GSMA

The Mobile Economy China 2024

GSMA

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Contents

	Executive summary	**2**
1.	**The mobile industry in numbers**	**9**
2.	**Mobile industry trends**	**20**
2.1	5G's next wave: 5G-Advanced and 5G RedCap gain prominence	21
2.2	Network APIs: Chinese operators unite behind ecosystem efforts	23
2.3	Digital consumer: 5G new calling unlocks new opportunities	26
2.4	Satellite: new players join the race to develop aerial connectivity solutions	29
2.5	Generative AI: advances in AI underpin new services and devices	31
3.	**Mobile industry impact**	**34**
3.1	The mobile industry's impact on the SDGs	35
3.2	Managing natural resources with 5G connectivity	37
4.	**Mobile industry enablers**	**38**

Executive summary

5G advances to the next level

The evolution of 5G can be viewed in terms of distinct phases. The initial phase was about enhancing fundamental connectivity aspects, including wide area coverage, capacity and solution reliability. With the number of 5G connections in China surpassing 800 million (45% of total connections) at the end of 2023, mobile operators are ready to move to the next phase of the technology's development, with investment in 5G-Advanced. This could enable the industry to focus on new growth opportunities from enhanced 5G capabilities while also delivering economic benefits.

5G's contribution to GDP in China is expected to reach almost $260 billion in 2030 (23% of the overall annual economic impact of mobile in China). The mobile ecosystem also supports almost 8 million jobs (directly and indirectly) and makes a substantial contribution to the funding of the public sector, with $110 billion raised through taxation in 2023. This economic contribution underlines the importance of stakeholders taking the right steps to sustain the impact of mobile services on the digital economy, with spectrum availability a key driver of affordable 5G for all.

Key trends shaping the mobile ecosystem

5G-Advanced and 5G RedCap in focus

China continues to set the pace for cutting-edge 5G technology standards. Having already deployed 5G standalone (5G SA), Chinese operators are leading the way in the transition to 5G-Advanced and 5G reduced capability (RedCap) networks. This is anticipated to kickstart a new round of 5G investment in 2024 and beyond. It will also lay the foundation for the next wave of 5G use cases that could unlock new revenue streams for operators and the wider ecosystem in both the consumer and enterprise segments. 5G RedCap is in commercial trials for multiple use cases in several cities across China. Trials are ongoing for 5G-Advanced, setting the stage for commercial services.

Operators embrace network APIs to bolster 5G monetisation efforts

China Mobile, China Telecom and China Unicom joined the GSMA Open Gateway initiative ahead of MWC Shanghai 2023. The move demonstrates the commitment of Chinese operators to collaborate on the open network API framework. It also brings added scale and expertise to the initiative. China is the largest 5G market in the world and at the forefront of digital innovation. As 5G brings key API capabilities, China's established expertise in 5G will help unlock further value, which will flow through to the global economy and strengthen future investment in digital services.

China is at the forefront of introducing 5G new calling

According to the GSMA Intelligence Consumers in Focus Survey 2023, two thirds of people in China who have already upgraded or intend to upgrade to 5G find enhanced video calling a very or extremely appealing 5G use case. Operators are looking to tap into the consumer interest by developing new voice and video calling services. 5GNC is one example. It leverages the capabilities of 5G networks and IP multimedia subsystem (IMS) to enhance basic voice and video calls. It opens up new opportunities for operators to work directly with enterprises to develop new applications that can be invoked during a call, leveraging 5G's ultra-low latency, exceptional bandwidth and reliable quality of service.

Chinese entities join expanding satellite ecosystem

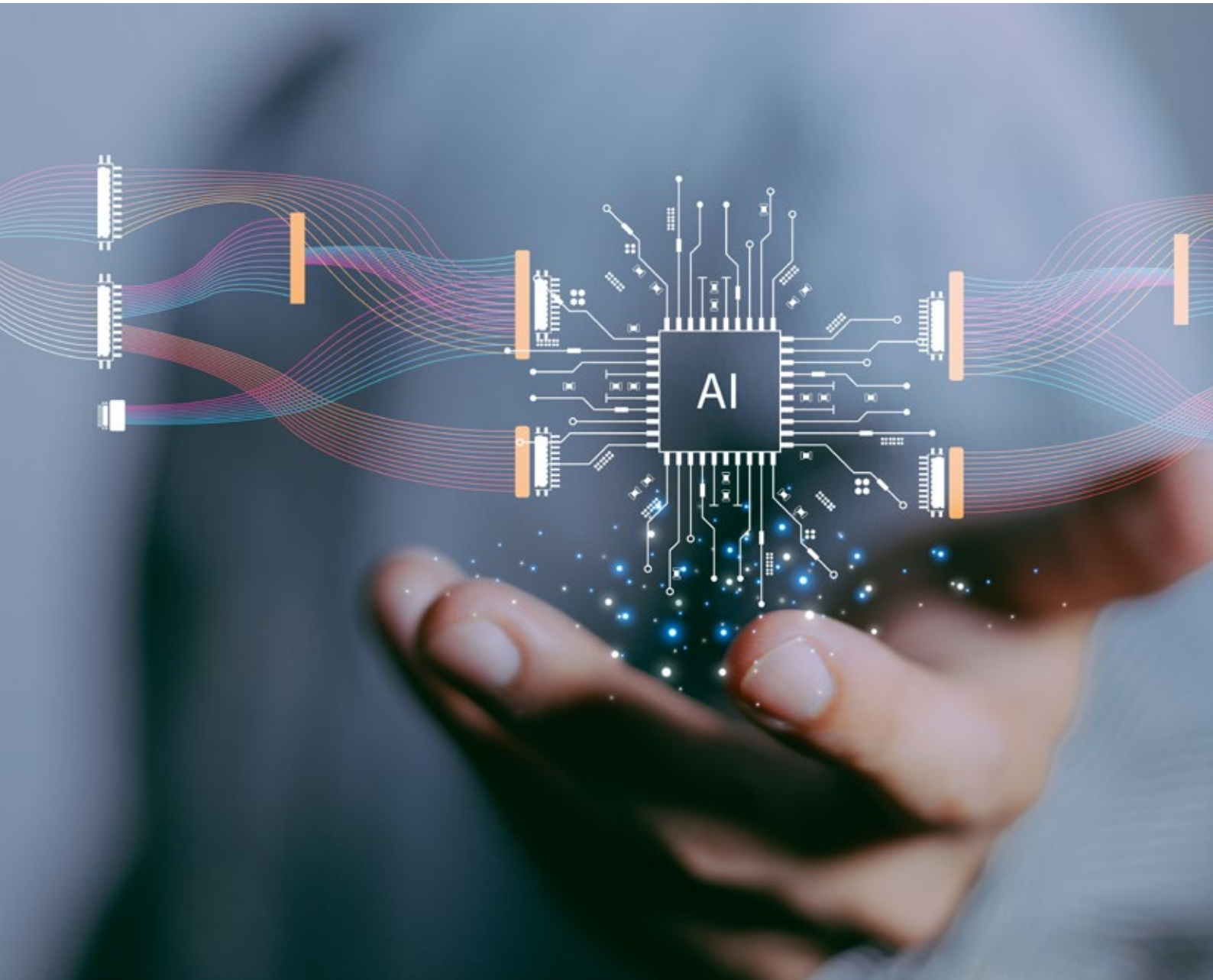
Telecoms networks remain the primary form of connectivity, supported by the wide area coverage of wireless networks and the mass production and adoption of mobile devices. However, in recent years, technological advances in satellite and other non-terrestrial networks (NTNs) have helped overcome some of the limitations traditionally associated with aerial connectivity.

Satellite connectivity offers telecoms operators access to new customers in underserved areas and the ability to provide connectivity for emergency services and existing customers where a terrestrial signal is not available. A number of collaborations have been announced to capitalise on this opportunity. Further partnerships are expected in 2024 as value becomes clearer and more satellite capacity becomes available.

Advances in AI underpin new services and devices

China's AI sector has seen rapid advancement since companies received permission in August 2023 to release their large language models (LLMs) to the general public. Recent developments in the mobile sector indicate that Chinese operators are not just utilising AI for internal purposes but are also exploring avenues to generate new revenues.

Meanwhile, smartphones are becoming a growing focus for the commercialisation of generative AI (genAI), with recent technology advances in mobile chipsets, cloud computing and small LLMs making genAI on smartphones possible.



Policies for growth and innovation

In 2022, the GSMA published research into the ecosystem outlook and economic cost-benefit analysis for the 6 GHz band. Encouraging results from those studies helped the mobile industry advocate for the band to support the continued evolution of mobile services. Nearly two years on, progress has been made, including at the World Radiocommunication Conference 2023 (WRC-23). We are now in a new phase that kickstarts the journey to commercialisation:

- Trials have been carried out across different regions using the 6 GHz band, showing that advanced 5G technologies can achieve coverage comparable to what is achievable in the 3.5 GHz band today.
- China became the first country in the world to identify the 6 GHz band to IMT in its national legislation in June 2023, well before the conclusion of WRC-23. This move sets a bright future in which the 6 GHz IMT ecosystem can thrive.

As the ecosystem looks forward to further progress in 2024, it is imperative that the industry engages closely with regulators and policymakers to implement the new spectrum bands in their national legislations in a timely manner to support spectrum harmonisation and avoid interference issues. For China, the stage is set to galvanise the mobile ecosystem around the 6 GHz band, boosting 5G-Advanced and helping realise the full potential of future technological improvements.

> For China, the stage is set to galvanise the mobile ecosystem around the 6 GHz band

The Mobile Economy China

Unique mobile subscribers

2023 **1.28bn**
88% penetration rate*

2030 **1.29bn**
89% penetration rate*

CAGR 2023-2030 **0.1%**

*Percentage of population

Mobile internet users

2023 **1.21bn**
83% penetration rate*

2030 **1.29bn**
89% penetration rate*

CAGR 2023-2030 **0.8%**

*Percentage of population

SIM connections

(excluding licensed cellular IoT)

2023 **1.81bn**
124% penetration rate*

2030 **1.92bn**
133% penetration rate*

CAGR 2023-2030 **0.8%**

*Percentage of population

4G

Percentage of connections (excluding licensed cellular IoT)

2023 **55%**

2030 **12%** ↓

5G

Percentage of connections (excluding licensed cellular IoT)

2023 **45%**

2030 **88%** ↑

Smartphones

Percentage of connections

2023 **84%**

2030 **93%**

Licensed cellular IoT connections

2023 **2.6bn**

2030 **4.1bn**

Operator revenues and investment

2023 **$225bn**

Total revenues

2030 **$249bn**

Total revenues

Operator capex for the period 2023–2030: **$319bn**

Mobile's contribution to GDP

2023 **$970bn**

5.5% of GDP

2030 **$1.1tn**

Public funding

2023

$110bn

Mobile ecosystem contribution to public funding (before regulatory and spectrum fees)

Employment

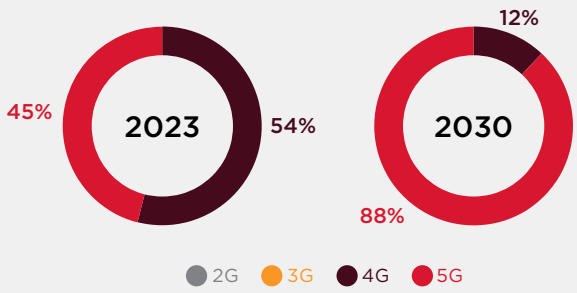
2023 **3.5m jobs**

Directly supported by the mobile ecosystem

Plus 4.4m indirect jobs

Mainland China

Technology mix*

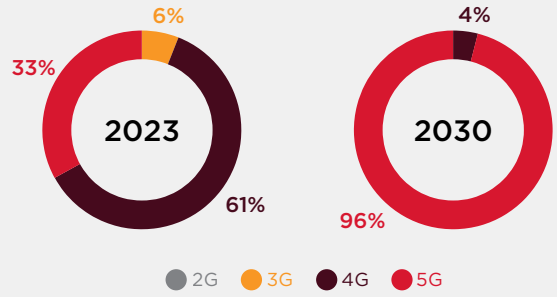


Subscriber penetration	2023	2030
	88%	89%

Smartphone adoption	2023	2030
	84%	93%

Hong Kong, SAR China

Technology mix*

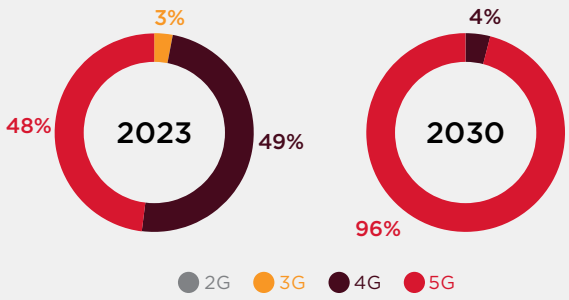


Subscriber penetration	2023	2030
	97%	97%

Smartphone adoption	2023	2030
	88%	93%

Macao, SAR China

Technology mix*

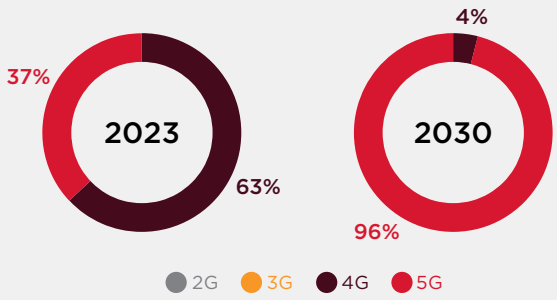


Subscriber penetration	2023	2030
	88%	93%

Smartphone adoption	2023	2030
	89%	94%

Taiwan, Province of China

Technology mix*



Subscriber penetration	2023	2030
	95%	96%

Smartphone adoption	2023	2030
	86%	96%

* Percentage of total connections

01

The mobile industry in numbers

The mobile internet usage gap has reduced significantly in recent years

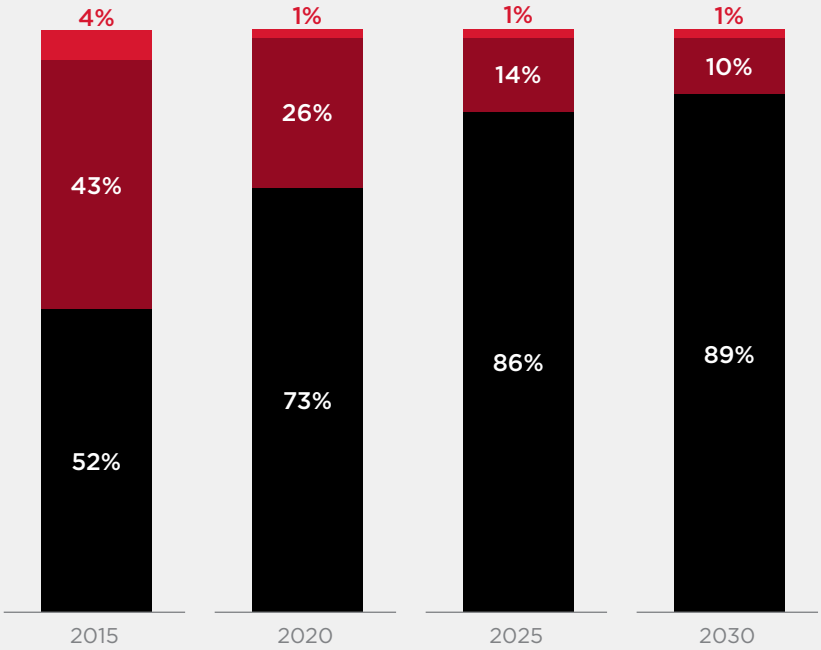
By the end of 2023, 1.3 billion people in China (88% of the population) subscribed to a mobile service – an increase of 290 million people since 2015. This figure will remain almost unchanged over the period to 2030, reflecting the fact that mobile adoption has largely peaked among the adult population in China.

More pronounced changes can be expected in mobile internet adoption, as the mobile internet usage gap continues to narrow. At the end of 2023, 83% of the population used mobile internet, equating to 1.2 billion users – an increase of 460 million since 2015. An additional 70 million mobile internet subscribers will be added by the end of the decade, taking mobile internet adoption to 89% by 2030. The remaining 160 million people who do not use mobile internet are mostly either the young or elderly.

Figure 1

China: mobile internet connectivity

Percentage of population



Coverage gap
Those who live in an area not covered by a mobile broadband network.

Usage gap
Those who live within the footprint of a mobile broadband network but do not use mobile internet services.

Connected
Those who use mobile internet.

Source: GSMA Intelligence

Over half of mobile connections in China will be on 5G by the end of 2024

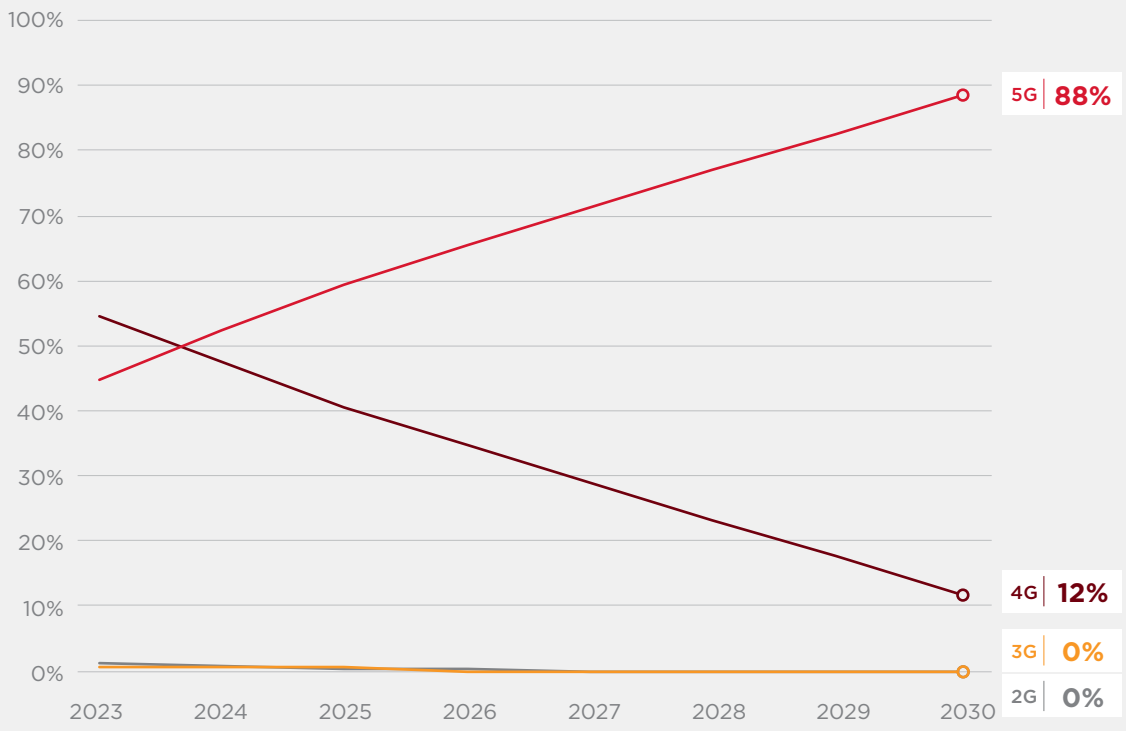
5G adoption in China continues to rise, as operators phase out legacy networks (2G and 3G) and bring 5G services to more locations. At the end of 2023, operators had installed 3.4 million 5G base stations, accounting for more than 30% of China's total mobile base stations.[1] Data from the Chinese telecoms regulator also shows that more than 80% of administrative villages have 5G connectivity.[2]

Innovative solutions may be needed to extend 5G coverage to hard-to-reach areas. In May 2023, China's four major mobile operators announced they will jointly launch the world's first cross-network 5G roaming trial in the Xinjiang Uygur Autonomous Region. The service enables users to access other operators' 5G networks when their operator does not have 5G coverage. Such initiatives could play a pivotal role in driving 5G adoption in rural areas.

Figure 2

China: mobile adoption by technology

Percentage of total connections



Source: GSMA Intelligence

1. Source: China's Ministry of Industry and Information Technology
2. "China 5G base station count approaches 3.4M", Mobile World Live, January 2024

China is forecast to record 1 billion 5G connections by the end of 2024

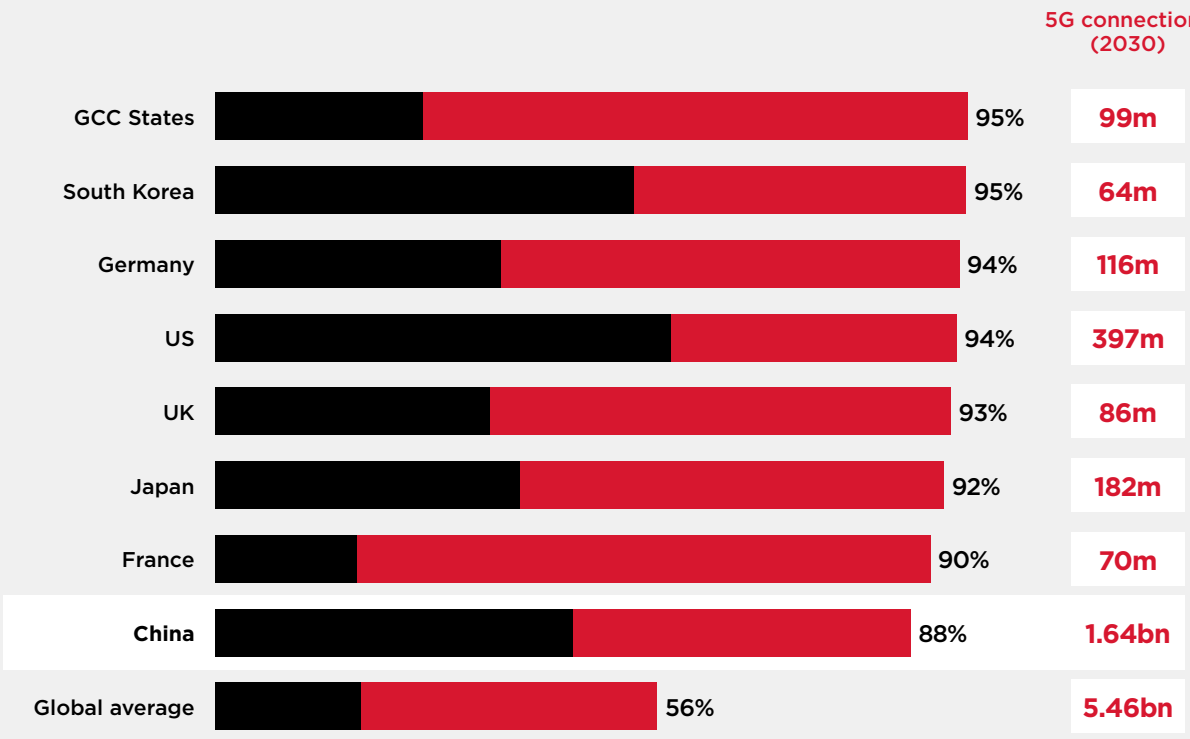
Demand for 5G services continues unabated in China, with the number of 5G connections reaching 810 million (45% of total connections) at the end of 2023. Macao leads the way, with 5G accounting for 48% of total connections, followed by mainland China (45%), Taiwan (37%) and Hong Kong (33%). Only the US and South Korea have higher 5G adoption rates than the three leading markets in China.

5G adoption is growing faster than anticipated due to the speed of network deployments and maturing device ecosystem. By 2030, the number of 5G connections in China will surpass 1.6 billion, accounting for nearly a third of the global total. By that point, 5G adoption in China will reach almost 90%, making it one of the leading markets globally.

Figure 3

5G adoption in 2030

Percentage of total connections



Source: GSMA Intelligence

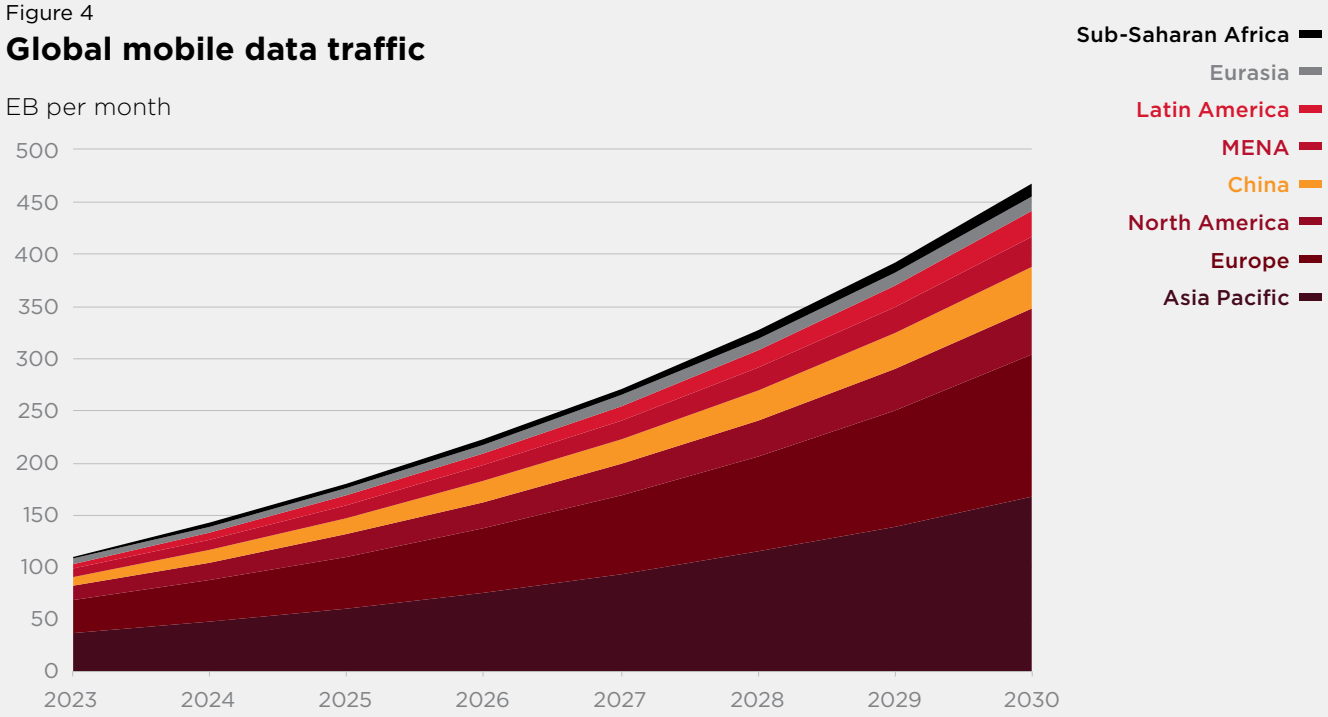
Mobile data traffic in China will quadruple between 2023 and 2030

Global mobile data traffic is forecast to grow at a CAGR of 23% between 2023 and 2030, reaching 465 EB per month by the end of the decade. China will account for nearly 10% of this figure. At a per-connection level, monthly mobile data traffic in China will rise from 13 to 54 GB over the same period. Mobile data traffic per connection in China will be above the global average (48 GB per month) by 2030.

China's Ministry of Industry and Information Technology (MIIT) has developed a five-year action plan to scale the country's virtual reality (VR) industry, which it believes will be worth around CNY350 billion ($48.1 billion) in 2026. To help achieve this, China's government will invest in the development of 100 enterprises with strong VR innovation capabilities. Advancements in VR and other extended reality solutions will drive new consumer use cases in areas such as entertainment, education and remote events.

Figure 4

Global mobile data traffic



Mobile data traffic per connection (GB per month)

Region	2023	2030	CAGR 2023–2030
Asia Pacific*	14	53	21%
Eurasia**	13	41	18%
Europe	17	71	22%
China	13	54	23%
Latin America	7	32	23%
MENA	10	31	18%
North America	29	90	17%
Sub-Saharan Africa	2	9	23%

* Asia Pacific excludes China
** Eurasia includes Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Uzbekistan.
Source: GSMA Intelligence

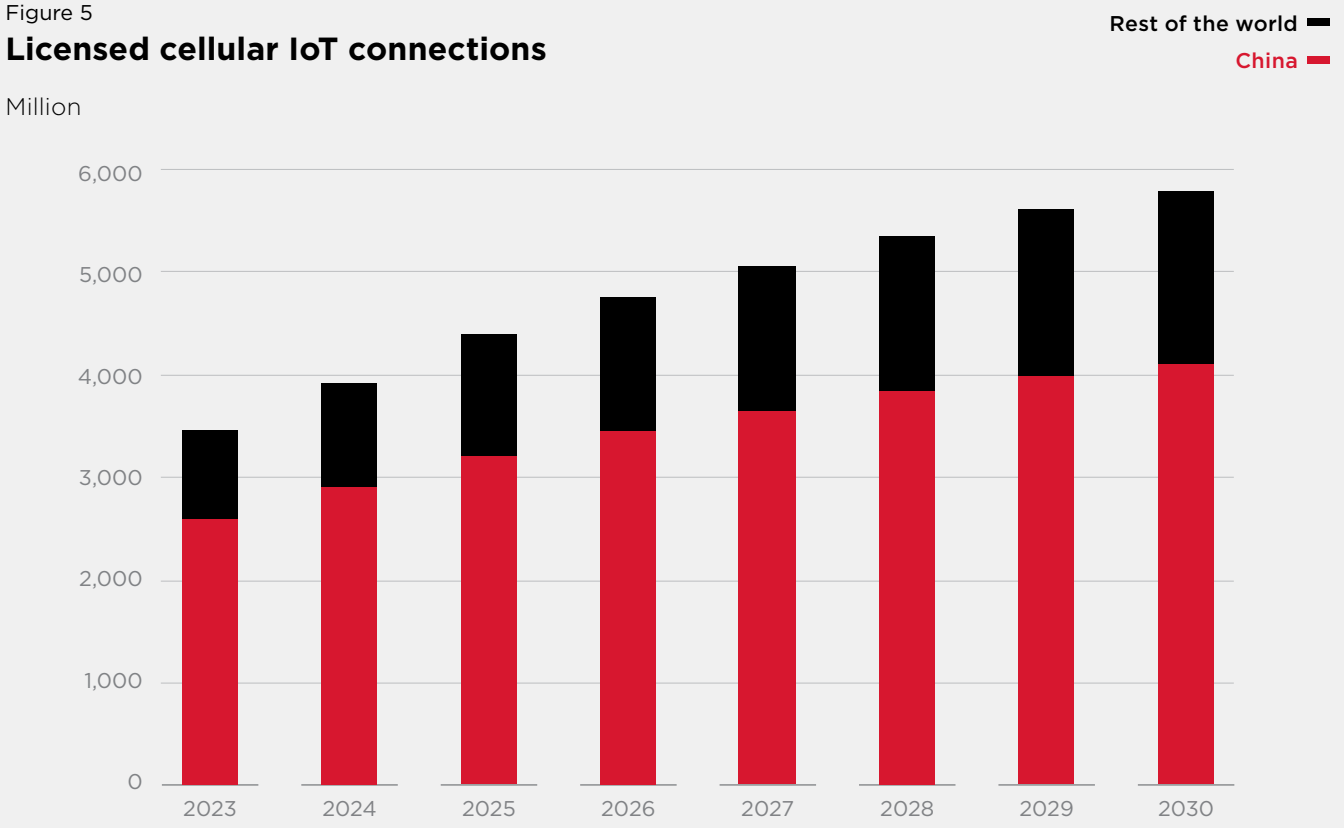
China will continue to drive the global licensed cellular IoT market

There will be 4.1 billion licensed cellular IoT connections in China by 2030, accounting for 70% of global cellular IoT connections. MIIT data shows that public services, connected vehicles, smart retail and smart home applications currently account for the largest share of connections.

5G will provide an impetus for IoT growth in China. Chinese operators and vendors report progress with 5G LAN, 5G IoT, edge compute and 5G private networks, supported by ambitious timelines for further service launches. There are already reports of deployment of the 5G-powered Future Railway Mobile Communication System (FRMCS) in railway projects, and deployments of indoor 5G in factories and warehouses, particularly in heavy industries, as well as smart cities, the public sector and national infrastructure.[3]

Figure 5

Licensed cellular IoT connections



Source: GSMA Intelligence

3. Should China be seen as a global benchmark for enterprise 5G?, GSMA Intelligence, 2023

By 2030, mobile revenues will reach almost $250 billion in China

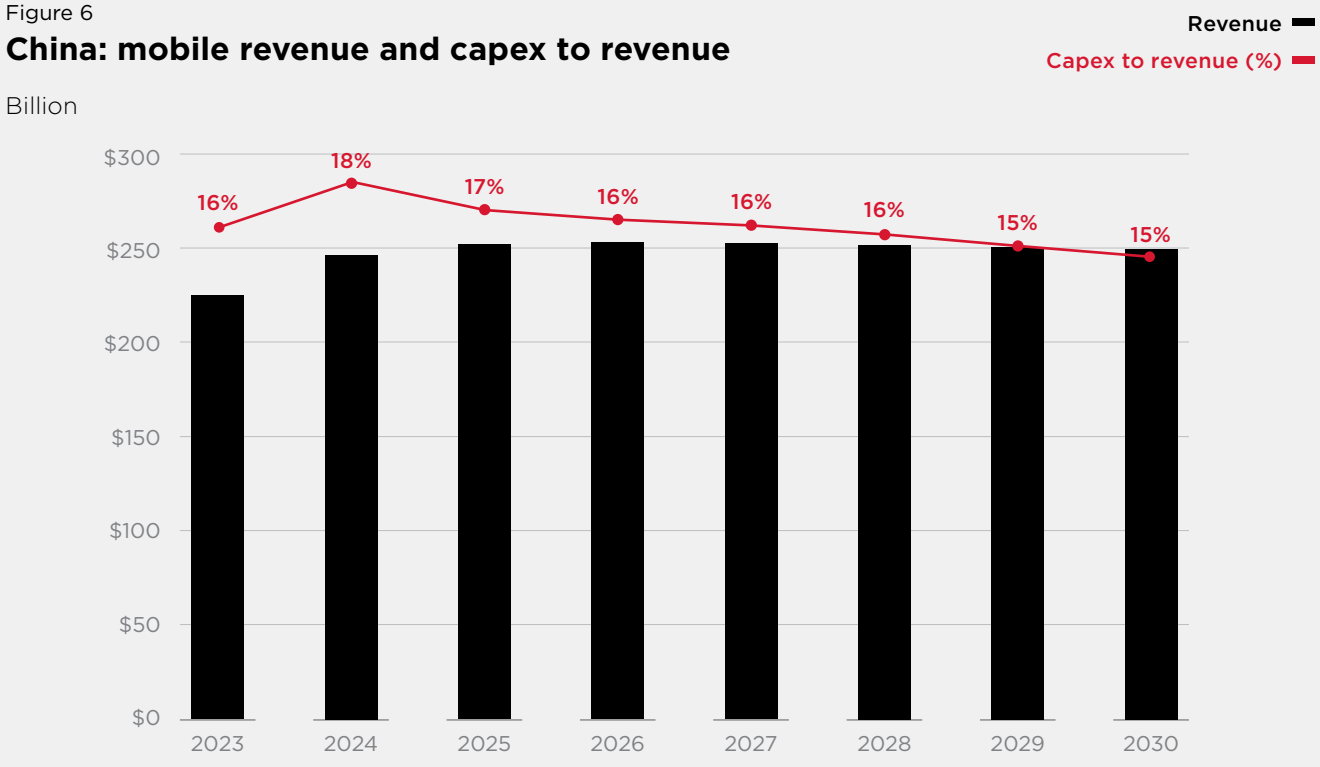
Mobile revenue growth is expected to moderate in China over the coming years as mobile internet subscriber growth slows and 5G adoption reaches maturity. Capex will also moderate in the period to 2030. However, Chinese operators are still projected to invest around $320 billion in mobile capex between 2023 and 2030. This is equivalent to around 20% of global mobile capex.

The expected slowdown in mobile revenue growth is driving Chinese operators to step up their revenue diversification efforts. According to GSMA Intelligence research, the share of revenue derived from services beyond core telecoms reached 24% on average for China Mobile, China Telecom and China Unicom in 2022.

Chinese operators are doing particularly well with business-to-business (B2B) services. Cloud is an important driver of this growth. Cloud revenues for the three largest Chinese operators in aggregate doubled in 2021 and again in 2022. Cloud revenue accounted for 48% of total revenue growth (from all services in aggregate) in 2022.[4]

Figure 6

China: mobile revenue and capex to revenue



Source: GSMA Intelligence

4. From telco to digital telco: navigating trends and drivers shaping revenue growth beyond connectivity, GSMA Intelligence, 2023

In 2023, the mobile sector added $970 billion of economic value to the Chinese economy

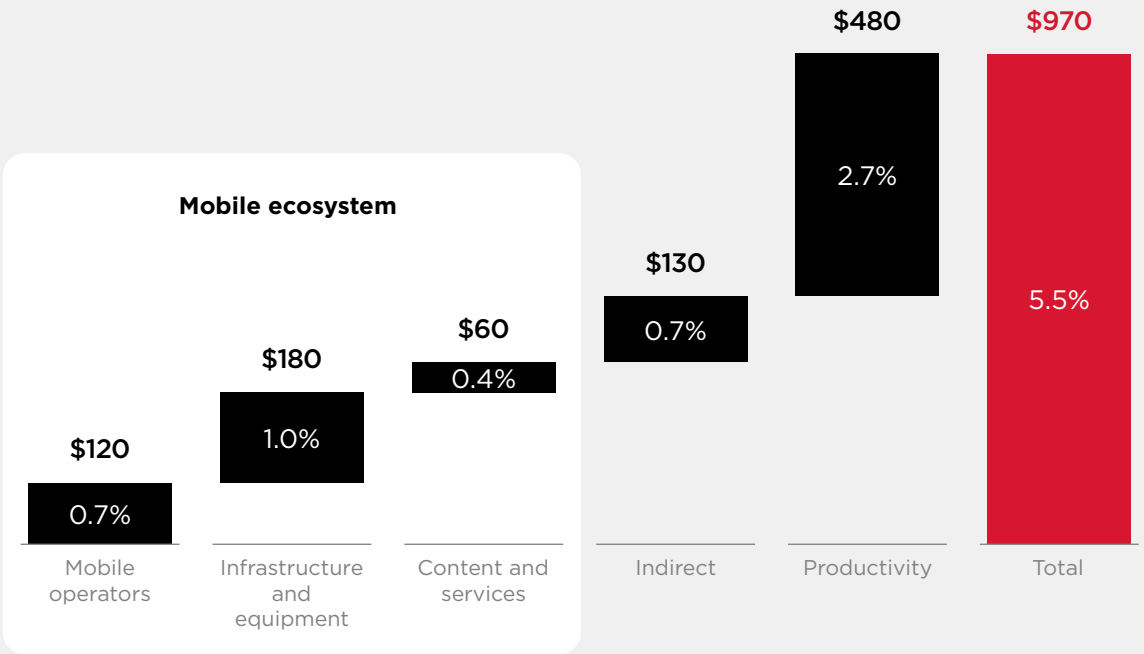
In 2023, mobile technologies and services generated 5.5% of Chinese GDP – a contribution that amounted to $970 billion of economic value added. The greatest benefits came from the productivity effects at $480 billion, followed by infrastructure and equipment at $180 billion.

The mobile ecosystem comprises three categories: mobile operators; infrastructure and equipment; and content and services. The infrastructure and equipment category includes network equipment providers, device manufacturers and IoT companies. Meanwhile, content and services encompasses content, mobile application and service providers, distributors and retailers, and mobile cloud services.

Figure 7

China: total economic contribution of the mobile industry, 2023

Billion



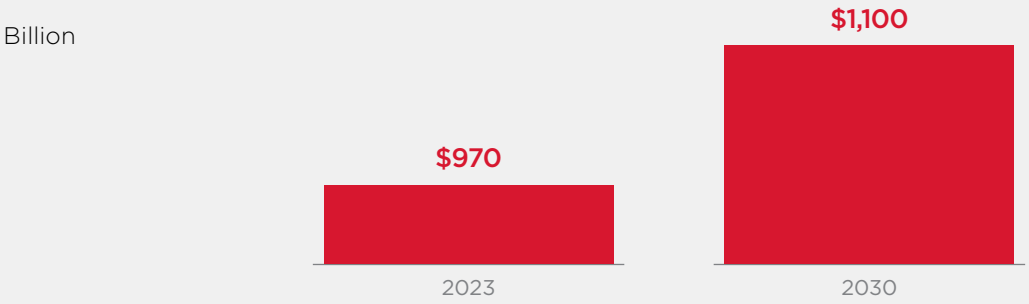
Source: GSMA Intelligence

At the end of the decade, mobile's economic contribution in China will reach $1.1 trillion

By 2030, mobile's contribution will reach approximately $1.1 trillion in China, driven mostly by the continued expansion of the mobile ecosystem and verticals increasingly benefitting from the improvements in productivity and efficiency brought about by the take-up of mobile services.

Figure 8

China: economic impact of mobile



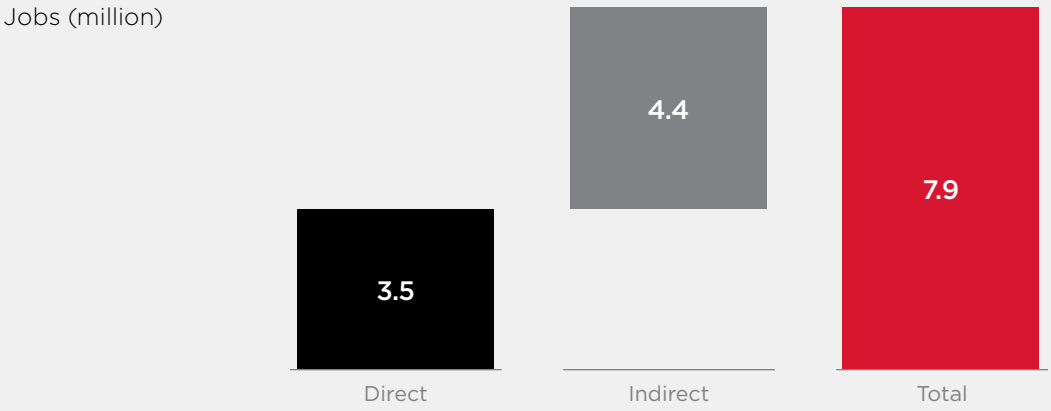
Source: GSMA Intelligence

The mobile ecosystem in China supported around 8 million jobs in 2023

Mobile operators and the wider mobile ecosystem provided direct employment to more than 3.5 million people in China in 2023. In addition, economic activity in the ecosystem generated around 4.4 million jobs in other sectors, meaning around 8 million jobs were directly or indirectly supported.

Figure 9

China: employment impact of the mobile industry, 2023



Source: GSMA Intelligence

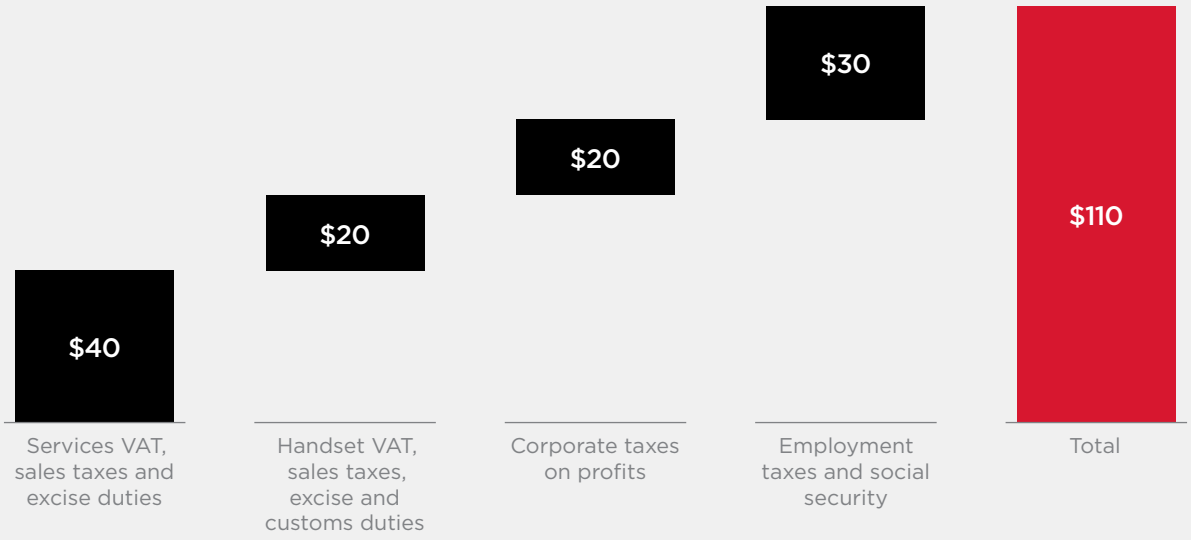
The fiscal contribution of the mobile ecosystem in China reached $110 billion in 2023

In 2023, the mobile sector in China made a substantial contribution to the funding of the public sector, with around $110 billion raised through taxes. A large contribution was driven by services, VAT, sales taxes and excise duties ($40 billion), followed by employment taxes and social security ($30 billion).

Figure 10

China: fiscal contribution of the mobile ecosystem, 2023

Billion



Source: GSMA Intelligence

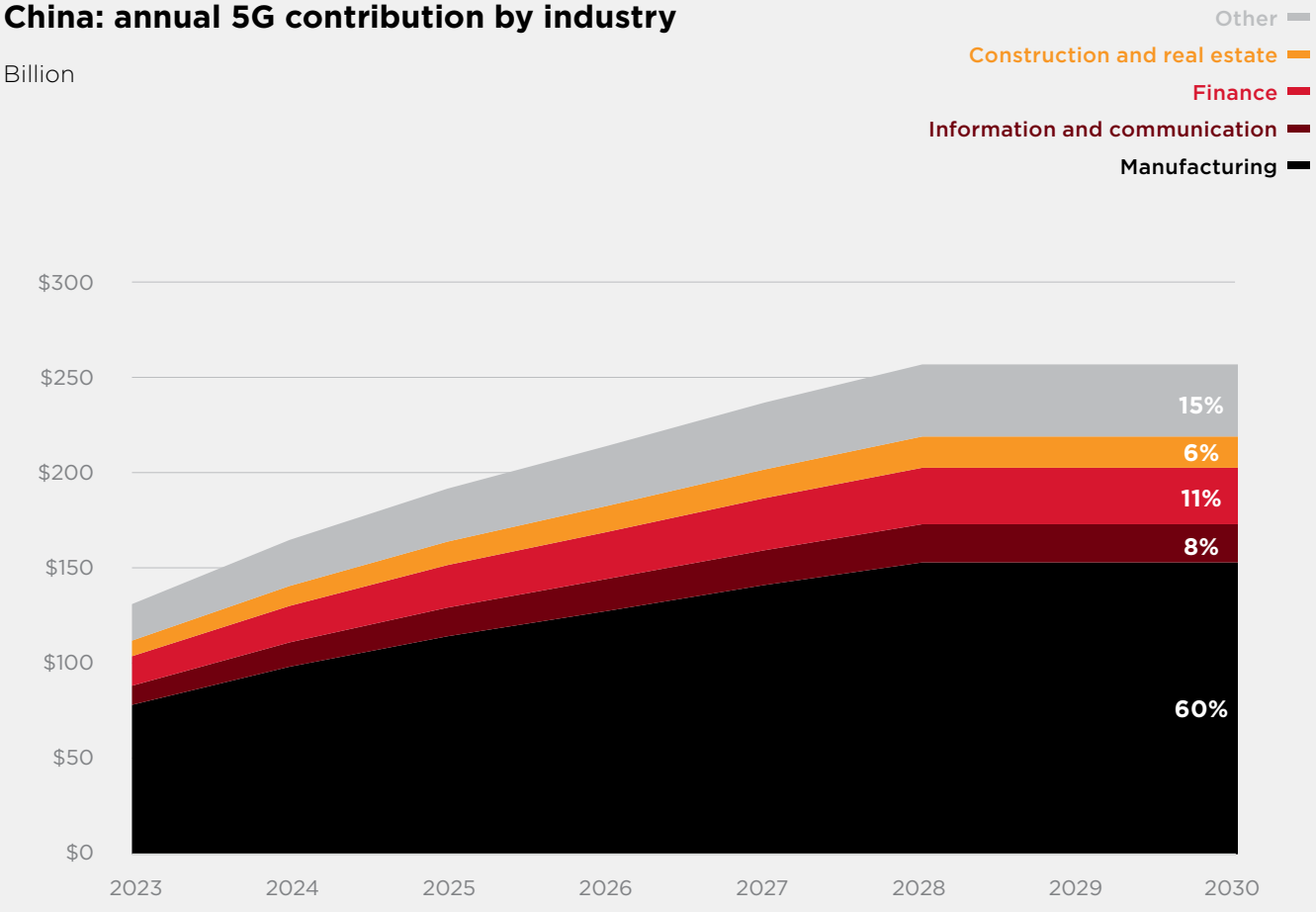
5G will add almost $260 billion to the Chinese economy in 2030

5G is expected to benefit the Chinese economy by around $260 billion in 2030, accounting for more than 23% of the overall economic impact of mobile. Much of this will materialise over the next five years. Towards the end of the decade, 5G economic benefits will level off as the technology starts to achieve scale and widespread adoption.

While 5G is expected to benefit most sectors of the Chinese economy, some industries will benefit more than others due to their ability to incorporate 5G use cases in their business. Over the next seven years, 60% of the benefits are expected to originate from the manufacturing sector, driven by applications including smart factories, smart grids and IoT-enabled products. Other sectors that will experience significant benefits are the financial sector and the information and communication sector at 11% and 8%, respectively.

Figure 11

China: annual 5G contribution by industry



Source: GSMA Intelligence

02

Mobile industry trends

2.1
5G's next wave: 5G-Advanced and 5G RedCap gain prominence

China continues to set the pace for cutting-edge 5G technology standards. Having deployed 5G standalone (5G SA), Chinese operators are leading the way in the transition to 5G-Advanced and 5G reduced capability (RedCap) networks. This will kickstart a new round of 5G investments in 2024 and beyond. It will lay the foundation for the next wave of 5G use cases that could unlock new revenue streams for operators and the wider ecosystem in both the consumer and enterprise segments.

Operators explore new opportunities with 5G-Advanced

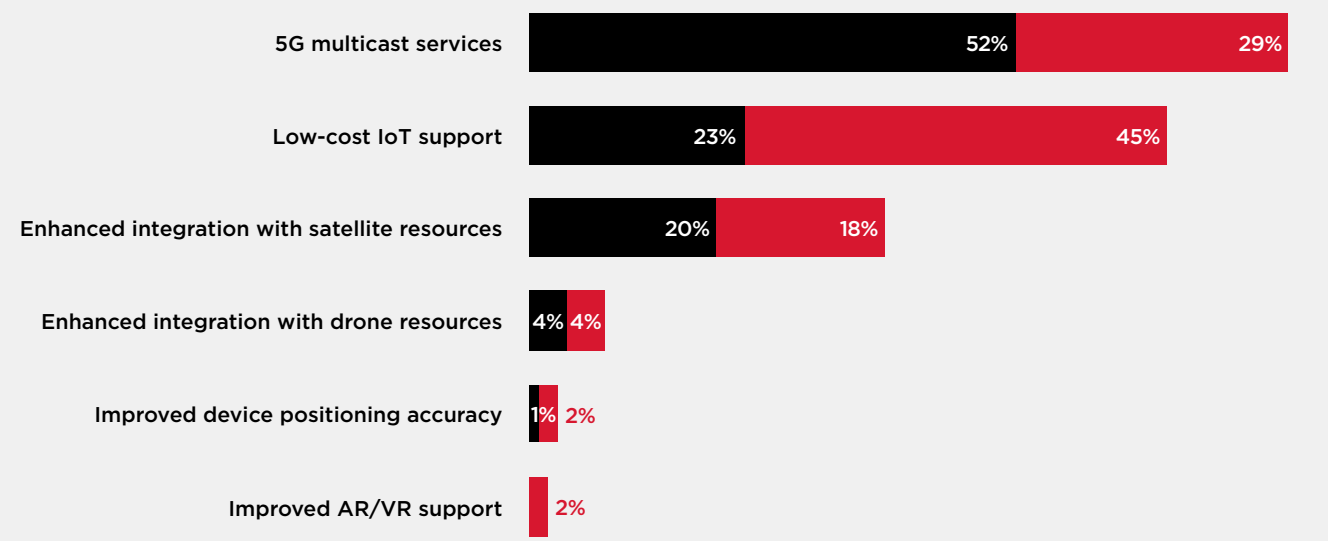
As part of 3GPP Release 18 in 2024, 5G-Advanced is the next milestone in the 5G era. It brings innovations to strengthen the 5G systems, improving speed, maximising coverage and enhancing mobility and power efficiency. This has the potential to open up a wealth of opportunities to enable enhanced functionality and use cases for the enterprise market.

5G-Advanced is set to enhance mobility by enabling uplink and multicast at better latency and increased accuracy for extended reality (XR). It will offer improved sustainability from the use of AI/ML data-driven designs. Insights from the GSMA Intelligence Network Transformation Survey 2023 show that 5G multicast and low-cost IoT top the list of 5G-Advanced priority use cases for operators (Figure 12).

Figure 12

Priority use cases for 5G-Advanced

Which 5G-Advanced use cases and applications are most important to your network transformation priorities? (Percentage of operators, top two choices)



N = 100
Source: GSMA Intelligence Operators in Focus: Network Transformation Survey 2023

In China, operators are already trialling these capabilities to prepare for commercialisation, as highlighted by the following examples:

- At the 2023 Asian Games held in Hangzhou, China Telecom demonstrated the capabilities of 5G-Advanced, including immersive viewing experiences and multiple simultaneous 8K-video live broadcasts and streaming, in collaboration with ZTE.
- In December 2023, China Unicom and Huawei started deploying a commercial 5G-Advanced flexible production line, featuring ultra-reliability and ultra-low latency, at a subsidiary of Great Wall Motor (GWM) located in Baoding, Hebei.
- In September 2023, China Mobile Hong Kong completed 5G-Advanced network testing and verification in a laboratory environment in Hong Kong, recording a peak download speed of nearly 12 Gbps.
- In March 2023, Chunghwa Telecom and Ericsson signed a memorandum of understanding to align their efforts around 5G-Advanced and 6G, with a particular focus on bringing more energy-efficient networks to the private wireless market.

5G RedCap to support IoT use cases

3GPP Release 17 introduced the RedCap user equipment category for energy- and cost-efficient 5G IoT connectivity. Whereas 5G enhanced mobile broadband (eMBB) devices can deliver gigabits per second throughput in both the downlink and uplink using optimised spectrum holdings, RedCap devices efficiently support 150 Mbps and 50 Mbps in the downlink and uplink, respectively. The reduced complexity of RedCap devices contributes to cost efficiency, a smaller device footprint and a longer battery life due to lower power consumption.

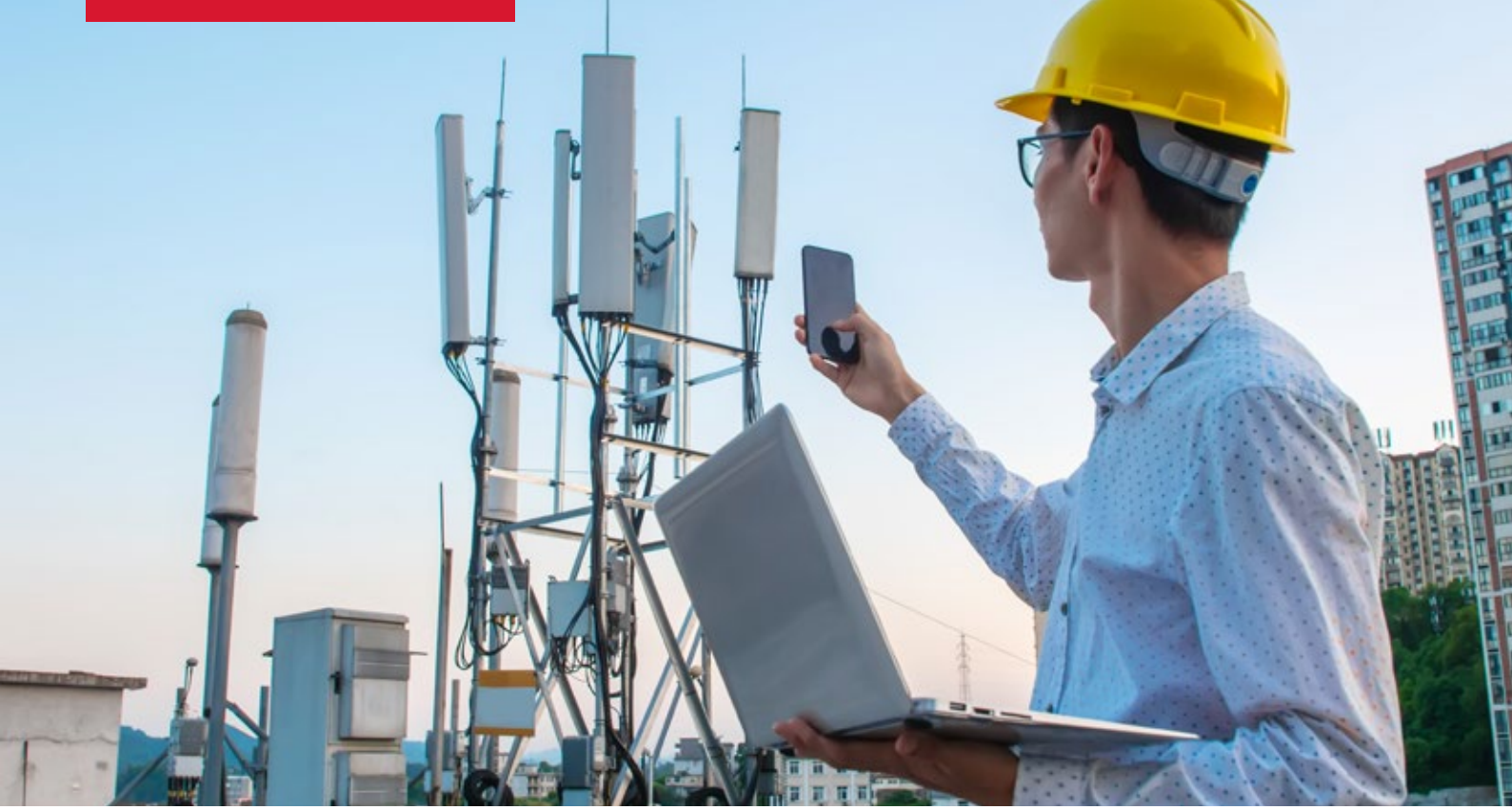
5G RedCap is an important enabler for mid-tier cellular IoT applications. It serves as a platform for the successful migration of IoT applications to 5G networks to take advantage of the benefits of 5G beyond just speed. A range of use cases will benefit from RedCap – notably, wearables, video monitoring and telematics. For example, most wearables support medium data rates in small form factors with relatively low power consumption, which is not achievable with eMBB or mMTC. Further, many video applications for surveillance do not require eMBB's high data rates and so can benefit from the lower power consumption achievable with 5G RedCap.

China has been at the centre of initial commercial deployments of RedCap. In November 2023, China Unicom partnered with State Grid Shandong and Huawei to launch a city-wide commercial 5G RedCap solution in Laiwu, Shandong Province, with the deployment of 3,220 RedCap power terminals. Huawei revealed in October 2023 that RedCap was now commercially available on the networks of China Mobile, China Telecom and China Unicom, spanning more than 10 cities, including Shanghai, Hangzhou, Ningbo, Shenzhen, Foshan, Ningde, Jinan and Suzhou.

Vendor activities are key to expanding 5G RedCap opportunities

With the increasing saturation of the smartphone market, much of the future growth in the device ecosystem will be driven by IoT applications. 5G RedCap will be crucial for this to materialise in the 5G era. To this end, device vendors and other OEMs have stepped up efforts to expand the 5G RedCap device ecosystem and tap into emerging growth opportunities:

- Huawei has forged partnerships with various Chinese IoT solution specialists and device manufacturers, such as Aumiwalker, Hangzhou For-X, Hongdian and Lierda, to showcase an initial set of RedCap products. This includes IoT modules, data transmission units and CPE. Huawei estimates that more than 50 industry-specific devices were launched by the end of 2023.
- MediaTek has launched the new M60 modem, which reduces power consumption by up to 70% compared to existing 5G eMBB solutions, and the MediaTek T300 chipset series. This will make it easy for MediaTek to facilitate the transition to 5G-NR with 5G RedCap for a range of applications, such as wearables, lightweight AR devices, IoT modules and devices built with edge AI in mind. The MediaTek T300 series devices will be piloted in the first half of 2024.



2.2

Network APIs: Chinese operators unite behind ecosystem efforts

Although it has been possible to expose network APIs for some time, operators have struggled to adopt a standardised approach that achieves scale. However, recent initiatives by the mobile industry have sought to bring fresh momentum behind developing a common set of network APIs. This began when Telefónica officially launched CAMARA (Telco Global API Alliance) at MWC Barcelona 2022 in collaboration with the Linux Foundation, other operators and hyperscalers. It was then extended with the launch of the GSMA's Open Gateway initiative at MWC Barcelona 2023.

China Mobile, China Telecom and China Unicom joined the GSMA Open Gateway initiative ahead of MWC Shanghai 2023. This demonstrated the commitment of Chinese operators to collaborate on the open network API framework. It also brings added scale and expertise to the initiative. China is the largest 5G market in the world and at the forefront of digital innovation. As 5G brings key API capabilities, China's established expertise in 5G will help unlock further value, which will flow through to the global economy and strengthen future investment in digital services.

By the end of February 2024, 47 operator groups had signed up to the GSMA Open Gateway initiative, representing 239 mobile networks and accounting for 65% of mobile connections globally. The initiative is focussed on commercialising eight network APIs (see Figure 13), with plans to launch further APIs throughout 2024.

Figure 13

GSMA Open Gateway APIs

API name	Description	Example use case
Carrier Billing – Check Out	Allows an online merchant to enable the purchase of third-party digital goods by requesting payment against the user's operator carrier billing system	Mobile payments across media, gaming, mobile services, ticketing, content and other digital services
Device Location	Allows an application to check if a mobile device is in proximity of a given location	Asset tracking; fraud prevention (banking, payments); retail marketing; traffic management of drones
Device Status	Checks the connectivity status of user equipment. In its current version, this API only checks the roaming status of a device.	Fraud prevention (banking, payments); regulatory compliance; service delivery (e.g. a content provider may need to enforce territory restrictions of their content)
Number Verification	Enables the authentication of a mobile device by the mobile network	App login; app onboarding; application password reset
One-Time Password SMS	Delivers a short-lived one-time password to a mobile phone number via SMS	Account management (e.g. password reset); high-value transactions; onboarding for digital services (e.g. banking, social media)
Quality on Demand	Allows an application developer to request stable latency or throughput for specified application data flows between application clients and application servers	Real-time media and entertainment (e.g. online gamers require a guaranteed level of quality to ensure a good user experience); remote control of machine and vehicles (e.g. automated guided vehicles require stable data throughput and low latency)
Simple Edge Discovery	Allows an application to discover the nearest edge-cloud node to connect to (may be telco edge cloud or hyperscaler edge cloud, whichever is required)	All edge cloud use cases (e.g. automotive, mixed/augmented reality, high-resolution video streaming, cloud gaming, remote control of moving objects or vehicles)
SIM Swap	Checks the last time that the SIM card associated with a mobile number has changed	Fraud prevention in banking; fraud prevention for password reset

Source: GSMA

APIs can unlock new monetisation opportunities

The business logic for exposing network capabilities via APIs is straightforward: by allowing developers to tap into network capabilities without directly engaging the operator, developers can innovate more easily and quickly, delivering use cases with more value than undifferentiated connectivity.

Operators view network API exposure as crucial to maximising returns on their 5G network investments, enabling them to generate higher returns compared to the traditional approach of selling standard connectivity services. This shift empowers operators to harness the full potential of new capabilities built into 5G networks.

Research shows that 5G consumers are willing to pay a premium for differentiated connectivity.[5] Using techniques such as network slicing or providing quality-on-demand (QoD) APIs, operators can introduce quality-of-service (QoS) based offerings. Examples of operators introducing QoS-based offerings include 5G Stock Pro from 3 Hong Kong, which allocates more network resources and prioritised network usage to enhance the experience of a stock trading application, and China Unicom's Super Live Streaming service plans, which provide streamers with uplink prioritisation capabilities.

China Unicom builds custom plans for livestreamers

China has the world's largest livestreaming market, with CNY3.5 trillion ($500 billion) worth of goods sold via livestreaming on apps such as Douyin, the Chinese version of TikTok, and Kuaishou, another short-video platform.[6] This surge in livestream shopping underscores the need for high-quality connectivity, as streamers need clear imaging with no lag to effectively sell their products to those watching, requiring high uplink bandwidth to guarantee the user experience.

Recognising this imperative, China Unicom has launched its Super Live Streaming service plans. The plans include three different package sizes and upstream rates, which provide uplink speeds four times faster than general 5G packages. The service plans, which are more expensive than general 5G packages, surpassed 500,000 subscribers in October 2023,[7] demonstrating that customers are willing to pay extra for a premium 5G experience. The service also helps illustrate how 5G can support the development of the digital economy and reduce the digital divide. For example, China Unicom's 5G livestream packages have helped farmers promote and sell agricultural products.

Network API exposure will be a key theme in 2024. The next 12 months will bring more operator commitments and further market launches. However, with 80% of operators claiming to have exposed network APIs on a commercial basis,[8] concrete examples of how federation and agreement on common APIs can drive success will be key to spur usage. This will require operators to focus on the developer experience, dedicating internal resources to work directly with developers while building partnerships with API aggregators who can help operators reach a broader set of developers.

5. "5G Value: Turning performance into loyalty", Ericsson, October 2023
6. "2022 Live Streaming E-Commerce White Paper Officially Released", Beijing Business Daily, December 2022
7. "How China Unicom are addressing the issue of 5G monetisation", Total Telecom, November 2023
8. Network Transformation 2023, GSMA Intelligence, 2023

2.3
Digital consumer: 5G new calling unlocks new opportunities

For many years, voice calling was the primary use case of cellular networks and instrumental to the rapid adoption of mobile devices. However, with 4G making mobile broadband available, several alternative voice services emerged, either as standalone applications (e.g. Skype, Viber), extensions of messaging services (e.g. WhatsApp, WeChat) or as part of social media platforms (e.g. Meta, X).

In response, operators upgraded their voice services using voice over LTE (VoLTE), which offers incremental advantages over traditional circuit-switched voice. However, operators are still struggling to reverse the decline of cellular voice services. The new capabilities introduced by 5G networks offer another opportunity for operators to further enhance voice calling with innovative features.

Introducing 5G new calling

According to the GSMA Intelligence Consumers in Focus Survey 2023, two thirds of people in China who have already upgraded or intend to upgrade to 5G find enhanced video calling a very or extremely appealing 5G use case. Operators are looking to tap into this interest by developing new voice and video calling services.

5G new calling (5GNC) leverages the capabilities of 5G networks and IP multimedia subsystem (IMS) to bring intelligent and interactive capabilities to voice and video calls. With 5GNC, consumers will be able to enjoy the benefits of carrier-grade communication services that are at least at functional parity with equivalent services offered by OTT players. The services will work out-of-the-box, without the need to install and update applications.

5GNC will also provide enterprises with new ways to reach customers. Enterprises can work with operators to create bespoke mini-apps,[9] which take advantage of operators' quality of service, security, global reach and other capabilities. The control of the connectivity, as well as the hosting of the application servers that realise the advanced service logic, will ensure operators maintain a strong presence in the value chain.[10]

9. The new calling mini-app is an application stored on the operator's network which is invoked during a call to provide additional features to the user. Unlike the regular apps consumers are familiar with today, new calling mini-apps do not require pre-installation. They can be developed by operators, device manufacturers and third party developers, forming an open ecosystem for 5GNC.
10. For more information on 5G new calling, see 5G New Calling: Revolutionising the Communications Services Landscape, GSMA, 2023
11. "Xiaomi Civi 4 smartphone to support satellite communication", Technode, February 2024

Figure 14

5G new calling use cases

Use case	Explanation
Smart translation	Smart translation enables a user to enjoy effective video communication with a contact who speaks a different language or is hearing impaired.
Augmented reality (AR) calling	AR calling enables the user to include a virtual background, stickers and an avatar in a video call.
Content sharing	Users can send each other photos, share their location, send files and business cards, and share screens. This requires both users to have devices that support the IMS data channel (DC).
Social gaming	Users can play social games during two-person or multiplayer calls. This requires both users to have devices that support the IMS DC.
Mixed reality (MR) based immersive calling	Users can create their own digital twin or avatar in a mixed reality space, where multiple users can communicate and interact. During an MR-based immersive call, facial movement and body gestures can be tracked and portrayed digitally, synchronised with voices.
Enterprise caller ID	Enterprise caller ID provides a way for enterprises to identify themselves when calling users. This use case allows employees (e.g. customer-service staff) to create exclusive and verified business cards that are displayed when they make calls.
Smart customer service	When a consumer dials a specific customer-service number on their IMS DC device, they will automatically enter the smart customer service mini-app corresponding to the number. Users can choose different services within the customised menu or they can connect to an employee and perform the corresponding operations.

Source: GSMA

Making 5GNC a reality

The launch of 5GNC will take place in two phases. In the first phase, operators will need to upgrade their core networks to enable enhanced media processing capabilities. The first phase of 5GNC is compatible with existing devices in the market. In the second phase, further network upgrades will need to occur in parallel with device upgrades to harness the IMS DC and enable real-time data interaction between the cloud and the user, as well as between two users.

China Mobile is at the forefront of introducing 5GNC services to the market. The operator is piloting and verifying smart translation and AR calling in several provinces of China. It is also in the process of implementing the second phase of 5GNC. It has successfully tested the IMS DC-based 5GNC smart translation mini-app, which indicates that the second phase of 5GNC is ready to operate in a live network environment.

To construct a robust new calling ecosystem, industry organisations, operators, equipment suppliers, terminal and chip vendors, and content producers need to make a concerted effort – in China and globally. There are indications that this is taking place. In October 2023, China Mobile and Huawei opened a New Calling Innovation Center to help develop new use cases and an ecosystem of partners for 5GNC.

Other Chinese operators and vendors are also involved in developing the 5GNC ecosystem. For example, China Mobile, China Telecom, China Unicom, Hisense, Huawei, iFlytek, MediaTek, Oppo, Unisoc, Vivo, Xiaomi and ZTE participated in the launch of the 5G New Calling Industry Initiative during MWC Barcelona 2023. Furthermore, momentum behind 5GNC is building outside China. AIS Thailand, STC Bahrain, STC Kuwait and Zain Kuwait are among operators that have either conducted or are close to implementing a proof of concept (PoC) and trial. While 5GNC is still in its early stages, signs that companies across the ecosystem are working in tandem are a positive step towards scaling the service.

2.4
Satellite: new players join the race to develop aerial connectivity solutions

Telecoms networks remain the primary form of connectivity, supported by the wide area coverage of wireless networks and the mass production and adoption of mobile devices. However, in recent years, technological advances in satellite and other non-terrestrial networks (NTNs), such as unmanned aerial vehicles (UAVs), have helped overcome several limitations associated with aerial connectivity. This has resulted in significant performance improvements, lower deployment costs and more commercially viable business models for satellite and NTN-based connectivity solutions.

Low Earth orbit (LEO) satellite and high-altitude platform station (HAPS) providers have attracted much attention on the back of significant investments and technical breakthroughs that improve the business case for delivering connectivity at scale. A key selling point for aerial connectivity solutions is the potential to provide ubiquitous coverage around the world. Telecoms networks now cover more than 95% of the world's population but less than 45% of the world's landmass. Satellites and NTNs are well-suited to deliver connectivity in maritime, remote and polar areas where deploying conventional terrestrial networks could be costly and challenging.

3GPP has laid the foundation for satellite-based connectivity through standardisation to extend the reach of 5G to regions lacking terrestrial infrastructure. Four broad use cases have been identified:

- **service continuity** – coverage where it is not feasible with terrestrial networks, such as in maritime or remote areas
- **service ubiquity** – mission-critical communications, such as for disaster relief during terrestrial network outages
- **service scalability** – offloading traffic from terrestrial to NTNs for better system efficiency
- **backhaul services** – transport for sites with weak or no backhaul capacity.

Chinese entities unveil ambitious plans for satellite connectivity

China has a clear strategic interest in satellite capacity, and has the advantage of scale and speed in an increasingly competitive global satellite market. In November 2023, the China Aerospace Science and Technology Corporation (CASC) announced the completion of its first high-orbit satellite communication network to provide coverage across the entire expanse of China and vital regions within the participating countries of the Belt and Road Initiative. The government expects the total capacity of China's high-orbit satellites to exceed 500 Gbps by the end of the 14th Five-Year Plan period (2021–2025), providing internet connectivity in areas such as aviation, navigation, emergency response, energy and forestry.

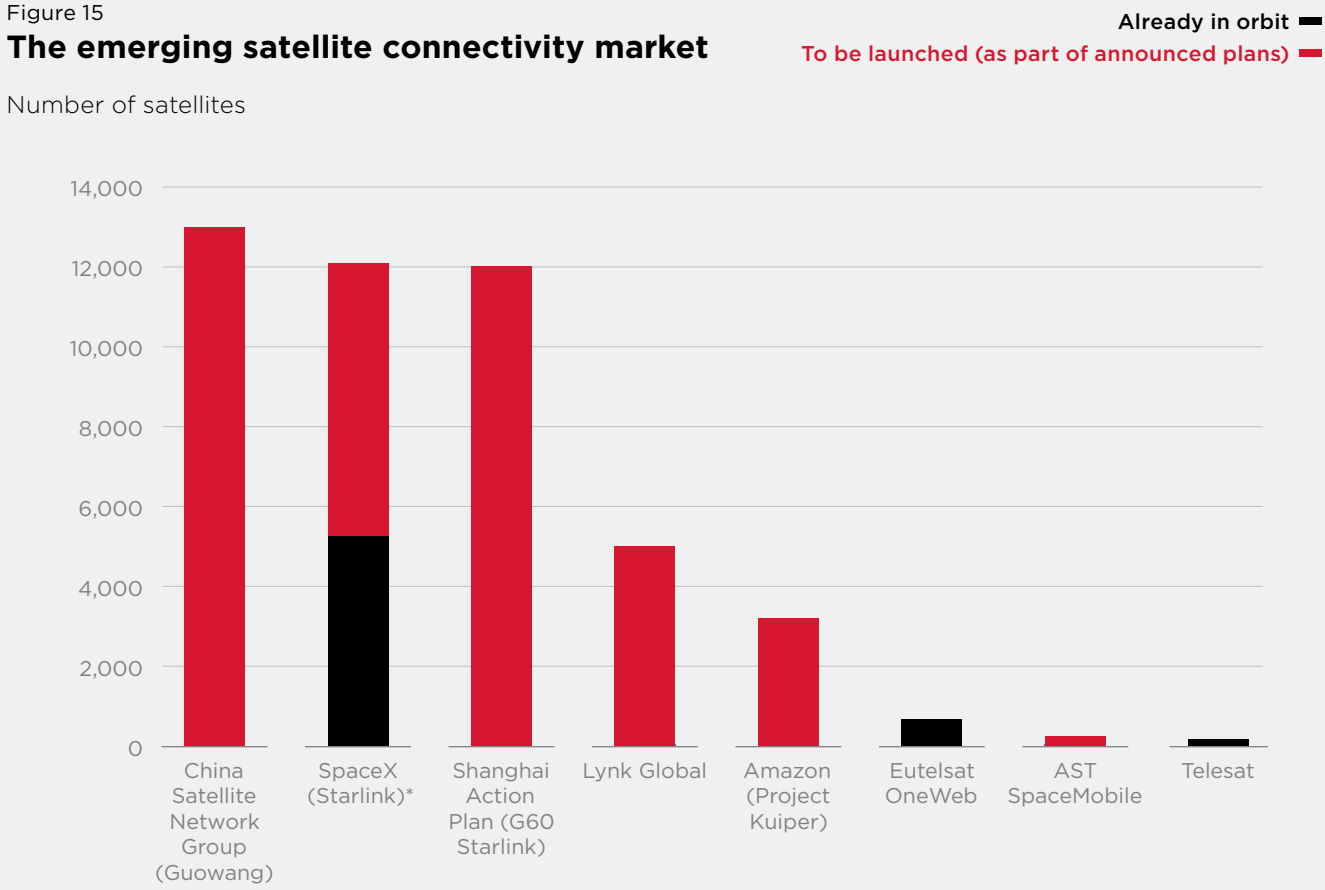
Chinese entities are also active in the LEO space and could directly compete with US and European counterparts in the fast growing market (see Figure 15). To date, several Chinese entities have announced plans to launch more than 26,000 LEO satellites for internet connectivity in the coming years. These include the China Satellite Network Group, which plans to launch around 13,000 satellites, and a Shanghai government initiative known as G60 Starlink, which envisions more than 12,000 satellites in orbit once complete. In December 2023, CASC confirmed the launch of three LEO broadband test satellites, with more launches expected in 2024.

The availability of compatible devices will contribute to the take-up of end-user satellite-enabled services. Chinese vendors are at the forefront of efforts to bring satellite capability to the regular smartphone format. In August 2023, Huawei unveiled its Mate 60 Pro smartphone, which supports satellite calls on China Telecom's network. In January 2024, Oppo and Honor both disclosed they will offer new smartphone models capable of satellite calls. It has also been reported that Xiaomi's Mix Flip has received Ministry of Industry and Information Technology (MIIT) certification for satellite connectivity.[11]

12. "China's AI 'war of a hundred models' heads for a shakeout", Reuters, September 2023

Figure 15

The emerging satellite connectivity market



* SpaceX has indicated it may expand beyond 12,000 originally planned satellites to as many as 42,000 in a mega-constellation.
Note: data correct to February 2024
Source: GSMA Intelligence

Telecoms and satellites: a new era for partnerships

Advances in satellite technologies have heralded new partnerships between telecoms operators and satellite providers in ways that could reshape the connectivity landscape. A number of partnerships have been announced in the last two years, spanning several continents and use cases, including rural coverage and disaster relief. In November 2023, Chunghwa Telecom signed an exclusive distribution partner agreement for LEO satellite services with Eutelsat OneWeb to deliver greater resiliency and to complement terrestrial network services for government and business customers.

For satellite providers, partnerships with telecoms operators are key to scaling their services, leveraging operators' existing relationships with end users and, in some cases, existing spectrum holdings. For telecoms operators, satellite connectivity offers access to new customers in underserved areas and the ability to provide connectivity for emergency services and existing customers where a terrestrial signal is not available. More of such partnerships are expected in 2024 as the value of collaboration becomes clearer and as more satellite capacity becomes available.

2.5
Generative AI: advances in AI underpin new services and devices

China's AI sector has rapidly advanced since companies gained permission in August 2023 to release their large language models (LLMs) to the general public. According to September 2023 data from brokerage CLSA, approximately 40% of global LLMs are developed in China, with Baidu's Ernie Bot gaining significant traction, amassing more than 100 million users by the end of 2023.[12] This is driving innovation across the tech ecosystem, with a wide range of companies exploring how to use the technology.

Much of the early work on generative AI (genAI) in the mobile industry has focused on using the technology to support internal use cases, such as improved customer care via enhanced chatbots and automated development of marketing collateral. Chinese operators have also demonstrated their interest in using genAI for network operations and management. For example, China Telecom is building its own AI-based system to identify the root cause of network faults. Meanwhile, China Mobile has discussed the potential to make AI native to its 6G networks.[13]

13. "China telcos following their own path to AI", Light Reading, September 2023
14. "China Mobile unveils 'Jiutian' generative AI model, achieving self-reliance in key technologies", Global Times, October 2023

Chinese operators are not only looking to use AI to support internal use cases but also to help generate new revenues. China Mobile, China Telecom and China Unicom have each made announcements in recent months that indicate their progress in developing AI models and services that can be sold to enterprises. Key announcements included the following:

- **China Mobile** launched its Jiutian AI model in October 2023. The model was trained on more than 2 trillion tokens and has professional knowledge in eight industries including telecoms, energy, steel and transport. China Ocean Shipping Company and China Railway Construction Company are reportedly among the first customers.[14]
- **China Telecom** released its Xingchen LLM in November 2023. It focuses on supporting government and public services, with application scenarios such as corporate business analysis, government affairs and official document writing. In January 2024, the operator announced it had made Xingchen open source to increase transparency and facilitate broader collaboration.
- **China Unicom** released its Honghu Graphic Model 1.0 at MWC Shanghai 2023. The AI model is available in two versions: one with 800 million training parameters and another with 2 billion training parameters. These versions enable functionality such as generating images from text, video editing and generating images from other images.

The size of the AI opportunity is also driving companies to set up dedicated subsidiaries. For example, China Telecom has established an AI subsidiary, China Telecom AI Co., backed by RMB3 billion ($557 million) in investment from the operator. The subsidiary's scope will include AI software development, hardware sales and solutions. The rationale behind such moves is often to accelerate internal decision-making and make it easier to attract external investment.

The GSMA and IBM collaborate to accelerate AI for the industry

The GSMA and IBM have announced a new collaboration to facilitate and accelerate the adoption of genAI and the development of AI skills in the telecoms industry. Two initiatives are being launched: GSMA Advance's AI Training programme and the GSMA Foundry Generative AI challenge and programme.

Research from GSMA Intelligence shows that while 56% of operators are trialling genAI solutions, commercial deployment is less prevalent among mid-sized and smaller operators. Democratising AI is critical to ensure all players in the industry and their customers can reap the benefits. To achieve that, the new initiatives launched by the GSMA and IBM in partnership aim to provide the industry with access to AI tools and knowledge, alongside the necessary skills and training.

The initiatives should help provide scale, allowing operators and industry players of all sizes and in all regions to navigate the fast-evolving landscape of AI technologies and associated opportunities. This includes investigating the use of genAI in various functional areas of a telecoms provider and exploring innovative use cases across vertical sectors.

15. Digital consumer: five trends to watch in 2024, GSMA Intelligence, 2023

Making devices smarter with AI

Smartphones, as the most ubiquitous personal consumer devices, were always going to be a prime focus for genAI commercialisation. Recent technology advances in mobile chipsets, cloud computing and breakthroughs in smaller LLMs have made genAI on smartphones possible. For example, the Samsung Galaxy S24 features Qualcomm's new AI-optimised flagship chip – the Snapdragon 8 Gen 3 – and Gemini Nano on-device.

The integration of genAI on smartphones will help hyper-personalise the user experience, enhance the OS feature set and evolve native digital assistants. On the app side, genAI is expected to help introduce a plethora of new functionality in mobile apps across verticals, such as text-to-digital content generation. Existing mobile apps should also see advanced AI-enabled improvements in functionality, such as text-analysis apps.[15]

GenAI solutions will be integrated into other consumer devices. At MWC Shanghai 2023, for example, ZTE showcased new devices, including its Nubia Neo Air (a set of lightweight refractive AR glasses), which uses genAI to provide real-time visual aids to wearers. Meanwhile, Huawei has recently unveiled XiaoYi, its AI assistant supported by Cloud Pangu models. This advanced assistant features multimodal functions and is seamlessly integrated into its product range, spanning phones, laptops and potentially smart cars.[16] Other Chinese companies such as Xiaomi, Oppo and Vivo have begun to integrate genAI into their latest devices, responding to intense competition in the consumer devices market.

Organisations must consider how to ethically design, develop and deploy AI systems

Despite the potential to reap significant benefits from the application of advanced AI in business and society, there are valid ethical concerns around the technology that still need to be addressed.

The mobile industry is committed to the ethical use of AI in its operations and interactions to protect customers and employees, remove any entrenched inequality and ensure AI operates reliably and fairly for all stakeholders. The GSMA's AI Ethics Playbook serves as a practical tool to help organisations consider how to ethically design, develop and deploy AI systems.[17]

16. "Chinese Smartphone Makers Aim To Beat Apple And Samsung In Generative AI", Forbes, November 2023
17. The Mobile Industry Ethics Playbook, GSMA, 2022
18. "MOE renews agreements on digital education with big telecom companies", Ministry of Education, February 2023

03

Mobile industry impact

3.1
The mobile industry's impact on the SDGs

In 2022, the Chinese mobile industry accelerated its impact on the Sustainable Development Goals (SDGs). SDG 6 (Clean Water & Sanitation) and SDG 4 (Quality Education) scored highest in the region, driven by rising mobile internet adoption and use, as well as the growing uptake of IoT solutions.

Figure 16

Mobile's impact on the SDGs in China

Source: GSMA Intelligence

5G drives innovation in water management

SDG 6 focuses on ensuring the availability and sustainable management of water and sanitation for all. Mobile technology improves many aspects of water delivery and sanitation provision. Effective metering and revenue collection are central to a healthy, functioning water utility. At the same time, IoT solutions such as smart water meters are helping utility providers and their customers understand consumption behaviours to drive efficiencies in the energy and water sectors.

The mobile industry in China is driving deployment of smart solutions leveraging 5G IoT. China Mobile, for instance, has made increasing efforts in the water industry aimed at digital transformation, including sewage treatment, smart metering and smart video surveillance of water areas.

China Mobile's 5G-powered smart management system enhances sewage treatment

In collaboration with the industrial park of Zhengpugang New District, Ma'anshan City, China Mobile has established an "environmental protection map" for construction sites. This is an intelligent decision-making management system based on a two-dimensional map and satellite map data of the new district.

The smart system conducts full monitoring of atmosphere, water, soil, solid waste and noise using the 5G network. Through the system's real-time monitoring module for illegal sewage discharge by enterprises, data is collected and displayed in the form of a line chart. Where there are abnormal events, the system automatically informs relevant staff in real time through telephone, text message and WeChat, in a bid to ensure sewage discharge is treated as soon as possible.

Operators aim to advance digital education and the use of clean energy

SDG 4 seeks to ensure inclusive and equitable quality education and to promote lifelong learning opportunities for all. SDG 4 is the most improved SDG in China since 2015. Mobile operators have played a crucial role in developing the digital infrastructure required to access online educational resources.

They have also contributed to the development of digital tools in education. For example, in early 2023, the Ministry of Education in China renewed strategic cooperation agreements with China Mobile, China Telecom and China Unicom. The Ministry of Education and the three companies will deepen strategic cooperation in building a smart education platform, promote digital management in education, improve teachers' and students' digital literacy and skills, and push ahead with reform in education evaluation, among other activities.[18]

SDG 7 aims to ensure access to affordable, reliable, sustainable and modern energy for all. The mobile industry continues to make progress on using clean energy and reducing carbon emissions. One of the key challenges to overcome in decarbonising the mobile sector is access to renewable electricity. Operators in China are increasingly switching to renewable electricity sources and exploring green networks to fight climate-change issues.

Chinese operators showcase energy-saving initiatives

Under the guidance of China's 2030 carbon peak and 2060 carbon neutrality goals, China Telecom has proposed its own "dual carbon strategy". It aims to reduce costs and increase efficiency to drive new revenue growth, while helping enterprise customers accelerate their green transformation.

The operator's strategy has yielded positive results. China Telecom's co-construction and sharing of 5G base stations reduces carbon emissions by more than 10 million tonnes each year, while its AI energy-saving platform reduces energy consumption by more than 15%. Meanwhile, its recent pilot solution that integrates site solar access and photovoltaic energy storage reduces electricity costs by more than 40%.[19]

Other Chinese operators have also implemented energy-saving solutions. For example, China Unicom has collaborated with Intel to make full use of the Intel Intelligent Energy Management solution to further drive energy conservation and emissions reduction at data centres. Tests have shown that the solution saves 28% more energy than a baseline configuration not using the Intel Intelligent Energy Management solution.[20]

19. "China Telecom's Chief Expert Explains How Low-, Mid-, and High-Band Coordinated Networking Enables an Ultimate 5G Experience", Mobile World Live, June 2023
20. "China Unicom Drives Data Center Energy Savings and Emissions with Intel Intelligent Energy management Solution", Intel, April 2023
21. NRM refers to the sustainable use and management of the planet's natural resources, such as land, water, air and forests, and a diversity of plant and animal species.

3.2
Managing natural resources with 5G connectivity

The combination of mobile devices, satellites, IoT and AI offers significant potential to develop innovative solutions that support the sustainable use of natural resources. The use of mobile technologies in natural resource management (NRM)[21] is still nascent but has grown steadily in areas such as forest management, wildlife conservation and sustainable food production.

In China, 5G connectivity is helping to build smart agricultural solutions and supporting environmental protection initiatives. The solutions are enhancing agricultural productivity by minimising wastage and efficiently using resources such as water and seeds. At the same time, 5G connectivity is helping national parks with ecological monitoring and wildlife protection.

Using 5G for resource management: examples from China Mobile and ZTE

- **5G to power smart tea plantation.** China Mobile and ZTE have developed a 5G-enabled farm management solution designed to use water, fertiliser, fuel and seeds as efficiently as possible while lowering labour costs. The solution brings together a smart irrigation system, the remote control of farm vehicles and 5G-connected drones that can monitor the health of crops. A worker located in the farmhouse can use the 5G connectivity to remotely control three to five machines simultaneously, significantly boosting productivity. The smart irrigation system uses 40% less water than conventional systems, and unmanned tractors are 50% more efficient than conventional tractors.
- **5G to safeguard heritage site.** In May 2023, ZTE collaborated with Sanjiangyuan National Park, China Mobile and China Tower to implement 5G coverage at the Zhuonai Lake Protection Station in Kekexili – China's highest-altitude World Natural Heritage site, known for its rich wildlife. This connects Kekexili to the world through 5G and heralds a new era in animal protection and ecological monitoring. The 5G network helps to preserve Kekexili's precious ecosystem, enabling future environmental protection efforts, scientific expeditions and smart park management. The connectivity will greatly improve scientific management efficiency in national parks and establish a more comprehensive mechanism for wildlife protection and research.

04

Mobile industry enablers

Securing the future for 5G's evolution

5G continues to gather momentum as its reach and depth expand globally. While previous years have focused on initial deployments and infrastructure builds, 2024 will mark an important milestone as 3GPP R18 (5G-Advanced) is to freeze by the end of Q1 2024. This will usher in a deeper exploration of 5G's full potential, unlocking transformative applications across industries, driven by trends such as the rise of private networks and the wider adoption of 5G SA. This new era will also be spurred by AI, wider spectrum support, greater uplink performance, improved reduced capability (RedCap) and enhanced energy efficiency.

None of this will be possible without a constantly evolving spectrum strategy. 2024 marks the dawn of an important period that will shape 5G's evolution, as the industry turns the results of the ITU's World Radiocommunication Conference 2023 (WRC-23) into reality. WRC-23 has opened the door to connectivity for all services, and laid the foundation for progress to 5G-Advanced and 6G.

One of the significant outcomes of WRC-23, especially for China and Asia Pacific, was the identification of additional mid-band spectrum to meet growing demand for mobile data. The 6 GHz band (6.425–7.125 GHz) was identified for mobile use by countries in every ITU Region – EMEA, the Americas and Asia Pacific. This band, supported by countries representing more than 60% of the world's population, is now harmonised for expanding mobile capacity for 5G-Advanced and future technologies.

This is an important achievement for Asia Pacific. Despite the possibility of a reduced scope of only 7.025–7.125 GHz in the preparation leading up to WRC-23, forward-looking countries and industry in the region, including China, went above and beyond to secure an identification for parts of Asia Pacific, laying the foundation for the 6 GHz ecosystem to take off and the rest of the region to join this new global spectrum band.

The decisions made at WRC-23 serve as a catalyst for delivering mobile connectivity to more people, closing the usage gap and ensuring sustainability, affordability and global inclusivity. In addition to the 6 GHz band, the WRC-23 results have provided a clear roadmap for planning in the low bands below 1 GHz and in the 3.5 GHz band (3.3–3.8 GHz). Final harmonisation of the 3.5 GHz band, recognised as the pioneer 5G band, was achieved across Europe, the Middle East and Africa (EMEA) and the Americas. In the low bands, WRC-23 took a step towards greater digital equality by defining the use of more spectrum for mobile in the 470–694 MHz band in EMEA.

In 2022, the GSMA published research into the ecosystem outlook and economic cost-benefit analysis for the 6 GHz band. Encouraging results from those studies helped the mobile industry advocate for the band for the future of IMT. Nearly two years on, progress has been made, including at WRC-23. We are now in a new phase of development that kickstarts the journey towards commercialisation:

- Trials have been carried out across different regions using the 6 GHz band, showing that advanced 5G technologies can achieve coverage comparable to what is achievable today in the 3.5 GHz band.
- China became the first country in the world to identify the 6 GHz band to IMT in its national legislation in June 2023, well before the conclusion of WRC-23. This move sets a bright future for the 6 GHz IMT ecosystem.

As we look forward to further progress in 2024, it is imperative that the industry engages closely with regulators and policymakers to implement the new spectrum bands in their national legislations in a timely manner to support spectrum harmonisation and avoid interference issues. For China, the stage is set to galvanise the mobile ecosystem around the 6 GHz band, boosting 5G-Advanced and helping realise the full potential of future technological improvements.

> 2024 marks the dawn of an important period that will shape 5G's evolution

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