing new channels to market. For instance, China Unicom has collaborated with Datang Mobile and Xiamen Public Transport to launch the Xiamen 5G BRT Connected Vehicle-Infrastructure Cooperative

System project, China's first city-level 5G intelligent connected application. Leveraging 5G networks and C-V2X technology, the project implements four main commercial applications: real-time vehicle-infrastructure collaboration; intelligent speed strategy; safe and precise parking; and non-line-of-sight anti-collision mechanisms.⁸

In April 2021, China Mobile held the inaugural meeting of its 5G Smart City Alliance with core partners, including Gosuncn, Huawei and Inspur. The association aims to promote cooperation, build an open technology platform and jointly develop new products, services and technologies in the field of smart cities. Further, between December 2021 and January 2022, the three Chinese operators all released "5G City" white papers, outlining their approaches to using 5G connectivity and emerging technologies to support smart city and sustainable urban development initiatives, in line with the country's 14th Five-Year Plan (2021-2025).

8 5G Use Cases for Vertical China 2021, GSMA/CAICT, 2021



2.2 The metaverse: melding the digital and the physical

The metaverse can trace its roots back to the 1992 sci-fi novel, *Snow Crash*. Since then, the term has been used loosely to describe the integration between digital and physical spaces, building on the advancing capabilities of augmented reality (AR) and virtual reality (VR) technology. Today, the metaverse – the kind that many tech firms are racing to build – refers to a scaled, virtual fusion of video games, social networking and entertainment that creates new immersive experiences for users. Though still largely embryonic, the metaverse and its development will likely be based on three foundational pillars for it to function effectively and be accessible for everyone: decentralised; interconnected and interoperable; and safe and trustworthy.

A degree of scepticism surrounds the metaverse and its potential to reach mainstream adoption, particularly considering the likely connectivity and device requirements. However, momentum behind applications that incorporate AR/VR with social media and the cloud is evident across markets such as gaming and business communications. Across China, several tech companies have outlined long-term visions and strategies for the metaverse, in addition to raising significant funding commitments (see Figure 12). This highlights the power of the metaverse to attract large-scale investments that will drive innovative use cases towards the mass market.

Figure 12

Source: GSMA Intelligence

Examples of ecosystem activities around the metaverse

Alibaba	Though its strategy remains unclear, Alibaba has invested in AR/VR startups and applied for multiple metaverse-related trademarks. In April 2021, the e-commerce giant unveiled its first digitally generated, AI-powered celebrity idol, Ayayi, subsequently establishing an XR lab in December of that year.
Baidu	In November 2021, Baidu's Xirang (Land of Hope) metaverse app went live, offering a virtual exhibition environment and workplace for users, which is accessible via smartphones, PCs or VR goggles. Baidu has also made hardware investments through subsidiaries such as iQIYI.
ByteDance	ByteDance is beta testing a metaverse social media app after investing in multiple companies that operate in this space, including VR headset maker Pico and chip designers Stream Computing. The app, called Party Island, allows invited users to create avatars, join virtual events (e.g. concerts) and message other participants.
NetEase	Chinese video gaming company NetEase has voiced its commitment to the metaverse, stating that the firm would lead the country into the future digital reality and that it is already preparing the requisite strategies and technologies for the metaverse's development. In August 2021, NetEase's AI arm released an immersive virtual meeting system called Yaotai.
Nreal	In September 2021, Beijing-based AR technology company Nreal completed a Series C funding round led by NIO Capital, Yunfeng Fund and Hongtai Fund, raising over \$100 million.
Tencent	Tencent has yet to fully outline its ambitions, but it has identified three main pathways to the metaverse: gaming, social networking and AR/VR-based experiences. In January 2022, it was reported that Tencent had opened talks to acquire Black Shark, a gaming devices and accessories manufacturer. ⁹
The Sandbox	In November 2021, Hong Kong-based gaming platform The Sandbox raised \$93 million from investors led by SoftBank's Vision Fund 2.
Zhongqingbao	Zhongqingbao, a games studio listed on the Shenzhen Stock Exchange, is developing a metaverse concept game called Brew Master, which will allow players to create their own wine-making business in a simulated environment but experience the produce in real life.

9 "Tencent Nears Deal for Smartphone Maker in Major Metaverse Push", Bloomberg, January 2022

By leveraging the capabilities of 5G, AI, AR and VR, the disruptions and applications that may emerge in the development of the metaverse have the potential to be wide-ranging, from interactive entertainment to industries such as retail, banking, construction and manufacturing. As indicated by the actions of Lilith Games, Tencent, Zhongqingbao and others, gaming could be a foundational use case within immersive metaverse environments. According to PWC, China's metaverse market is set to grow 13% each year to be worth \$1.5 trillion by 2030.¹⁰

The metaverse may also have the potential to have positive socioeconomic impacts, for example by enabling digital education and improving public services delivery. To that end, several Chinese cities are incorporating the concept into their official economic plans. In December 2021, the Shanghai Municipal Commission of Economy and Information Technology released its five-year development plan, which calls for the promotion of the metaverse's use in public services, business offices, social leisure, industrial manufacturing, production safety and electronic games.

At the national level, Chinese government entities – such as the MIIT – are actively steering the development of metaverse-adjacent technological capabilities, such as AI, in domestic startups. Moreover, in January 2022, China's Blockchain Services Network (BSN), a state-backed blockchain company, announced plans to launch infrastructure to enable the trading of non-fungible tokens (NFTs). NFTs, which are non-interchangeable assets that represent ownership of a unique digital item, could be a key metaverse enabler, allowing virtual assets to be moved freely between platforms controlled by different companies. BSN's Distributed Digital Certificate will use modified blockchains and could represent an important step in creating a Chinese NFT industry that is not linked to decentralised cryptocurrencies.

At the national level, Chinese government entities – such as the MIIT – are actively steering the development of metaverse-adjacent technological capabilities, such as AI, in domestic startups.

Though opportunities abound, there are barriers to developing a metaverse that works for everyone. These include interoperability, accessibility (i.e. not exacerbating the digital divide) and user awareness and adoption. A pressing issue is the challenge to ensure trust and safety across virtual environments, particularly for younger users, with concerns around cybersecurity, data privacy, false information and wellbeing all expected to intensify in the metaverse.

Accordingly, Chinese regulatory bodies are keeping a close eye on developments in this space – with the National Intellectual Property Administration even rejecting various metaverse-related trademark applications that contain the phrase 'yuan yuzhou' (which translates to 'metaverse' in Mandarin). In October 2021, the China Institutes of Contemporary International Relations (CICIR), a think tank affiliated with the Ministry of State Security, published a research note on metaverse and national security. The CICIR argues that metaverse environments could pose political and social problems and urged tighter regulation and guidance from the government, particularly in areas such as anti-money laundering and intellectual property rights.¹¹

¹⁰ "The top 10 metaverse companies in China", SupChina, February 2022

¹¹ "Chinese state-owned think tank flags national security risks of metaverse, citing potential political and social problems", South China Morning Post, November 2021



Metaverse opportunities for mobile operators in China

The successful running of sophisticated digital worlds and XR will require similarly advanced – and consistent – mobile broadband services. The rollout of high-quality, reliable 5G networks (and future generations) is therefore a main way for operators to carve out a position in the metaverse ecosystem. Further, network innovations, such as edge computing and slicing, could enable operators to capture new value from metaverse growth areas, while digital identity solutions present opportunities for operators to support interoperability between virtual worlds.

Like AT&T, KDDI, SKT, Verizon and more, Chinese operators are already exploring the metaverse opportunity:

- China Mobile released an immersive digital twin app ahead of the Beijing 2022 Winter Olympics that centres on skier Eileen Gu. In addition, its subsidiary Migu is targeting the metaverse for future development as it steps up efforts to integrate 5G, AR, VR and other cutting-edge digital technologies. At China Mobile's 2021 Global Partner Conference, Migu released its roadmap for the metaverse, which will focus on four pillars, reflecting the four letters of the company's name: mixed reality; immerse social connection; gamified interaction engine; and ubiquitous computing.
- China Telecom has entrusted its cloud gaming and entertainment subsidiary Digital Culture (formerly Besttone) to develop an integrated metaverse platform and cloud to serve all types of virtual worlds, which will leverage the operator's own computing and product content capabilities. The metaverse platform will develop in two parts. First, a series of large and small virtual worlds based on the real world will be gradually combined. In the second stage, after several years of development, a "super virtual world" will form.¹²

¹² "China telecom operators join the metaverse race", LightReading, November 2021

2.3 Telco of the future: 5G and the cloud to lay the groundwork for transformation

With the commercialisation of 5G and introduction of mobile network innovations such as open RAN, edge networking and network automation, operators' decisions on network transformation strategies are more important than ever. Such decision-making is crucial to the operators, their network infrastructure suppliers and the customers who will rely on the networks of tomorrow.

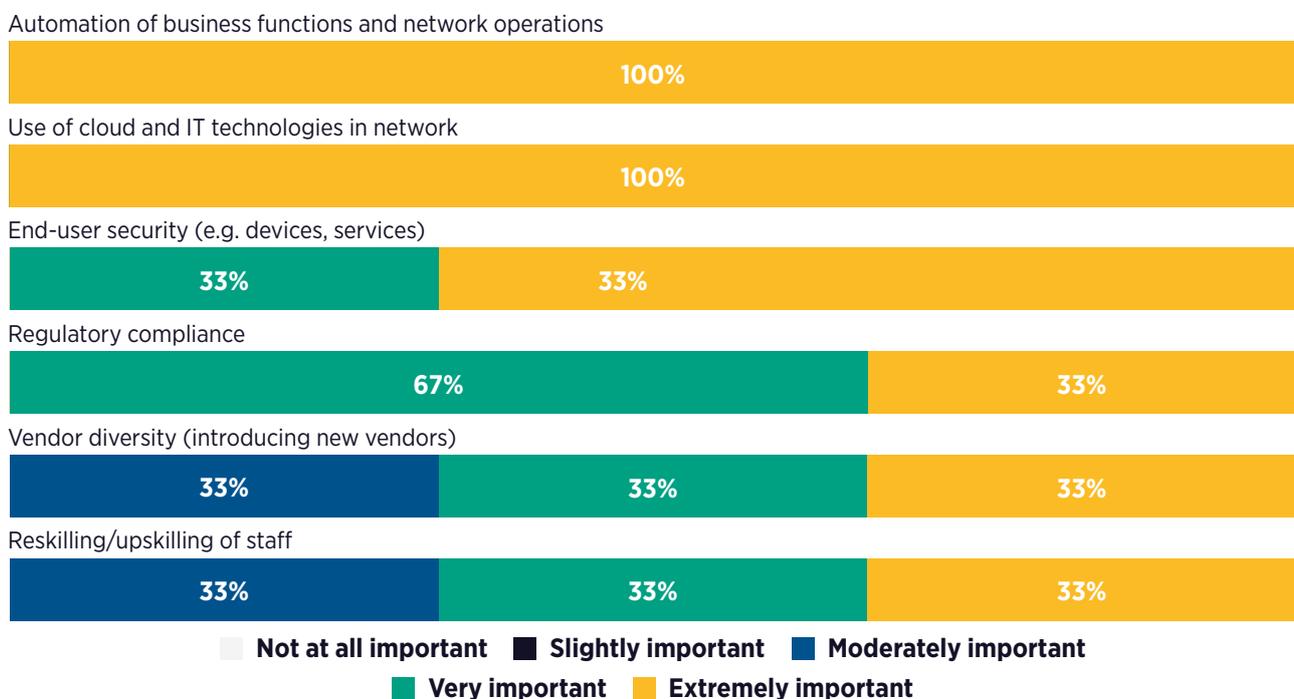
In mainland China, revenue generation and customer experience are driving operators' network transformation strategies. This aligns with the strategies of operators in other regions, signalling that operators globally are optimistic about

options for driving profitability rather than cost cutting. However, network transformation priorities for operators in mainland China display some clear differences compared to the global picture: according to GSMA Intelligence's latest survey, operators in mainland China consider automation and the use of cloud and information technologies to be primary focus areas, while other telcos are targeting security and sustainability.¹³ Moreover, the country is relatively circumspect about open RAN, which is reflected by the lack of commercial deployments and concerns around administration, integration and reliability.

Figure 13 Source: GSMA Intelligence Operators in Focus: Network Transformation Survey 2021

Top network transformation priorities for operators in mainland China

How important are the following priorities as a part of your network transformation strategy? (Percentage of operators in mainland China)



¹³ Network Transformation 2021, GSMA Intelligence, 2021



Since the outbreak of Covid-19, China's telecoms networks have been instrumental in sustaining many social and business activities, remaining resilient despite surges in data traffic and changes to consumption patterns. However, leading operators are now looking beyond connectivity and to how they can apply a combination of high-performance telecoms services and cloud technologies. While the cloud is not considered to hold much promise for opex savings within network operations, operators consider it key to digitising industries and the wider economy.

China Unicom's new Chairman, Liu Liehong, announced the company's "big computing" strategy as it seeks to be a first-mover in the group of operators and other telecoms sector players promoting the digitisation, networking and intelligence of thousands of industries. China Unicom's strategy is based on a "one body, two wings" approach, which is based on two main undertakings:

- The integrated development of information technology (IT) and communications technology (CT) based on CT, supported by data centre build-out and the upgrade of computing resources.
- The integration of IT and data technology (DT) to provide a one-stop service, leveraging six core capabilities: cloud, big data, IoT, AI, blockchain and security.

At the 2021 Tianyi Intelligent Ecological Expo, China Telecom Chairman Ke Ruiwen shared the operator's thinking and practice on cloud-network integration and the development of the digital economy. China Telecom sees high-speed, ubiquitous network connectivity as the foundation and the deployment of cloud technology as the core. The subsequent integration of the two provides for the central feature of "intelligent and comprehensive digital information infrastructure", which is also secure, controllable and energy efficient.

In Ke Ruiwen's view, 5G is the best place for cloud-network integration and that China Telecom's pioneering of a "Three Clouds" 5G network architecture enables it to offer differentiated, customised 5G services to meet the demands of customers (including individuals, families, industries, urban and rural areas, and society) on a large scale.

China Mobile's 2021 Global Partners Conference called for industrial partners to work together to pursue opportunities in developing the digital economy and creating a future with an intelligent computing force. Chairman Yang Jie stated that the operator would support China's ambitions to be a digital power and smart society and to be home to world-class information services and sci-tech innovation enterprises, by focusing on "digital-intelligent transformation and high-quality development". At the event, China Mobile expressed its willingness to collaborate with firms from across the ecosystem to build a new type of information service system based on "connectivity + computing power + capability". It also released its Computing Force Network White Paper, developed with partners such as Shanghai Pudong Development Bank and Mango Super Media.

While operators do not expect the cloud to deliver significant opex savings within network operations, they consider it key to digitising industries and the wider economy.

3

Mobile contributing to economic growth and social progress



3.1 Mobile’s contribution to economic growth

In 2021, mobile technologies and services generated 5.6% of China’s GDP, a contribution that amounted to almost \$900 billion of economic value added. The mobile ecosystem also supported more than 6 million jobs (directly and indirectly) and made a substantial contribution to the funding of the public sector, with around \$100 billion raised through taxes on the sector.

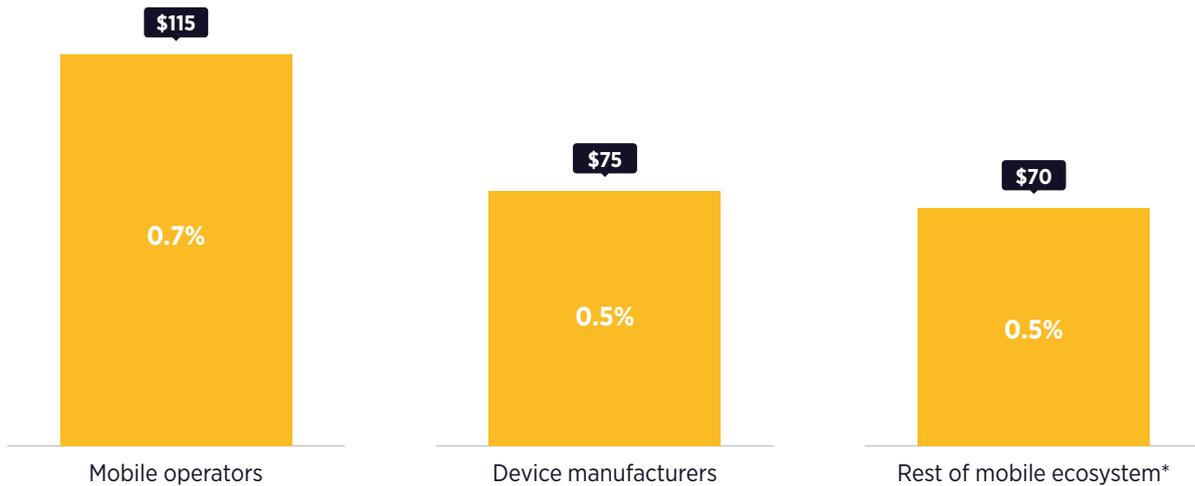
By 2025, mobile’s contribution will grow by around \$66 billion (surpassing \$960 billion) as China increasingly benefits from the expansion of the mobile ecosystem industry.

Figure 14

Source: GSMA Intelligence

The Chinese mobile ecosystem directly generated more than \$260 billion of economic value in 2021, with mobile operators and device manufacturers accounting for the vast majority

Billion, percentage of GDP



*Rest of mobile ecosystem category includes infrastructure providers, distributors and retailers, and content, apps and service providers.

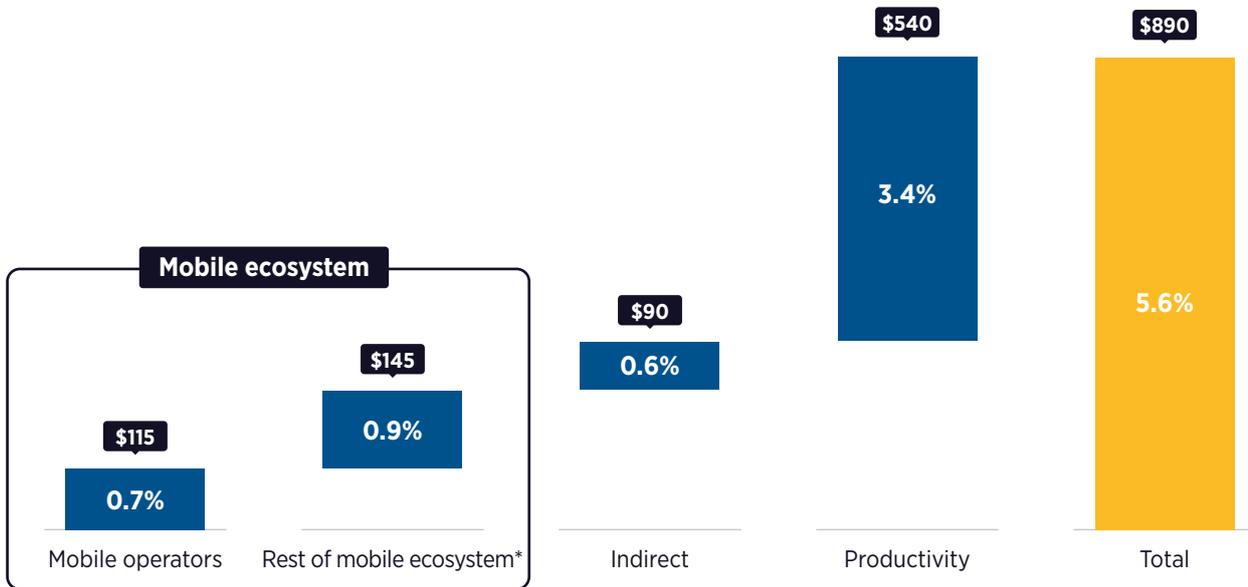
Note: Totals may not add up due to rounding

Figure 15

Source: GSMA Intelligence

Additional indirect and productivity benefits bring the total contribution of the mobile industry to Chinese economy to almost \$900 billion

Billion, percentage of GDP



*Rest of mobile ecosystem category includes infrastructure providers, device manufacturers, distributors, and content, apps and service providers.

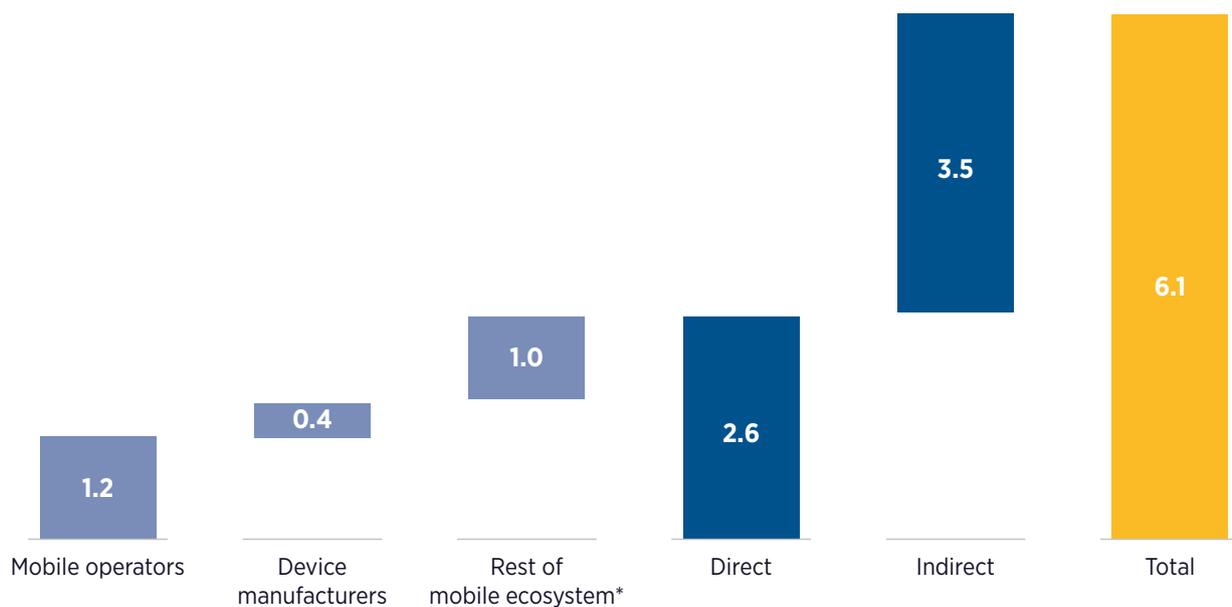
Note: Totals may not add up due to rounding

Figure 16

Source: GSMA Intelligence

The Chinese mobile ecosystem directly employs around 2.6 million people, plus another 3.5 million indirectly through adjacent industries

Jobs (million)



*Rest of mobile ecosystem category includes infrastructure providers, distributors and retailers, and content, apps and service providers.

Figure 17

Source: GSMA Intelligence

In 2021, the mobile ecosystem contributed around \$100 billion to the funding of the public sector through consumer and operator taxes

Billion

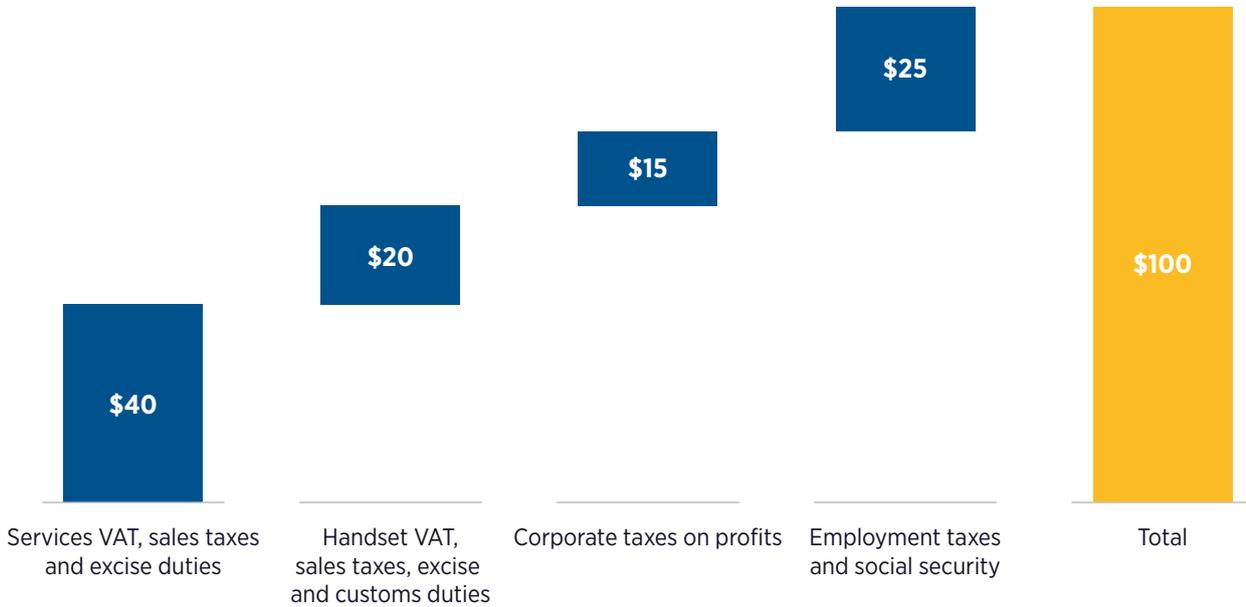
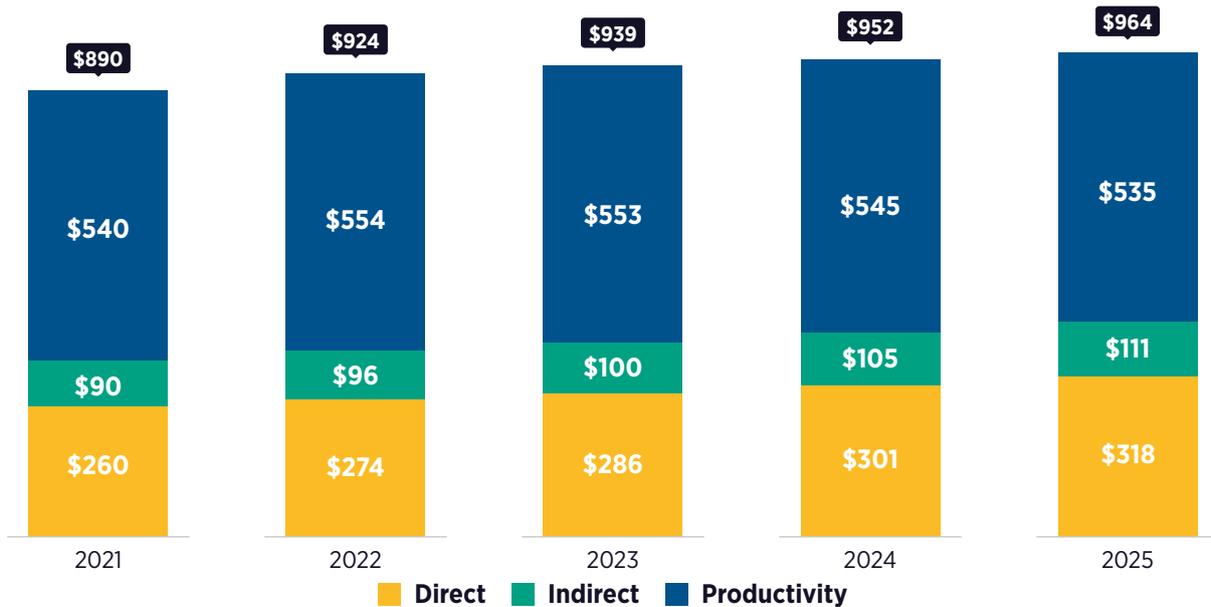


Figure 18

Source: GSMA Intelligence

Driven mostly by continued expansion of the mobile ecosystem, the Chinese economic contribution of mobile will increase by over \$65 billion by 2025

Billion



Note: Totals may not add up due to rounding

3.2 Expanding the benefits of mobile internet

Mobile internet access continues to grow in China. Over the past decade, operators have invested significantly in the rollout, upgrade and maintenance of mobile networks to increase digital inclusion and reduce the 'coverage gap' i.e. those with no access to mobile broadband services (3G and above).

Since 2010, the number of people subscribing to mobile internet across the region has grown substantially, having surpassed the 1 billion mark (over 70% of the population) by the end of 2021. However, this leaves a large section of the population – more than 420 million people – covered but unconnected.

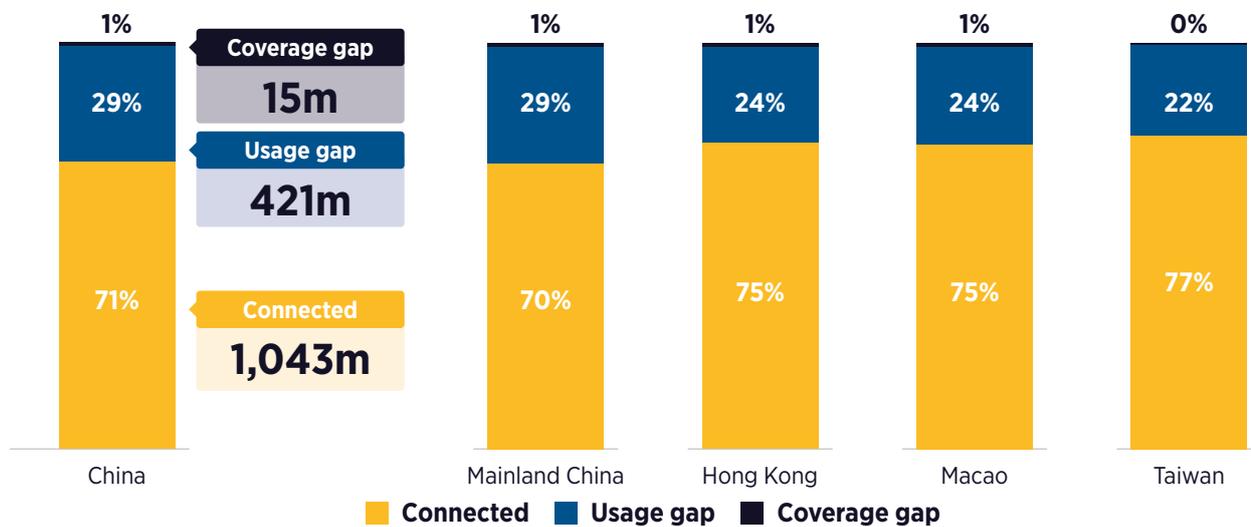
This is the 'usage gap', which represents those who live within the footprint of a mobile broadband network but are not using mobile internet services.

As the key barriers to mobile internet adoption are overcome – namely infrastructure, affordability and consumer readiness – the usage gap will continue to close. By 2025, almost 150 million people across China will start using mobile internet for the first time, reducing the proportion of those unconnected to just over 20% of the population.

Figure 19 Source: GSMA Intelligence

Mobile internet penetration has more than trebled since 2010, although non-users still account for almost three in every 10 people

Percentage of population



Note: Totals may not add up due to rounding

According to the GSMA's Mobile Connectivity Index (MCI), mainland China is considered a 'Leader', having progressed from being a 'Transitioner' market in 2014.¹⁴ It joins Hong Kong in this foremost category. The country's digital development has

been driven by various factors, principally operator investments in network performance, reductions in mobile tariffs and device costs, improvements in online security, and greater smartphone ownership and social media penetration.

¹⁴ mobileconnectivityindex.com

3.3 Mobile tackling social challenges

As the first sector to have committed fully to the UN Sustainable Development Goals (SDGs), the mobile industry continues to have substantial positive effects on lives and livelihoods.¹⁵

Figure 20

Source: GSMA Intelligence

Mobile's impact on the SDGs in mainland China, 2020



Supporting good health and wellbeing

SDG 3 focuses on ensuring healthy lives and promoting wellbeing for all. Mobile technology contributes to this by helping to secure healthcare financing, optimising healthcare service delivery and providing frontline workers with the skills and infrastructure needed for early disease detection through analytics. During the pandemic, China Unicom's big data unit developed a novel infectious disease model, USEIR. This builds on the classic infectious disease SEIR model by analysing operator signalling data and simulating potential spread trends and patterns. This helps relevant

agents establish effective policies to facilitate the resumption of normal social and business activities.

Across China, more individuals are now using mobile technology to improve and monitor their health by accessing telehealth services and other applications on their smartphones. Wearables, too, have benefited from an increased interest among consumers with regard to personal health and fitness features and services – growth out to 2030 will be driven by demand for smartwatches.¹⁶

¹⁵ 2021 Mobile Industry Impact Report: Sustainable Development Goals, GSMA, 2021

¹⁶ IoT market update: assessing disruption and opportunities, forecasting connections to 2030, GSMA Intelligence, 2021

Boosting industry, innovation and infrastructure

SDG 9 aims to build resilient infrastructure, promote inclusive and sustainable industrialisation, and deliver affordable internet access for all. With almost 1.2 billion unique mobile subscribers and 99% 4G population coverage in mainland China, mobile technology contributes to this goal as a provider of critical infrastructure and a platform for innovation.

The high score for SDG 9 in mainland China is also driven by mobile's catalytic effect on adjacent sectors. The connectivity provided by mobile operators enables industrial processes

and manufacturing to utilise technological advancements in IoT, AI and big data analytics, which in turn facilitates productivity gains. For example, China Mobile has partnered with Huaheng and Huawei to deploy the first 5G and multi-access edge computing (MEC) enabled automated guided vehicle (AGV) system, utilising the province's first 5G SA architecture. Using the low latency, high bandwidth and multi-concurrency performance of 5G technology, the solution enables the use of multiple AGVs to implement asset tracking and smart warehousing services.¹⁷



¹⁷ See [gsma.com/iot/manufacturing/benefits-use-case/huaheng-smart-factory/](https://www.gsma.com/iot/manufacturing/benefits-use-case/huaheng-smart-factory/)



Mobile industry at the forefront of environmental efforts

The mobile sector's contribution to SDG 9 also has knock-on effects for other goals, including SDG 13: Climate Action, which calls for urgent steps to combat climate change and its impact. The industry supports SDG 13 by improving energy efficiency, effecting changes in behaviour and reducing greenhouse gas (GHG) emissions. Given that mobile communications technologies are able to avoid 10× more emissions than they cause,¹⁸ the power of mobile is vital to drive decarbonisation efforts, improve quality of life and support the delivery of the SDGs.

Mobile became one of the first sectors to set a milestone ambition – to transform the industry to reach net-zero carbon emissions by 2050 in line with the Paris Agreement. Following this, the UN's Race to Zero campaign declared that the mobile industry had made a critical breakthrough in early 2021, as more than a third of operators by revenue globally had committed to achieving net-zero emissions by 2050 or earlier.¹⁹

Operators in China are increasingly taking steps and making investments to support the global transition towards a zero-carbon economy:

- Through its ongoing “Green Action Plan”, China Mobile has cooperated with stakeholders to save energy and develop energy-efficient technologies to better address climate change, with the aim of reaching carbon-neutral operations. In 2020, the plan saved 2.51 TWh of electricity, reducing overall energy consumption per unit of China Mobile's telecoms business by 18% compared with 2019. The operator also promoted energy efficiency classification standards and green packaging to support efforts to developing a circular economy.

- For the construction of its IP bearer network, China Unicom Beijing used Huawei's NetEngine routers to cope with increasing data traffic. The routers use three key technologies: SuperCooling; mixed flow fan; and intelligent power supply. As a result, China Unicom has been able to make annual electricity savings of 2 million kWh, cutting CO₂ emissions by more than 900 tonnes.
- Chunghwa Telecom aims to be a “Green Enterprise” that leads the industry toward environmental protection and sustainability via green operations. To efficiently monitor and manage energy utilisation and lower carbon emissions, Chunghwa Telecom laboratories developed the Environment ARTificer THEurgy (EARTH) system, which accordingly helped enhance the operator's environmental management efficiency and reduce energy consumption costs. Chunghwa Telecom also promotes paperless services, including electronic billing, automatic bill payment, consolidated billing, SMS billing and more, saving 560 million sheets of paper per year.²⁰

The GSMA and mobile operators are taking collaborative action to be fully transparent about the industry's own carbon footprint. At the end of 2020, 80% of operators by revenue worldwide had disclosed their climate impacts via the internationally recognised CDP global disclosure system.²¹ These include leading operators in the China region: China Mobile, China Telecom, China Unicom, Chunghwa Telecom, Far Eastone and Taiwan Mobile. This will enable full transparency for customers, policymakers, vendors and investors to follow progress.²²

18 The Enablement Effect: The impact of mobile communications technologies on carbon emission reductions, GSMA, 2019

19 “Mobile sector declares climate action breakthrough”, Race to Zero, April 2021

20 gsma.com/betterfuture/emissions-mitigation

21 See cdp.net/en

22 For more information, see *Mobile Net Zero – State of the Industry on Climate Action*, GSMA, 2021

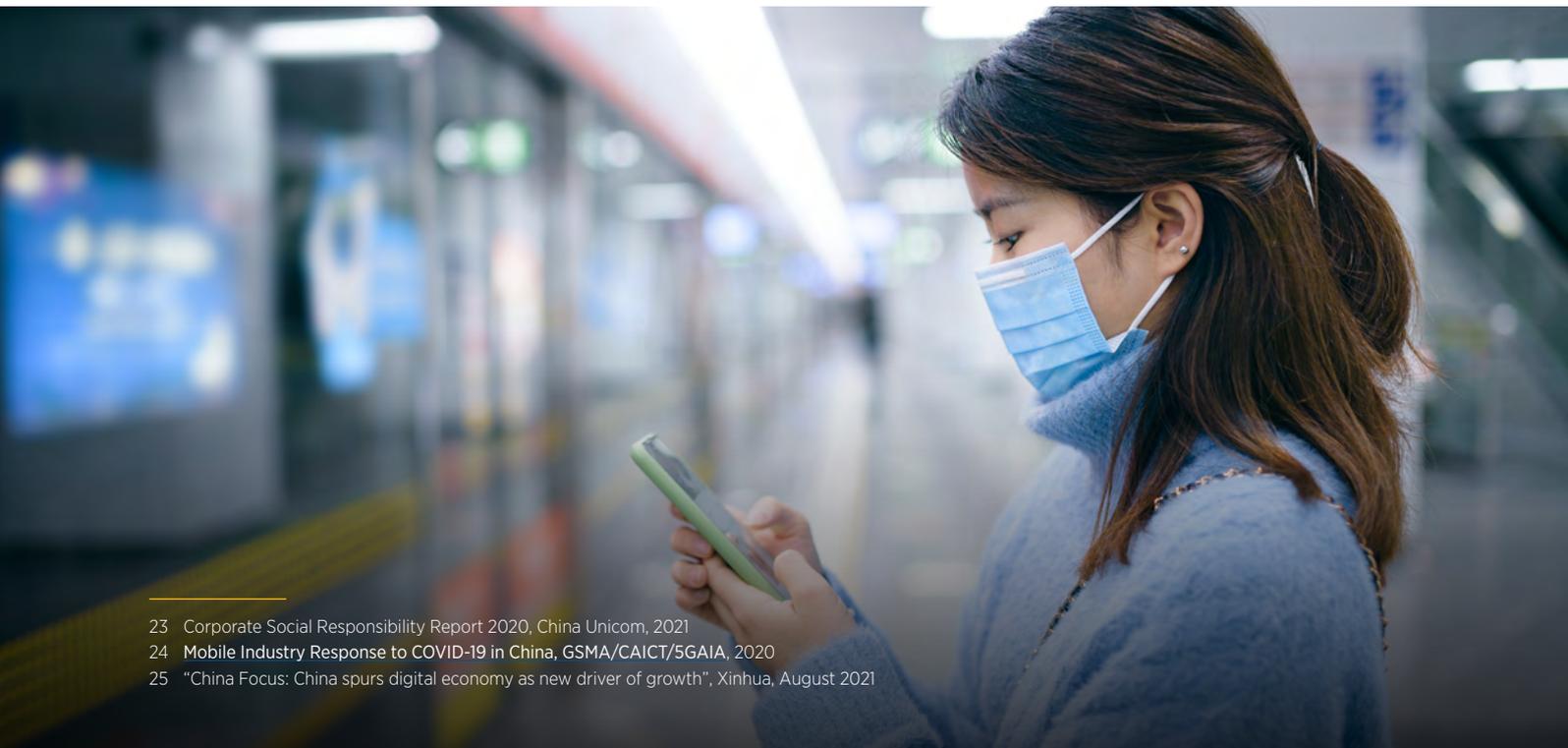
The mobile industry's response to Covid-19

As the original epicentre of the Covid-19 outbreak, China was impacted earlier than many other countries in Asia or elsewhere both in terms of its economy and mobile industry. As the severity of the pandemic has ebbed and flowed, operators have continued to ensure that people remain connected, support vulnerable individuals and communities, and protect the health and safety of employees. In January 2021, China Unicom reacted to a worsening situation in Harbin by working with the city's government on virus control procedures and by providing communication assurance for the Huo-Yan Laboratory for Covid-19 detection.²³

One of the most remarkable responses to the pandemic was the use of advanced technology to assist with frontline healthcare efforts in reducing transmission rates and treating patients. Examples of this include China Telecom and ZTE's 5G-based remote diagnosis system for West China Hospital and Sichuan University, and China Mobile's partnership with local education authorities in Hubei province to provide 5G-powered infrared thermal imaging and temperature-measuring equipment to schools.²⁴

As a result, the pandemic has presented a testing ground for 5G's application in medical settings and is likely to accelerate industrial deployments faster than would otherwise have been the case.

Now, more than two years on from the emergence of Covid-19, the Chinese government is focused on leveraging digital services and technologies to drive economic recovery and promote sustainable development. Amid the pandemic and global economic downturn, China's digital economy exhibited resilience, growing 9.7% in 2020 to reach RMB39.2 trillion (\$6.1 trillion).²⁵ On 12 January 2022, the State Council published a blueprint that aims to increase the contribution of core digital economy industries to 10% of GDP by 2025. The document's targets were determined in line with the country's 14th Five-Year Plan, which also covers the digitisation of public services and governance systems, as well as enterprise transformation, innovation in strategic technologies and self-sufficiency in areas such as semiconductors.



²³ Corporate Social Responsibility Report 2020, China Unicom, 2021

²⁴ Mobile Industry Response to COVID-19 in China, GSMA/CAICT/5GAIA, 2020

²⁵ "China Focus: China spurs digital economy as new driver of growth", Xinhua, August 2021



4

Policies to support digital advancement



4.1 Facilitating fast and cost-effective network rollouts

Digital connectivity and services will play a fundamental role in a post-pandemic world, enabling innovative business models for enterprises and new experiences for consumers. Governments are also using digital platforms to increase engagement with citizens and ensure the effective delivery of public services. In this context, forward-looking policies for the telecoms sector are essential to support the deployment of high-performance networks and development of innovative services.

As more people become connected and operators transition to 5G, addressing coverage and capacity requirements through network densification can become a challenge; there are only so many locations where base stations can be installed and each operator having to invest in network deployment will come at a significant cost. Network quality and reach are often key differentiators for operators in addition to competition in services; however, delivering additional capacity and coverage of 5G networks generally incurs a higher cost of deployment to meet performance and network densifications requirements compared to legacy mobile networks.

Authorities in China recognise the opportunity that digital advancement can bring to society and have taken steps to implement enabling policies for cost-effective infrastructure deployment. In January 2022, the MIIT revealed that operators in mainland China had launched more than 1.4 million 5G base stations. It has set an ambitious plan to triple the number of 5G base stations to 3.64 million by the end of 2025. This means the country will have 26 5G base stations for every 10,000 people, compared to just five 5G base stations for every 10,000 people in 2020.

The rapid rollout of 5G networks in China is a result of the MIIT's forward-looking policy of allowing operators to negotiate and form infrastructure-sharing partnerships on a commercial basis. In addition, the MIIT made special concessions for sharing deals to be developed with minimal regulatory red tape. The initiative to allow network sharing and minimise bureaucracy has helped to incentivise collaboration, as opposed to unnecessary competition, at the infrastructure level.

Authorities in China recognise the opportunity that digital advancement can bring to society and have taken steps to implement enabling policies for cost-effective infrastructure deployment.

Consequently, China Telecom and China Unicom reached an agreement in 2019 to jointly build a 5G network and share infrastructure, which also represented the world's first 5G network using 200 MHz of contiguous spectrum in the 3.5 GHz band. In 2020, China Mobile signed a 5G network-sharing agreement with China Broadcasting Network (CBN), giving it access to the broadcaster's 700 MHz spectrum, allowing it to improve its coverage more efficiently, particularly in rural regions, while also enabling CBN to deploy 5G services more quickly and at a significantly reduced cost.

The result has been the rapid rollout of 5G infrastructure, in addition to significant cost savings for operators and, by extension, improved profit models for 5G. Operators have also reported cost savings in 5G deployment. For example, China Telecom and China Unicom have disclosed that the deal to share 5G infrastructure has reduced construction costs by RMB80 billion (\$12.4 billion) and opex by about RMB8 billion (\$1.3 billion) per year. Furthermore, the joint approach is expected to cut energy consumption by 8.7 kWh annually, equivalent to 7 billion tonnes of greenhouse gas emissions. This is an important contribution to global carbon reduction objectives.

In December 2021, the MIIT published an ex-post regulation to formalise the regulatory guidance on network sharing and further encourage voluntary commercial partnerships between operators. The MIIT expects the regulations to accelerate the construction of 5G network infrastructure, as well as improve spectral efficiency and ultimately bring the benefits of mobile connectivity to people across the country.



Maximising the opportunity of the 6 GHz band

Considerations on the optimal approach for managing spectrum are currently at the forefront of the debate around the 5925–7125 MHz frequency range as governments decide how best to manage this spectrum over the coming decades. The key consideration is whether to utilise the spectrum for licensed mobile (i.e. 5G new radio (NR) and its evolution) or for unlicensed use (i.e. Wi-Fi 6).

To date, countries have taken divergent approaches to allocating this spectrum. Some have assigned the full 6 GHz band for unlicensed use, while others are considering the full band for licensed International Mobile Telecommunications (IMT) use. A third group are allocating the lower part of 6 GHz (5925/5945–6425 MHz) for unlicensed and considering the upper part (6425–7125 MHz) for licensed IMT. Included on the agenda of the next World Radiocommunication Conference (WRC-23) is the IMT identification of 6425–7025 MHz in ITU Region 1 (Europe, the Middle East and Africa)²⁶ and 7025–7125 MHz in all ITU regions.

The 6 GHz range sits at a balancing point between coverage and capacity, providing the perfect environment for citywide 5G connectivity. Harmonisation of 6 GHz spectrum will provide more bandwidth and improve network performance.

On top of this, the broad, contiguous channels offered by the 6 GHz range will reduce the need for network densification in cities if mid-band spectrum

is not made available, and make next-generation connectivity more affordable for all.

Research from the GSMA²⁷ on mid-band 5G spectrum needs shows that, on average, a total of 2 GHz of mid-band spectrum will be required to support the growth of 5G over the 2025–2030 time frame. Governments around the world therefore need to make a carefully considered decision as to what the most efficient use of 6 GHz spectrum will be. When considering which approach to take, policymakers should conduct a regulatory impact assessment to identify the best policy option for radio spectrum assignments – specifically the policy that will maximise the social and economic value of spectrum.

A GSMA Intelligence study²⁸ has conducted a cost-benefit analysis for different authorisation models for the 6 GHz band. The study implements a supply and demand framework in the 2021–2035 period to determine where 6 GHz spectrum will have its most productive use, especially taking into account current and expected demand for 5G and Wi-Fi. Considering three policy scenarios, the report finds that assigning the full 6 GHz band for licensed use would drive the largest socioeconomic benefit across most countries analysed. However, failure to allocate any 6 GHz spectrum to licensed use could mean higher operator costs and/or lower network quality, and would make it impractical to deliver on the full characteristics of 5G (IMT-2020).

²⁶ See ITU RR article 5.3 for exact definition.

²⁷ *Vision 2030: Insights for Mid-band Spectrum Needs*, GSMA, 2021

²⁸ *The socioeconomic benefits of the 6 GHz band*, GSMA Intelligence, 2022



For more information, please visit the
GSMA website at www.gsma.com