HUAWEI

PUBLIC CONSULTATION PAPER
WIRELESS LOCAL AREA NETWORK (WLAN)
IN THE 6 GHz FREQUENCY BAND

APPENDIX 3

[3] GSMA, “The Mobile Economy Report 2020”

The Mobile Economy 2020

The GSMA represents the interests of mobile operators worldwide, uniting more than 750 operators with almost 400 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and internet companies, as well as organisations in adjacent industry sectors. The GSMA also produces the industry-leading MWC events held annually in **Barcelona**, **Los Angeles** and **Shanghai**, as well as the **Mobile 360 Series** of regional conferences.

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GSMA
Intelligence

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.

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Contents

Executive Summary

5G learnings one year on

2019 was a pivotal year for 5G, as operators and enterprises began to stake their claim in the technology and consumers started to realise the benefits of the latest mobile generation:

- **Operators:** Operators are increasingly seeking ways to grow revenue and cut costs in a low-growth environment, which is made more complicated by the demanding requirements of 5G services (i.e. high speed, low latency and ultra-reliability). Operators therefore need to evolve their networks (using innovations such as virtual RAN, edge networking and network automation) to meet the demands of the 5G era. They will also need to diversify their revenue streams (into areas such as pay TV, media/entertainment, advertising and IoT) to seek growth beyond core telecoms services.
- **Enterprises:** While speed gains are a well-recognised benefit of 5G, other improvements (e.g. network slicing, edge computing and low-latency services) are not widely appreciated, with many companies believing that 4G remains 'good enough'. Most of the key benefits for enterprises won't come until standalone 5G is deployed. The challenge, therefore, is to lay the foundations now and start the conversations about what problems 5G can solve in the future. As this is a highly competitive area given the presence of Amazon, Microsoft, Google and other cloud companies, speed to market is an important factor.
- **Consumers:** Awareness and knowledge of 5G are both rising as hype makes way for reality. However, there is wide variation across the globe in terms of intentions to upgrade to 5G and the willingness to pay more for it. In general, consumers in South Korea, China and the Middle East tend to be the most willing to upgrade to 5G, while those in the US, Europe and Japan seem satisfied using 4G for the time being. 5G is still in its infancy though; as more tangible use cases are deployed, more consumers will appreciate the benefits of 5G.

4G rules, but 5G is ramping up

In 2019, 4G became the dominant mobile technology across the world with over 4 billion connections, accounting for 52% of total connections (excluding licensed cellular IoT). 4G connections will continue to grow for the next few years, peaking at just under 60% of global connections by 2023.

Meanwhile, 5G is gaining pace: it is now live in 24 markets; numerous 5G smartphones have been launched; and 5G awareness and the intention to upgrade among consumers are both on the rise. By 2025, 5G will account for 20% of global connections, with take-up particularly strong across developed Asia, North America and Europe. To support this generational shift and further drive consumer engagement, operators are expected to invest around $1.1 trillion worldwide between 2020 and 2025 in mobile capex, roughly 80% of which will be in 5G networks.

IoT will be an integral part of the 5G era. Between 2019 and 2025, the number of global IoT connections will more than double to almost 25 billion, while global IoT revenue will more than triple to $1.1 trillion. The smart home is a critical battleground, with fragmentation being a major challenge to integration and adoption. There are, however, early signs that smart speakers could be at the centre of a smart home revolution in 2020.

Despite some financial headwinds, the outlook for global mobile revenue remains stable. Following a stabilisation of pricing trends, particularly in Europe and India, and continued strong data growth in emerging markets, total mobile revenues reached $1.03 trillion in 2019. Revenue will rise steadily at around 1% per year out to 2025, largely because of growing revenues in enterprise IoT segments and new 5G services.

Growth is becoming harder to see, but it's still there

By the end of 2019, 5.2 billion people subscribed to mobile services, accounting for 67% of the global population. Adding new subscribers is increasingly difficult as markets become saturated and the economics of reaching rural populations become more difficult to justify in a challenging financial climate for mobile operators. Despite this, there will be around 600 million new subscribers by 2025 – mostly in India, China, Pakistan and Nigeria – for a total of 5.8 billion subscribers to mobile services (70% of the global population).

Mobile continues to make a significant contribution to the global economy. In 2019, mobile technologies and services generated $4.1 trillion of economic value added (4.7% of GDP) globally. This figure will approach $5 trillion (4.9% of GDP) by 2024 as countries increasingly benefit from the improvements in productivity and efficiency brought about by increased take-up of mobile services. Further ahead, 5G technologies are expected to contribute $2.2 trillion to the global economy between 2024 and 2034. Key sectors such as manufacturing/utilities (particularly in China) and professional/financial services (especially in MENA and North America) will benefit the most from the new technology.

The benefits of mobile are reaching further than ever

The connectivity gap continues to close: almost 1 billion additional people have been covered by mobile broadband networks over the last five years. However, factors other than infrastructure are holding back the adoption of mobile internet, namely affordability, consumer readiness, and availability of locally relevant content and services. These barriers will slowly be overcome though, and by 2025 an additional 1.2 billion people will start using mobile internet for the first time, which will bring the total number of mobile internet subscribers globally to 5 billion (over 60% of the population).

With this growth in connectivity, individuals are increasingly using mobile to access an array of life-enhancing services that contribute to and catalyse the achievement of the UN Sustainable Development Goals (SDGs). In addition, the mobile industry is playing a key role in mitigating the catastrophic impacts of climate change, which threatens sustainable development everywhere. However, much more can be done to leverage the power of mobile and support the delivery of the SDG 2030 targets. This includes helping people realise the full benefits of accessing health information, public services and digital payments, and leveraging new technologies to reduce pollution, improve resilience to climate change and increase energy efficiency.

Policies remain essential for accelerating digital development

Mobile broadband generates vast benefits for society and the economy. However, the full potential of mobile technologies cannot be realised without the active participation of governments and regulatory authorities. They must work together with the private sector to enable vibrant, competitive markets and to help shape the digital environment citizens want. There are a number of key areas where forward-facing policies and regulations are particularly crucial:

1. **Network performance and reach:** Mobile connectivity requires continuous investment by operators to keep up with demand and provide the service consumers and businesses expect, whether through densification in cities or plugging coverage gaps in rural areas. Governments at all levels can take steps to facilitate network deployment and expansion: simplifying and standardising planning procedures and regulations for site acquisition, colocation and upgrades of base stations and small cells; offering a reasonable expectation of approval for voluntary network-sharing deals while avoiding mandated sharing agreements; and adopting policies that reduce costs for mobile operators while spurring investment.
2. **Spectrum policy for the 5G era:** Operators require access to sufficient radio spectrum in suitable frequencies, particularly in the sub-1 GHz coverage bands and prime 5G mid- and mmWave bands. With key spectrum (26 GHz and 40 GHz) secured for mobile at the 2019 World Radiocommunication Conference (WRC), a global ecosystem can now begin to develop equipment, devices and services that take advantage of these frequencies. However, governments and regulators should avoid inflating 5G spectrum prices (e.g. setting high auction reserve prices) or setting aside spectrum (e.g. for vertical industries) that has been identified for mobile.
3. **Capitalising on the 5G opportunity:** Governments and regulators must play their part to help propel 5G into commercial use by implementing policies that encourage advanced technologies (e.g. AI and IoT) to be applied across all economic sectors.
4. **Ensuring consumer trust:** Erosion of trust in digital services was a significant concern in 2019. As a result, governments around the world are implementing new or revised rules to ensure their citizens are protected when they engage with digital technologies. For data privacy laws to be successful, however, they must provide effective protection for individuals while allowing organisations the freedom to operate, innovate and comply in a way that makes sense for their businesses and secures positive outcomes for society.

To advance the mobile ecosystem and the digital economy overall, governments should strive, as much as possible, to lighten the regulatory load on the industry. When the business environment for mobile operators is less costly and more flexible, the performance and reach of mobile service expands, the pace of innovation increases and users' confidence in the digital ecosystem is strengthened.

Global Market

UNIQUE MOBILE SUBSCRIBERS

2019-2025 CAGR: 1.9%

2019: 5.2bn

2025: 5.8bn

Penetration Rate (% of population): 67% → 70%

MOBILE INTERNET USERS

2019-2025 CAGR: 4.6%

2019: 3.8bn

2025: 5.0bn

Penetration Rate (% of population): 49% → 61%

SIM CONNECTIONS

Excluding licensed cellular IoT

2019-2025 CAGR: 1.7%

2019: 8.0bn

2025: 8.8bn

Penetration Rate (% of population): 103% → 107%

OPERATOR REVENUES AND INVESTMENT

2019: $1.03tn

2025: $1.14tn

Operator capex of $1.1 trillion for the period 2020–2025 (78% on 5G)

INTERNET OF THINGS

2019

12.0bn

Total connections

2025

24.6bn

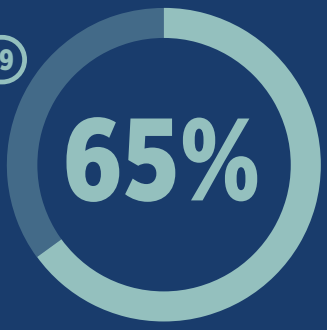
Total connections

SMARTPHONES

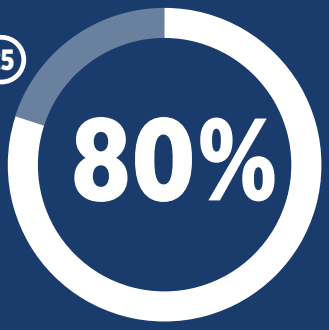
% of connections

Excluding licensed cellular IoT

2019



2025



4G

2019

2025

% of connections Excluding licensed cellular IoT

5G

2025

1.8bn connections

% of total connections

Excluding licensed cellular IoT

MOBILE INDUSTRY CONTRIBUTION TO GDP

2019

$4.1tn

of GDP

2024

$4.9tn

of GDP

PUBLIC FUNDING

2019

$490bn

Mobile ecosystem contribution to public funding

(before regulatory and spectrum fees)

EMPLOYMENT

2019

16m

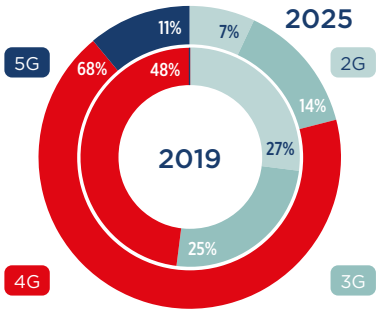
Jobs directly supported by the mobile ecosystem

+14m indirect jobs

Note: All data for **Asia Pacific** in this report excludes **China**, **Hong Kong**, **Macao** and **Taiwan** unless otherwise stated.

Asia Pacific

TECHNOLOGY MIX*



SUBSCRIBER PENETRATION

2019 — 2025

60% 65%

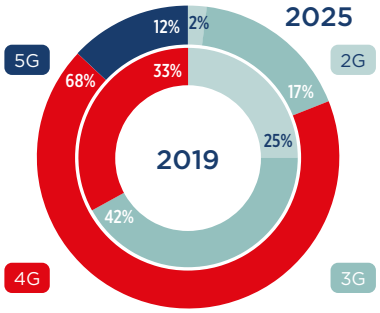
SMARTPHONE ADOPTION

2025

64% 81%

CIS

TECHNOLOGY MIX*



SUBSCRIBER PENETRATION

2019 — 2025

81% 82%

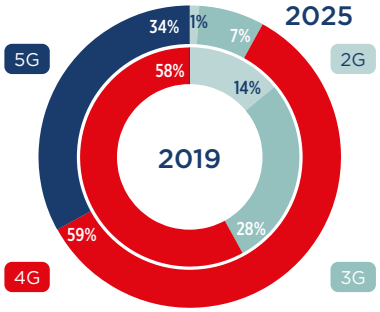
SMARTPHONE ADOPTION

2019 — 2025

62% 77%

Europe

TECHNOLOGY MIX*



SUBSCRIBER PENETRATION

2019 — 2025

86% 87%

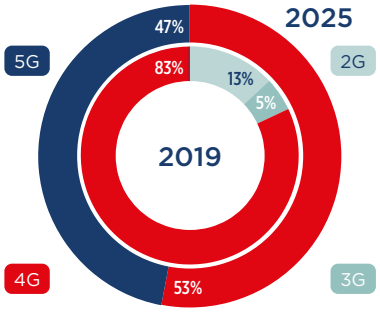
SMARTPHONE ADOPTION

2019 — 2025

76% 83%

Greater China

TECHNOLOGY MIX*



SUBSCRIBER PENETRATION

2019 — 2025

82% 85%

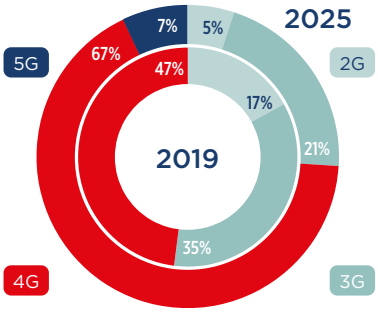
SMARTPHONE ADOPTION

2019 — 2025

72% 89%

Latin America

TECHNOLOGY MIX*



SUBSCRIBER PENETRATION

2019 — 2025

68% 73%

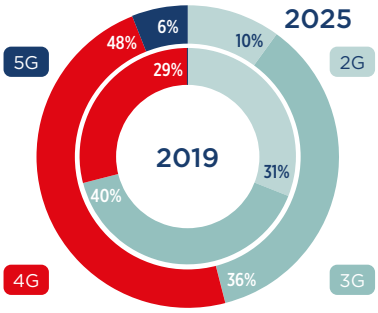
SMARTPHONE ADOPTION

2019 — 2025

69% 79%

MENA

TECHNOLOGY MIX*



SUBSCRIBER PENETRATION

2019 — 2025

64% 68%

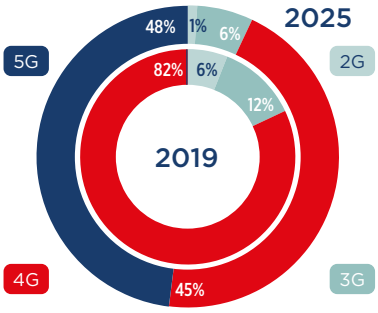
SMARTPHONE ADOPTION

2019 — 2025

57% 74%

North America

TECHNOLOGY MIX*



SUBSCRIBER PENETRATION

2019 — 2025

83% 85%

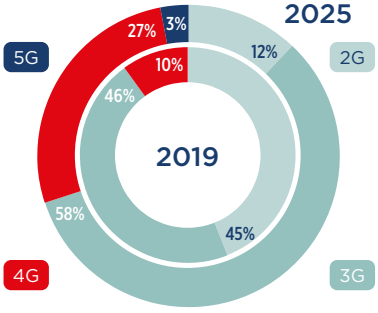
SMARTPHONE ADOPTION

2019 — 2025

83% 91%

Sub-Saharan Africa

TECHNOLOGY MIX*



SUBSCRIBER PENETRATION

2018 — 2025

45% 50%

SMARTPHONE ADOPTION

2018 — 2025

45% 67%

*% of mobile connections excluding licensed cellular IoT

Note: totals may not add up due to rounding

01

The mobile market in numbers

1.1
A new decade begins as growth continues

Source: GSMA Intelligence

Figure 1

Milestones for the mobile industry

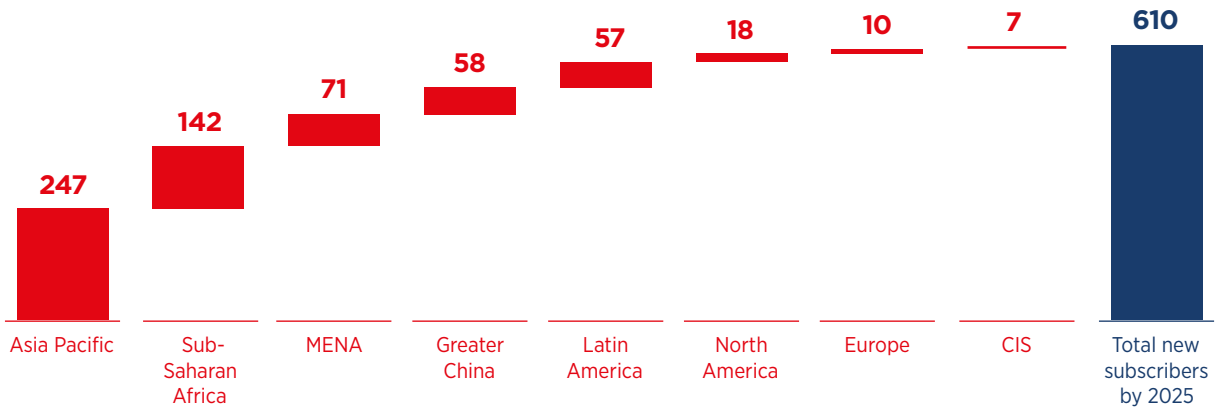
	2019	2020	2021	2022	2023	2024	2025
SUBSCRIBERS	Two thirds of global population subscribe to mobile services			5.5 billion subscribers			70% of population subscribes to mobile services
MOBILE INTERNET SUBSCRIBERS		4 billion mobile internet subscribers Half of population using mobile internet					5 billion mobile internet subscribers 60% of population using mobile internet
CONNECTIONS		8 billion mobile connections			8.5 billion mobile connections		
4G CONNECTIONS	4 billion 4G connections 4G accounts for over 50% of total connections				4G peaks at just under 60% of total connections	5 billion 4G connections	
5G CONNECTIONS					1 billion 5G connections 5G overtakes 2G		1.8 billion 5G connections 5G overtakes 3G
MOBILE BROADBAND (MBB)			MBB accounts for over 85% of total connections				MBB accounts for 95% of total connections
SMARTPHONE CONNECTIONS	5.2 billion smartphone connections 65% smartphone adoption			75% smartphone adoption			7.1 billion smartphone connections 80% smartphone adoption

Figure 2

Source: GSMA Intelligence

There will be more than 600 million new subscribers by 2025; nearly two-thirds will be from Asia Pacific and Sub-Saharan Africa

Million



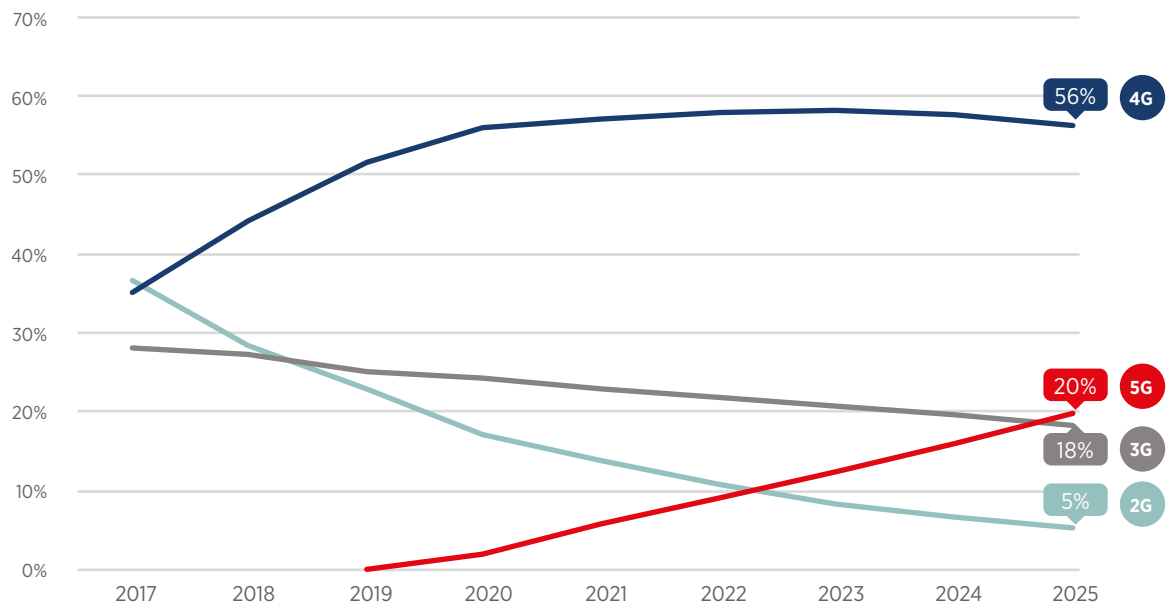
1.2
4G dominates as 5G begins to make its mark

Figure 3

Source: GSMA Intelligence

4G now accounts for half of total connections; 5G will start moving the needle in 2020

% of connections (excluding licensed cellular IoT)



Source: GSMA Intelligence

Figure 4

Mobile 5G is now commercially available from 46 operators in 24 markets worldwide; 79 operators across a further 39 markets have announced plans to launch mobile services*

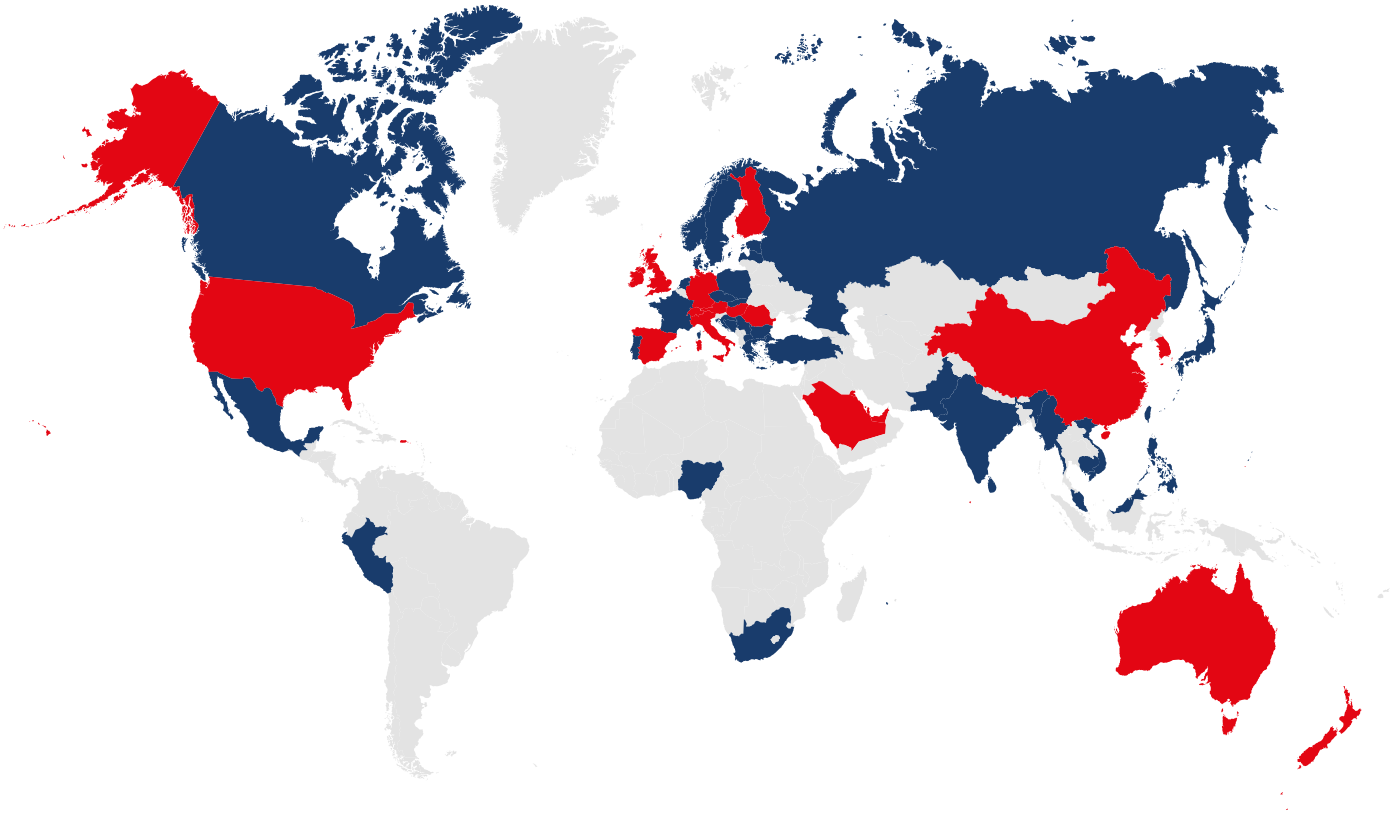
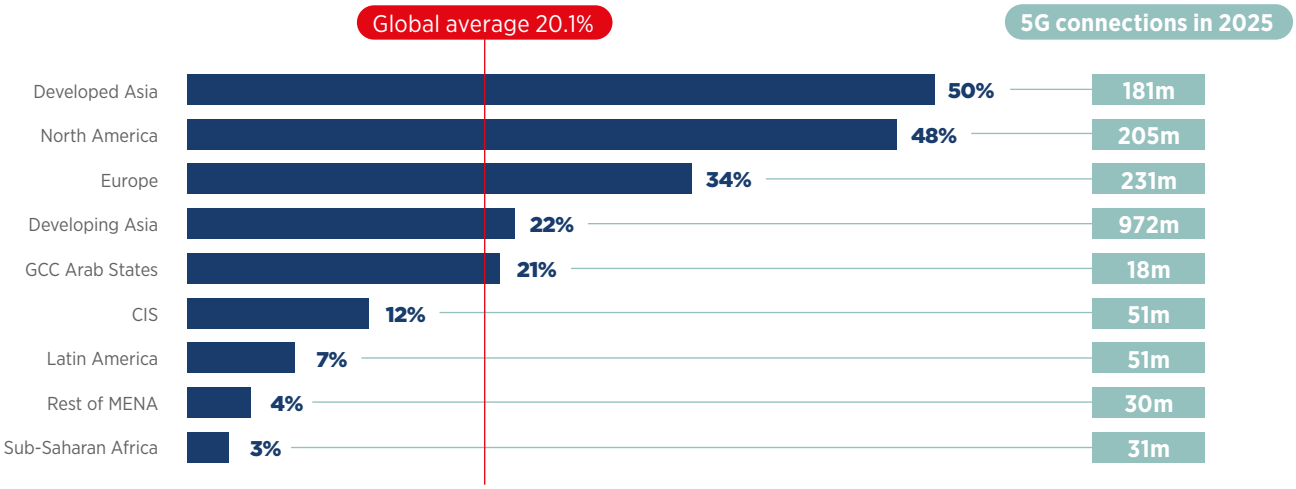


Figure 5

Source: GSMA Intelligence

1.8 billion 5G connections by 2025: developed Asia and the US will lead the way

5G adoption in 2025 (% of connections)



1.3
Evolution of the digital consumer

Figure 6

Source: GSMA Intelligence

1.2 billion more people will be using mobile internet by 2025

Mobile internet subscribers (% of population)

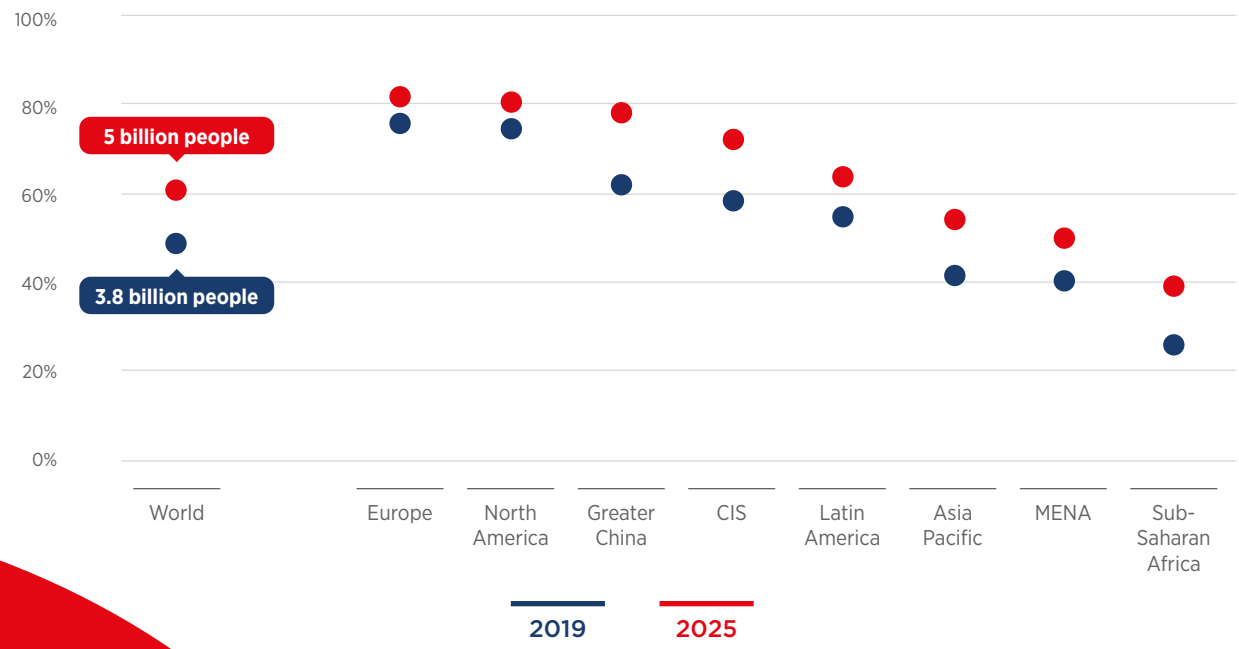


Figure 7

Source: GSMA Intelligence

Four in five connections globally will be smartphones by 2025; smartphone connections in Sub-Saharan Africa will nearly double

% of connections (excluding licensed cellular IoT)

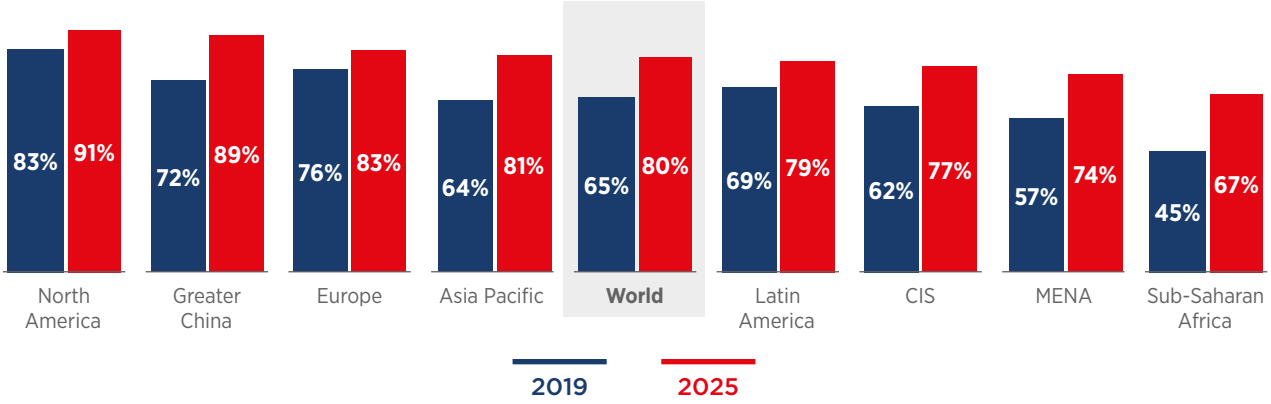


Figure 8

Source: GSMA Intelligence Consumer Insights Survey 2019

Digital engagement is rising, particularly in financial/commerce services; Latin America and developing Asia are key regions of growing engagement

% of smartphone users engaging in activity at least once per week

	Developed Asia		Developing Asia		Europe & CIS		Latin America	
	2019	YoY change	2019	YoY change	2019	YoY change	2019	YoY change
Communication	58%	-3 pp	68%	+10 pp	63%	+1 pp	79%	+9 pp
Information	34%	-2 pp	18%	+3 pp	36%	+1 pp	42%	+9 pp
Entertainment	31%	-1 pp	25%	+3 pp	30%	+3 pp	40%	+6 pp
Financial/digital commerce	28%	+8 pp	12%	+8 pp	26%	+12 pp	22%	+15 pp

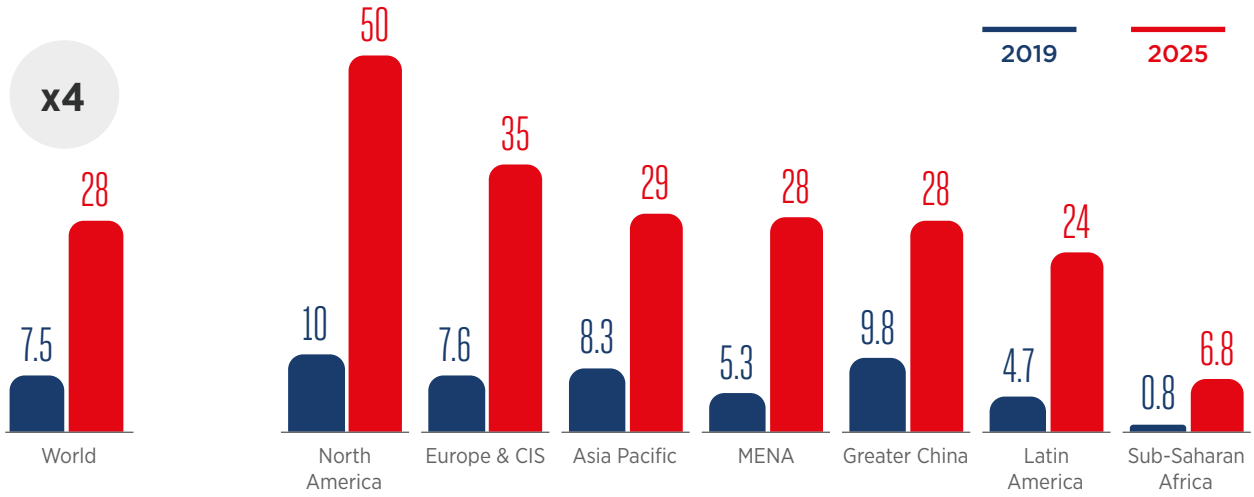
	MENA		North America		Sub-Saharan Africa	
	2019	YoY change	2019	YoY change	2019	YoY change
Communication	78%	+3 pp	60%	-	67%	+5 pp
Information	49%	+7 pp	35%	+1 pp	19%	-
Entertainment	43%	+4 pp	38%	+5 pp	22%	-2 pp
Financial/digital commerce	32%	+10 pp	28%	+12 pp	17%	+7 pp

Figure 9

Source: Ericsson, GSMA Intelligence

Global mobile data usage will grow almost fourfold by 2025, spurred by increased smartphone adoption and availablity of affordable high-speed network services

GB per subscriber per month



1.4
Financials recover in 2019 and 2020, with modest growth out to 2025

Figure 10

Source: GSMA Intelligence

Total mobile revenues grew 1.1% year-on-year to reach $1.03 trillion in 2019 – following a further pick-up in 2020, growth will slow to around 1% annually to 2025

Mobile revenue (billion), YoY growth

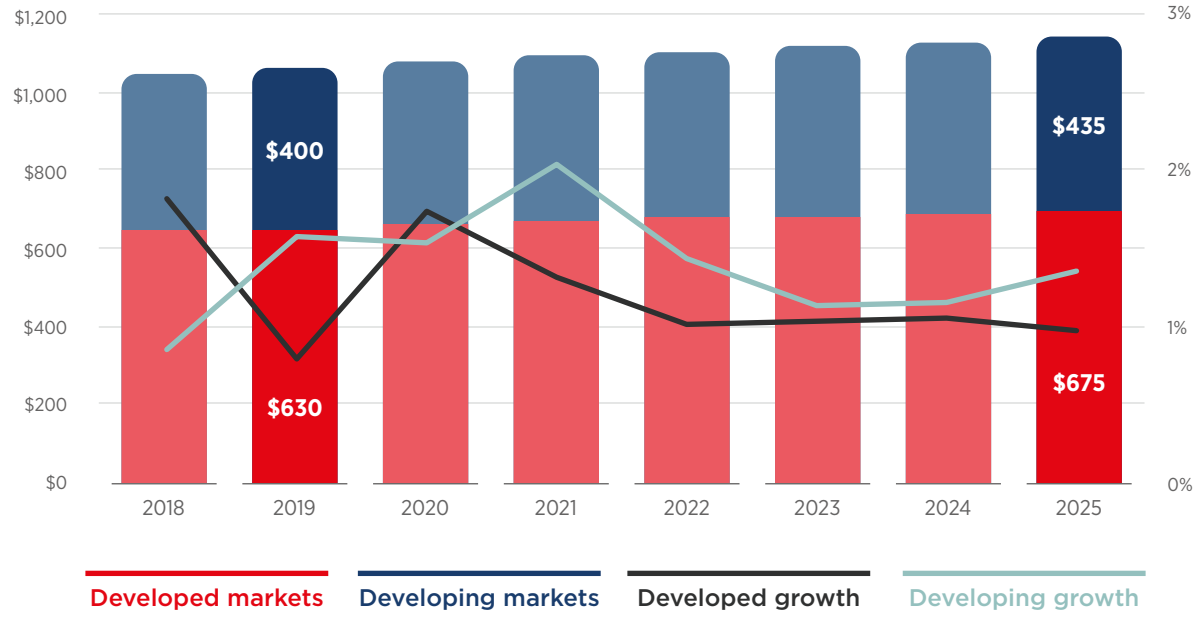
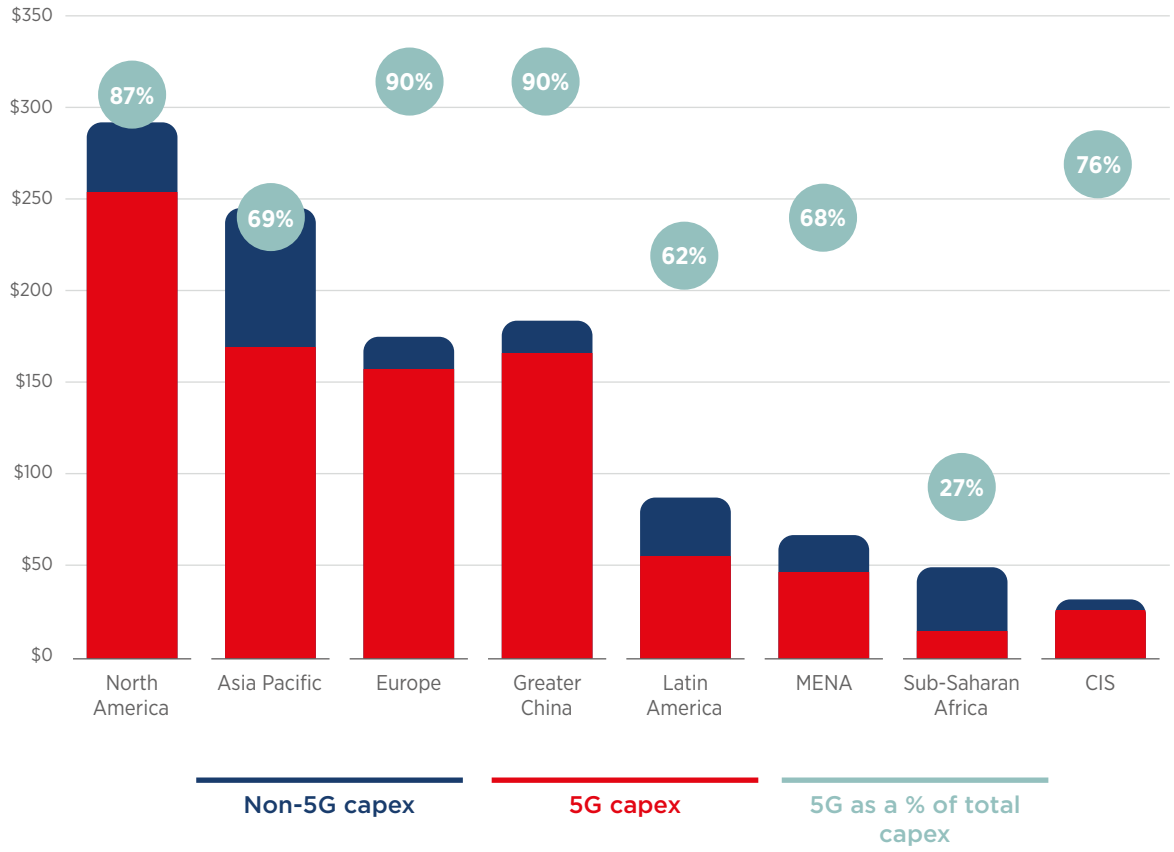


Figure 11

Operators will invest $1.1 trillion in their networks globally in the next five years; almost 80% will be in 5G

Capex, 2020–2025 (billion)



Looking out to 2025, 5G network investment can be divided into three main waves:

1. **Early deployments in 2018–2020:**
   The US, China, Japan and South Korea lead the way.
2. **Ramp-up during 2021–2023:**
   Europe and MENA accelerate their investments.
3. **5G proliferates in 2023 and beyond:**
   5G gathers steam in Latin America, CIS and parts of Africa.

02

Key trends shaping the mobile industry

2.1
A 5G reality check: learnings one year on

Enterprises are taking tentative steps into the 5G era

Companies across a range of verticals (such as manufacturing, power generation and aerospace) are evaluating their options for digitising product assembly and general operations management. This presents an opportunity for operators that can offer 5G with complementary infrastructure for low-latency services (mostly data centres close to the edge) and analytics. However, while a majority of enterprises recognise the benefits of speed gains brought about by 5G, other improvements (such as network slicing, edge computing and low-latency services) are not widely appreciated, with many believing that 4G remains 'good enough'. China is a clear exception in this regard: early partnerships and trials from local operators have paid dividends, as evidenced by the widespread intent among companies in the country's industrial sector to utilise 5G.

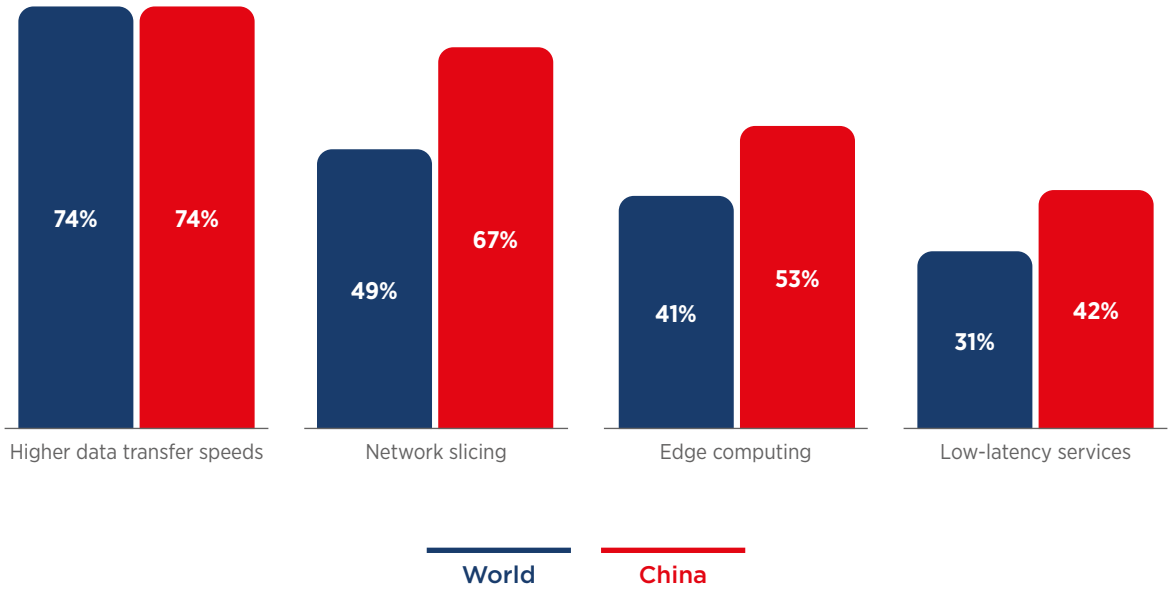
Multiple groups, besides operators, are targetting enterprise digitisation, including cloud and software-as-a-service companies and systems integrators. For example, for its manufacturing plant upgrade, Ford may look equally to Amazon or Verizon – or perhaps a combination of both. The challenge, therefore, will be to move the conversation about 5G away from technology and towards a consultative mentality of problem-solving.

Source: GSMA Intelligence IoT Enterprise Survey Q4 2018

Figure 12

Enterprise verticals are the real opportunity for 5G, with China racing ahead in this area

Which of the following 5G capabilities would make it compelling for your organisation to use 5G for future IoT deployments? (% of respondents, multiple answers possible)

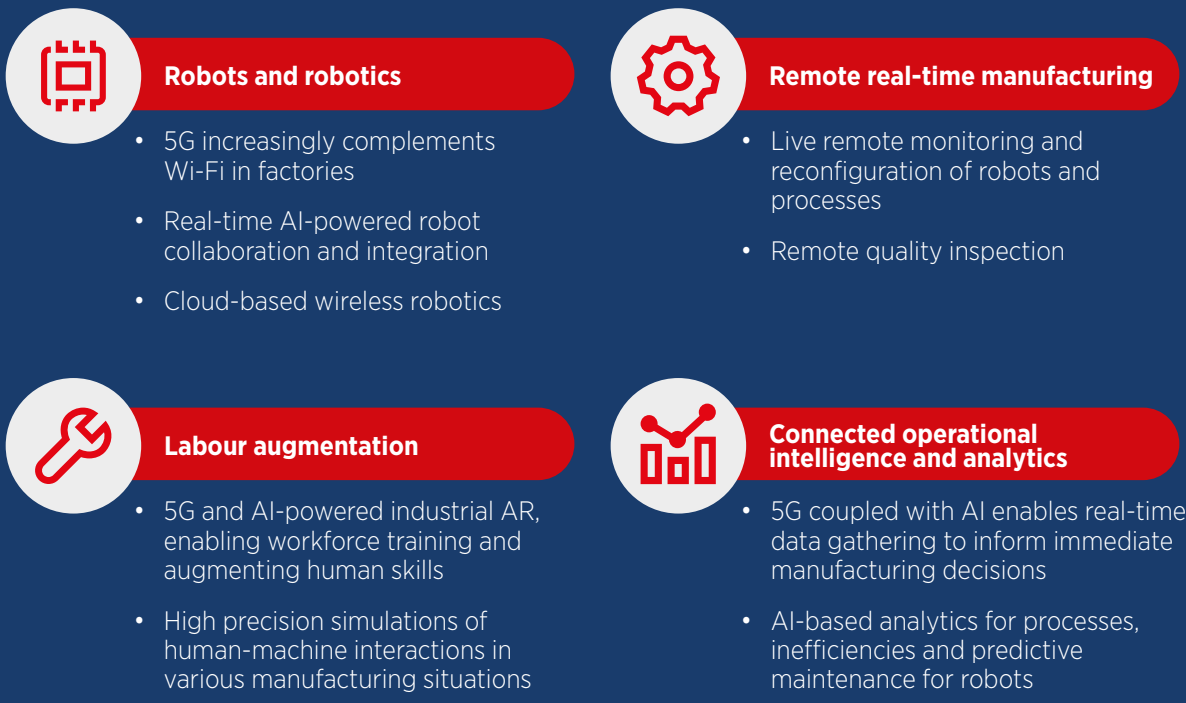


Smart manufacturing and autonomous cars are important verticals for 5G

Figure 13

Source: GSMA Intelligence

5G use cases in smart manufacturing



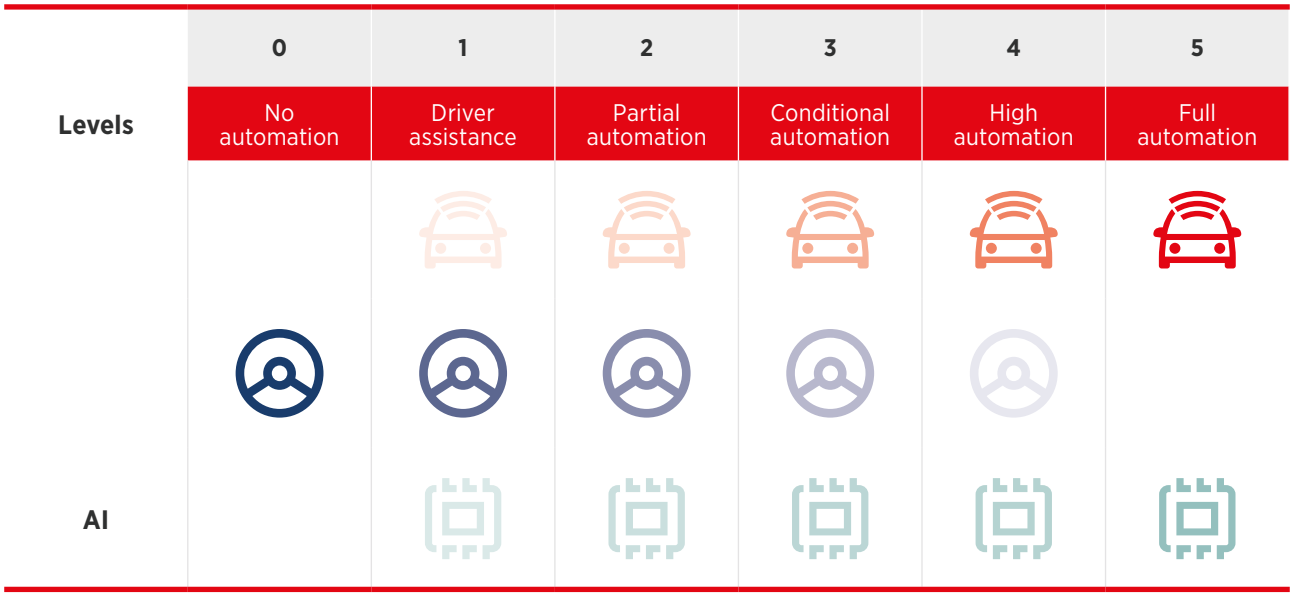
- Manufacturing companies are adopting robots, AI, sensors and a range of industrial IoT solutions to automate and monitor production. In many cases, these depend on low-latency connectivity (theoretically sub-1 ms round trip) for precision thresholds and real-time analytics, which will likely require edge-computing infrastructure.
- Globally, smart manufacturing IoT connections will grow fourfold between 2019 and 2025 to over 1.3 billion connections (largely driven by China as it aims to become a global leader in the industrial economy).
- The ultimate goal for smart manufacturing would be an autonomously controlled factory. An early template of such a design can be seen with the Changying Precision Technology Company in China (which automated 90% of its production line) and, more recently, in a satellite production facility in Florida jointly owned by OneWeb and Airbus.

Source: GSMA Intelligence

Figure 14

5G will be critical for autonomous vehicles, even if it's not driving them

Levels of vehicle autonomy



Level 4 The car is in full control for the entire trip under certain conditions with human backup driver.
Level 5 The car has no steering wheel, pedals or driver.

5G-V2X plays a key role in supporting autonomous driving

Vehicle-to-Vehicle (V2V)	Vehicle-to-Pedestrian (V2P)	Vehicle-to-Network (V2N)	Vehicle-to-Infrastructure (V2I)
e.g. emergency vehicle approaching	e.g. pedestrian on walkway ahead	e.g. traffic queue five kilometres ahead	e.g. traffic signal ahead turning red

- Automakers and automotive tech players aim to bring commercially available Level 4 and 5 autonomous cars to the roads over the next five years (Waymo was the first to do so in 2019). Mobility-as-a-service (ride hailing) in selected driving areas will be the key use case over the next five to 10 years.
- The rate of progress depends heavily on two factors: AI, to convert real-time recognition of the surrounding environment into actual decisions, and regulation.
- The role of operators will most likely be in helping cars communicate with their surroundings (C-V2X) and not with the actual driving given the risk of signal loss.
- Wi-Fi is a competing alternative but has the drawback of higher costs for successive equipment upgrades. The rejection of the Wi-Fi standard in autonomous vehicles by the European Commission in July 2019 provides a window of opportunity for cellular.

Consumers are wising up to the benefits of 5G – but will they pay for it?

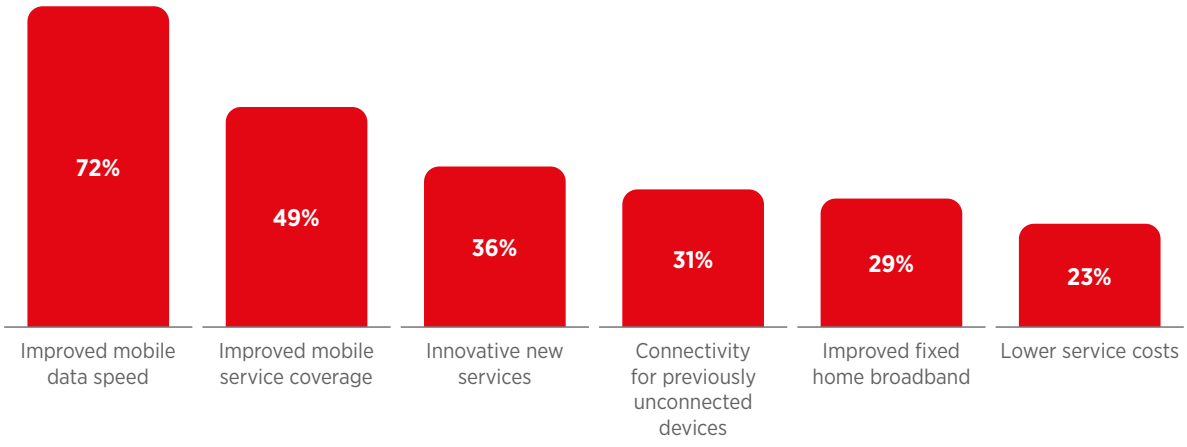
The number of live 5G markets is increasing by the day and consumers' awareness of the technology is also growing as hype makes way for reality. However, there is wide variation across the globe in terms of intentions to upgrade to 5G and the willingness to pay more for it. In general, consumers in South Korea and China – having witnessed some of the earliest launches – appear to be the most excited by the prospect of upgrading to 5G, while those in the US, Europe and Japan seem more content with 4G for the time being. 5G is still in its infancy though; as more tangible use cases are deployed, more consumers will appreciate the benefits of 5G.

Figure 15

Source: GSMA Intelligence Consumer Insights Survey 2019

Higher data speed is a well-recognised benefit of 5G; more needs to be done to raise awareness of other benefits

From what you know of 5G, what do you expect it will deliver?
(% of respondents, of those who have heard of 5G)



Source: GSMA Intelligence Consumer Insights Survey 2019

Figure 16

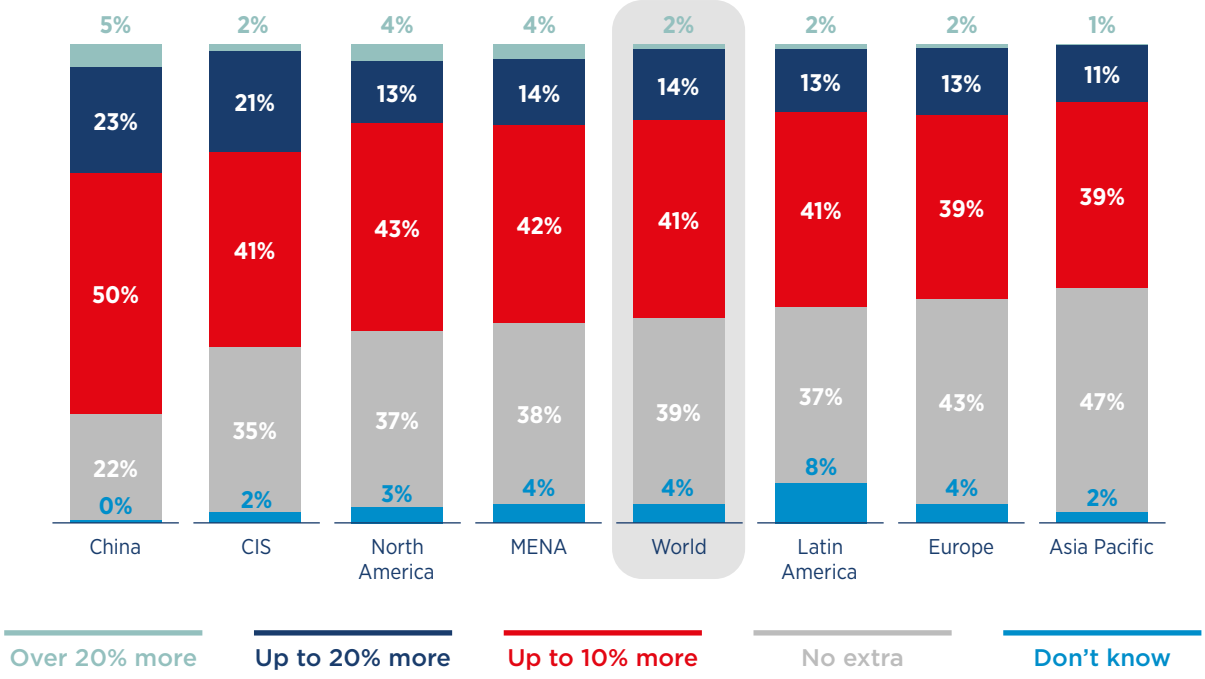
Awareness of 5G does not necessarily translate into an intention to upgrade

Source: GSMA Intelligence Consumer Insights Survey 2019

Figure 17

Early adopters tend to be willing to pay more for 5G

How much extra would you be willing to pay for 5G? (% of respondents, of those who intend to upgrade to 5G)



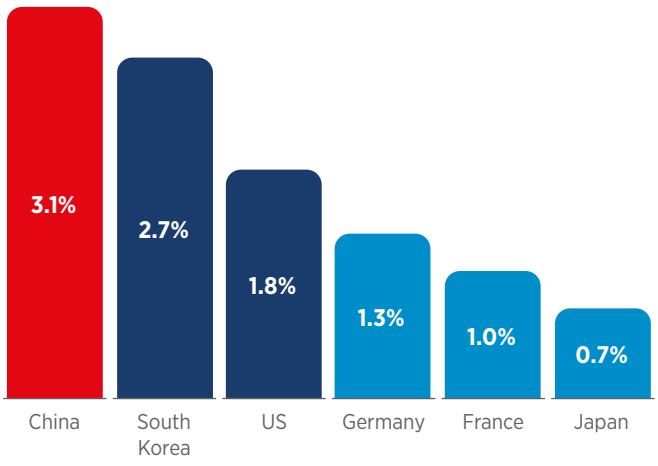
Note: totals may not add up due to rounding

Source: GSMA Intelligence

Figure 18

China and South Korea lead in potential 5G consumer revenue uplift

Potential service revenue uplift from 5G



Note: see Uncovering the impact of 5G on mobile revenue for more information and methodology details

- The projection for China is driven by a populace that is eager to upgrade to 5G (70%) and willing to pay more for it (see Figures 16 and 17).
- Upgrade intentions in South Korea (as in the US) are slightly weaker comparatively, but consumers appear willing to pay for faster service.
- Expectations are more tempered in Europe and Japan, where only around 20% of people intend to upgrade from 4G. In Japan, this should rise in 2020 as marketing intensifies ahead of the 2020 Summer Olympics in Tokyo. In Europe, the figure is likely closer to the true picture as consumers are content with 4G speeds and hesitant to increase spending amid weak economic conditions across the EU.

2.2
The telco of the future

As we enter the 5G era, network innovation has never been greater. Over the last decade, the mobile network model has trended away from asset ownership to infrastructure sharing, in an effort to cut costs in a low-growth environment. 5G further complicates matters, bringing new ways of operating a network with or without licensed spectrum.

The 'unbundled' network breaks down entry barriers, which for operators means:

- infrastructure competition becomes harder, not easier
- capex will need to be spent more selectively, particularly for small cells
- 'frenemy'-style partnerships with adjacent sector competitors become the norm rather than the exception.

The implications are clear: operators need to evolve their networks to meet the demands of the 5G era and to diversify their revenue streams to seek growth beyond core telecoms services.

Network transformation for the 5G era

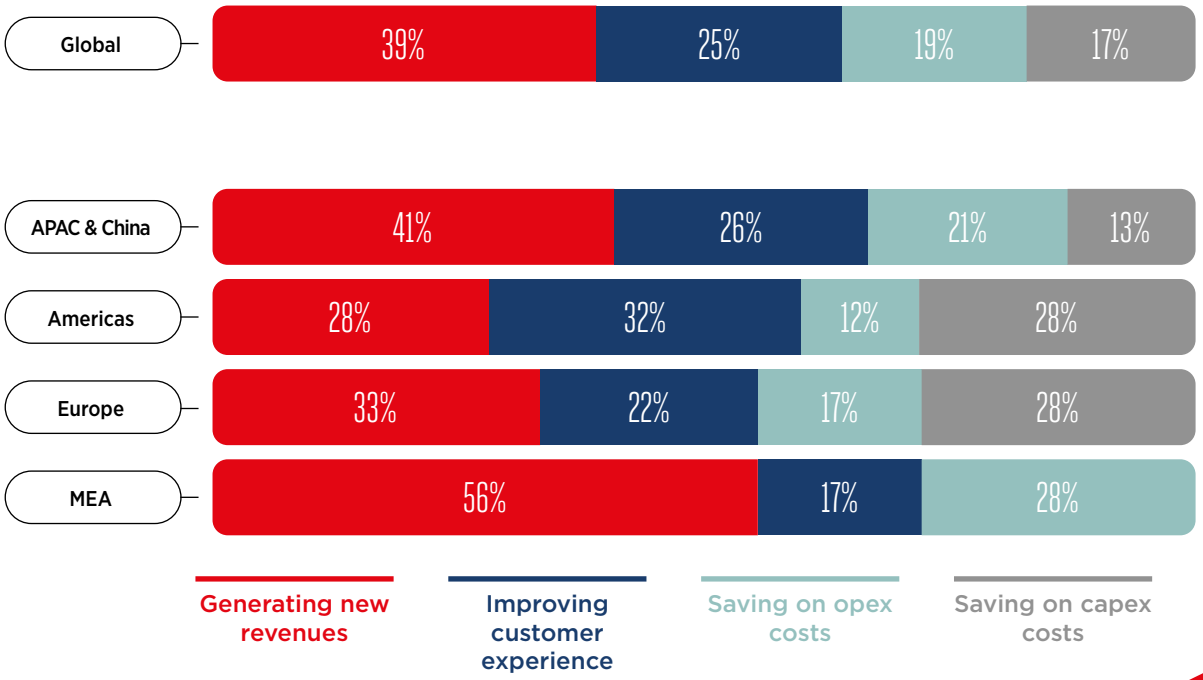
With the commercialisation of 5G and the introduction of mobile network innovations such as virtual RAN, edge networking and network automation, operators' decisions on network transformation strategies are more important than ever. Such decision-making is important to the operators, their network infrastructure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

Source: GSMA Intelligence Network Transformation Survey 2019

Figure 19

Revenue generation and customer experience prioritised over cost-cutting as the primary stimulus for network transformation

What is the primary goal driving your network transformation strategy? (% of respondents)



Source: GSMA Intelligence Network Transformation Survey 2019

Figure 20

Supporting new customers and network architectures are top priorities for RAN investments, while backhaul and virtualisation upgrades are crucial for the core network

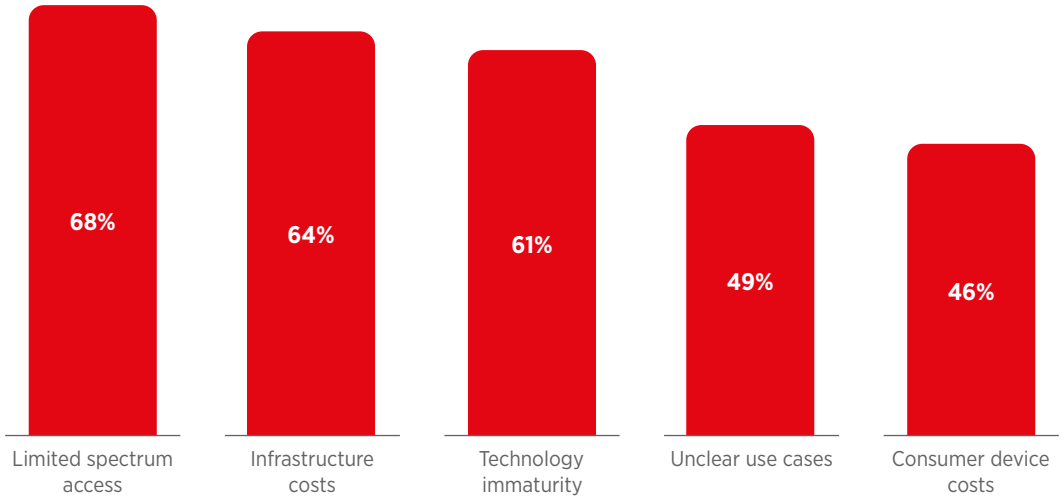
	Top ranked priorities for 5G investment	
	RAN	**Core**
Asia Pacific	1. In-building 5G coverage	1. Transport network upgrades
	2. RAN automation and planning tools	2. Network security upgrades
	3. New spectrum allocations	3. Virtualisation investments
Americas	1. In-building 5G coverage	1. Service core (IMS etc.) upgrades
	2. Network densification	2. NG core (service-based architecture) upgrades
	3. mmWave deployment	3. Transport network upgrades Edge computing
Europe	1. RAN automation and planning tools	1. Virtualisation investments
	2. Virtual RAN/OpenRAN	2. Service core (IMS etc.) upgrades
	3. New spectrum allocations	3. Network security upgrades
MEA	1. Virtual RAN/OpenRAN	1. Network security upgrades
	2. New spectrum allocations	2. Virtualisation investments
	3. In-building 5G coverage	3. Transport network upgrades

Source: GSMA Intelligence Network Transformation Survey 2019

Figure 21

Spectrum is the top concern for operators in the 5G era; cost and technology maturity barriers should resolve themselves over time, while use cases are becoming clearer

What is the greatest barrier to increasing your planned network investment in 5G?
(% of respondents, multiple responses possible)



The search for revenue beyond the core

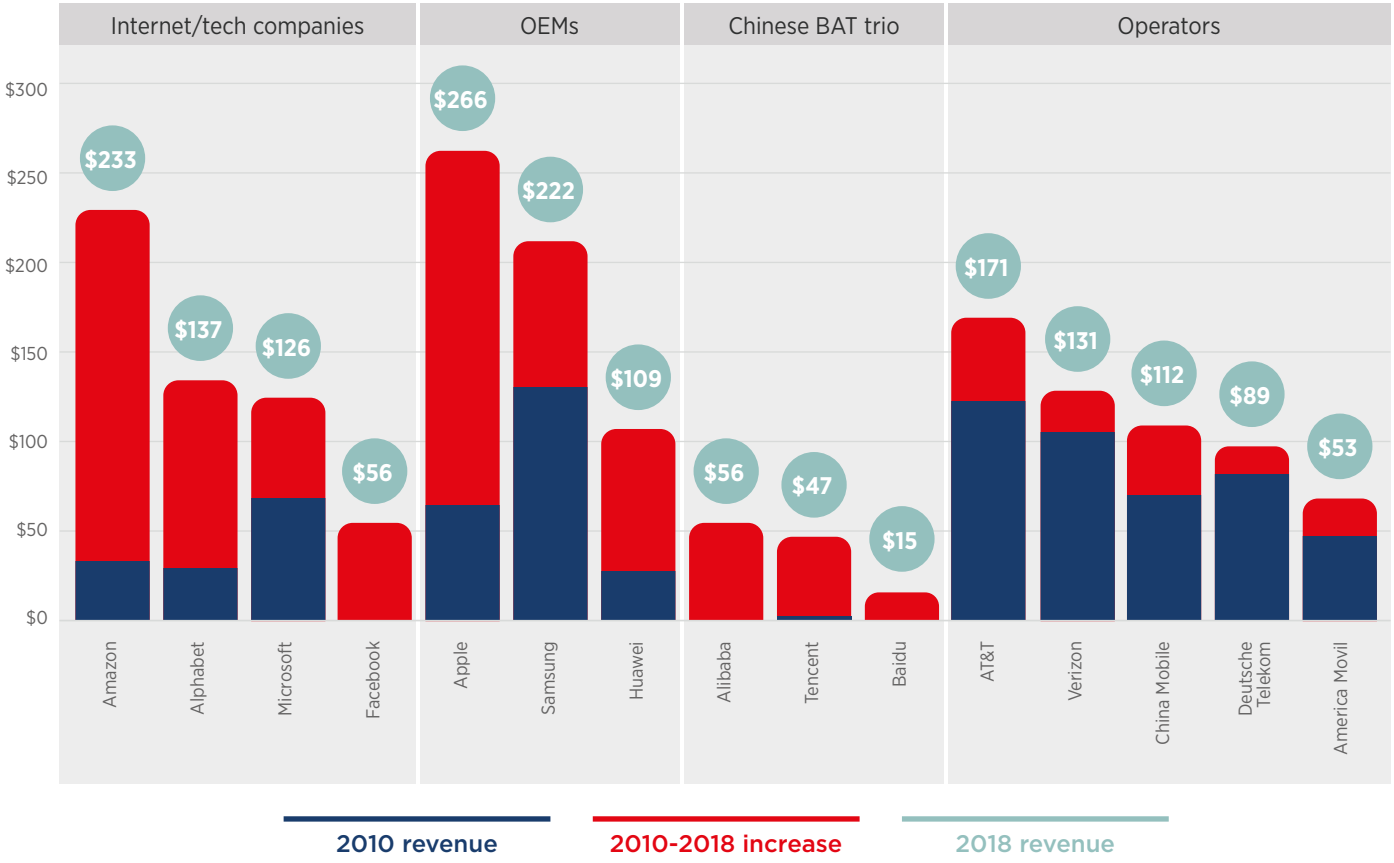
Over the last 10 years, the rise of the digital era (signified by the launch of 4G, take-off of smartphones and emergence of digital services) has allowed many companies in the wider tech and digital universes to reap the benefits of an expanding digital ecosystem. However, the pace and magnitude of revenue growth has varied significantly. Apple, Amazon and Alphabet each added $100–200 billion in revenue between 2010 and 2018, while Facebook, Alibaba and Tencent have reached considerable scale, with revenues now at around $50 billion. Meanwhile, mobile operators, which had their revenue boom in the previous decade, have experienced lower revenue increases since 2010. Growth has largely been driven by mergers and acquisitions (e.g. by AT&T and Verizon in recent years) or organic mobile subscriber growth in underpenetrated, large-scale markets (such as China and Latin America).

Source: Company reports, GSMA Intelligence

Figure 22

Operators have struggled to compete with the internet/tech giants in terms of revenue growth in the digital era

Revenue (billion)



Note: Annual figures based on fiscal year reporting periods. Revenue increase at 2018 constant forex.

For many operators, revenue growth as a percentage is in the low single digits, if that. As core telecoms revenue stagnates, a common strategy now for major operator groups is to seek revenue growth from adjacent services. Pay TV, media, IoT, enterprise solutions and the broader array of digital services still only account for a minor share of operator revenues (10–20% for most), although there are a few notable exceptions, largely enabled by M&A activity:

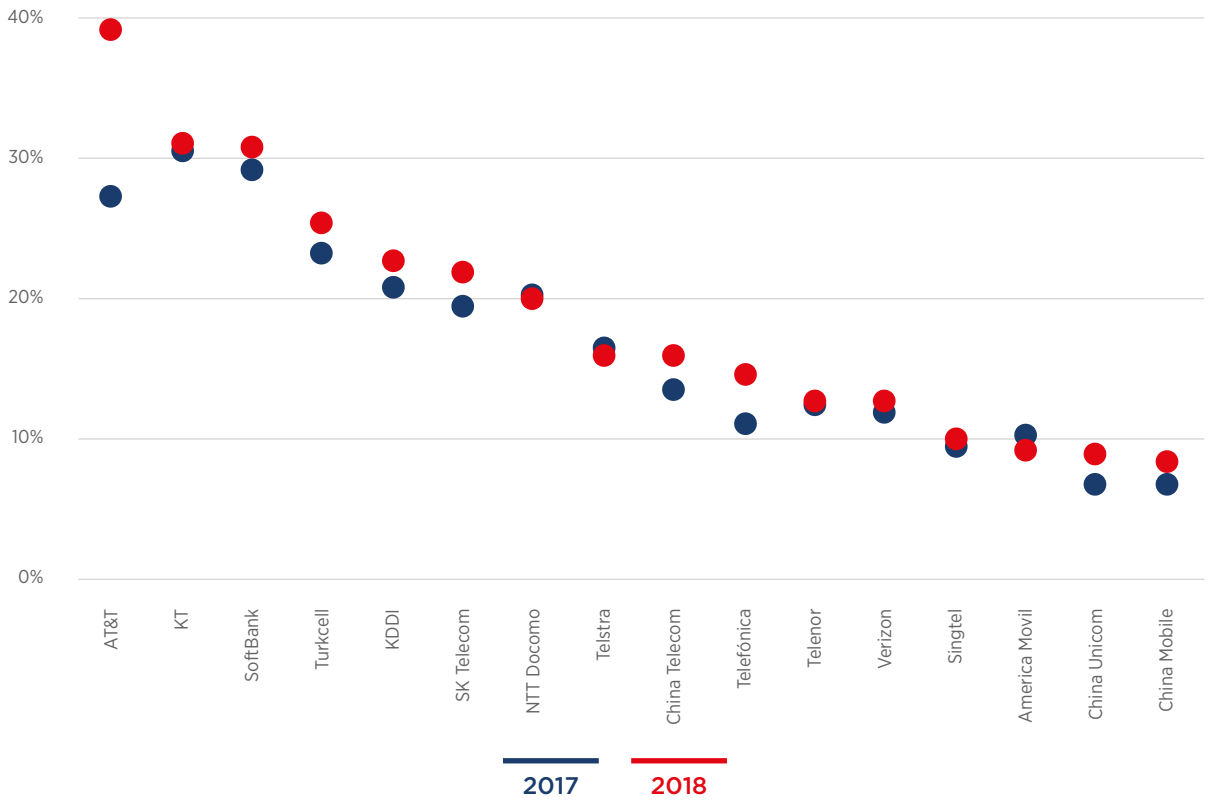
- AT&T is the big outlier: following its acquisitions of DirecTV and Time Warner, media and entertainment accounts for around 40% of its total revenue.
- Operators in Japan and South Korea lead in revenue generation from adjacent services; a common strategy involves targetting the digital consumer through a range of lifestyle and finance mobile commerce services.
- Non-telecoms services (consumer and enterprise) are a primary growth market for Chinese operators, with such services having generated a total of $22 billion in revenue in 2018 for the three local operators, a roughly 30% year-on-year increase.
- Turkcell provides one of the broadest portfolios of digital services, offering music, publishing, financial services, commerce, identity and payments products to consumers.

Source: Company reports, GSMA Intelligence

Figure 23

The contribution of non-telecoms services is growing slowly (AT&T aside): the challenge is for non-telecoms revenue to grow fast enough to offset declines in core service revenues

Contribution of non-telecoms services to total revenue



Note: Annual figures based on fiscal year reporting periods. For AT&T: last 12 months to June 2019 (to reflect 100% of WarnerMedia, fully consolidated since Q3 2018). For SoftBank: SoftBank Corp. plus Yahoo Japan

Low contributions of non-telecoms services to total revenues do not necessarily translate to low strategic importance or focus. For many operators, particularly those in developed markets, non-telecoms services are the only source of growth. There is considerable potential as we enter the 2020s, particularly in the enterprise space as digitisation continues apace. The biggest challenge will be finding the right balance between defending core operations and exploring opportunities beyond the core. An additional challenge will be to embrace a long-term organisational culture that stimulates innovation and digital transformation.[1]

1. For more information, see Telco 2020: seeking growth beyond the core

2.3
IoT: the battle is on to connect the home and workplace

Understanding the Internet of Things

- IoT describes the coordination of machines, devices and appliances, which are connected to the internet through multiple networks and technologies.
- These connected devices include everyday consumer objects and machines from across different verticals. Devices generate data, most of which is unstructured, providing actionable insights while creating value for society.
- In the enterprise context, IoT enables new business models, which create value by connecting existing and new devices together to establish new business processes, reduce costs, increase business efficiency, enable greater innovation and drive improved visibility across an organisation.
- For consumers, the connectivity provided by IoT can enhance quality of life. Examples include energy efficiency, home security, and fitness and well-being monitoring.

IoT connections will reach almost 25 billion globally by 2025, up from 12 billion in 2019. The business case for IoT is shifting from just connecting devices to addressing specific problems or needs with solutions to collect, process and integrate data from multiple sources, which can then be analysed to create value and provide actionable insight.

Enterprise IoT connections will overtake consumer in 2024, and will almost triple between 2019 and 2025 to reach 13.3 billion. This will account for just over half of all IoT connections in 2025.

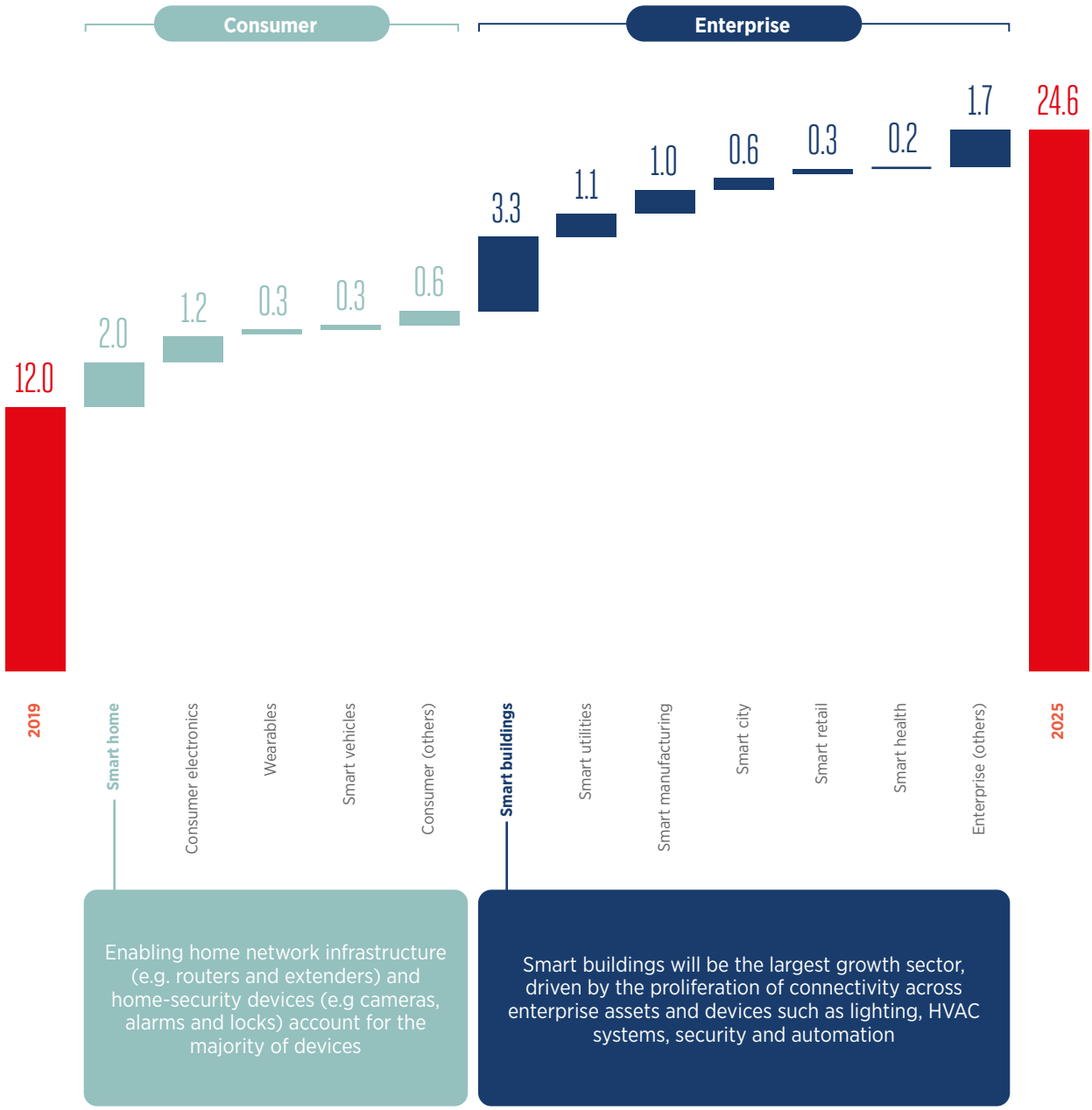
Consumer IoT connections will almost double to 11.4 billion in the same time frame. More and more devices include connectivity built in by default and interoperability within the ecosystem is increasing.

Source: GSMA Intelligence

Figure 24

There will be around 13 billion new IoT connections by 2025; smart buildings and smart home are key growth verticals

Connections (billion)

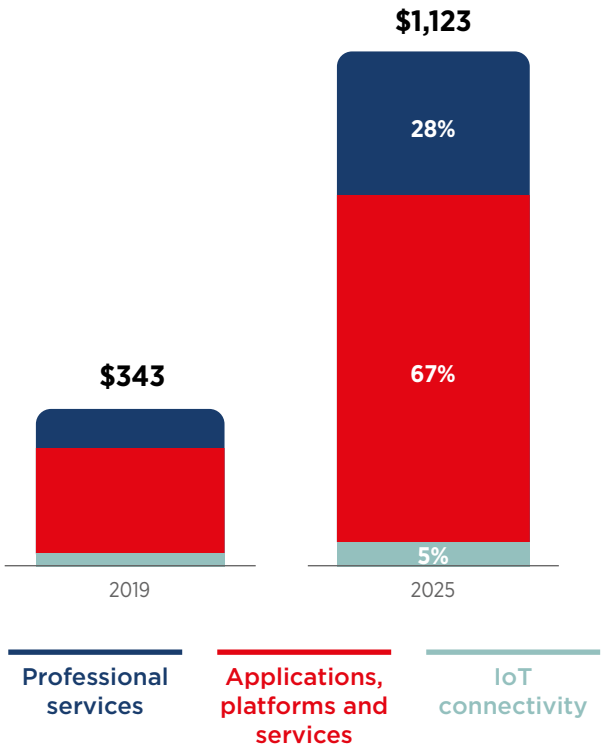


Source: GSMA Intelligence

Figure 25

$1.1 trillion in IoT revenue by 2025, with value continuing to move up the stack to platforms

IoT revenue (billion)



With automation comes the need for companies to implement sophisticated controls and analytics.

Therefore, most of the value gain for telcos and cloud firms supplying enterprise clients will be in the applications/platform layer.

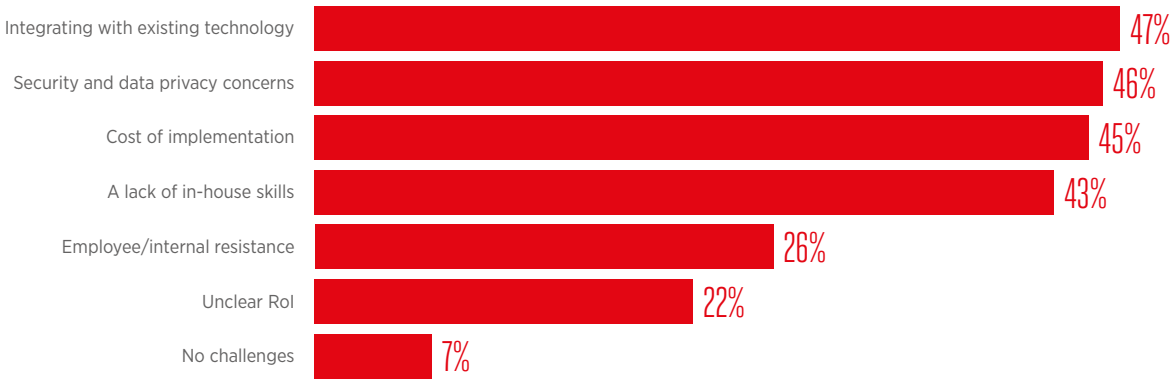
The deflationary nature of connectivity means it will shrink by half to 5% of total IoT revenue by 2025, meaning that connectivity will be unsustainable unless as part of a broader service package.

Source: GSMA Intelligence IoT Enterprise Survey Q4 2018

Figure 26

Integration with existing technology and security concerns persist as main challenges

Which of these challenges does your organisation face in deploying IoT-based solutions? (% of respondents)



Operators could offer managed security services as part of a broader IoT contract, relieving enterprises of the skills gap and costs to do so themselves

Smart home spotlight: is 2020 the year smart speakers become mainstream?

The smart home concept is often portrayed as a set of devices seamlessly interconnected and controlled from a central point. In reality, it is closer to a web comprised of three categories: entertainment, smart speakers, and appliances. Spurred by falling prices and easy-win use cases, speakers are the fastest growing category. Entertainment is still mostly about smart TVs, while appliances (such as connected light bulbs and burglar alarms) are more niche, with adoption at below 20% of households. To date, no one has been able to integrate all three under the same roof because of the morass of fragmentation and indiscriminate attitudes of consumers.

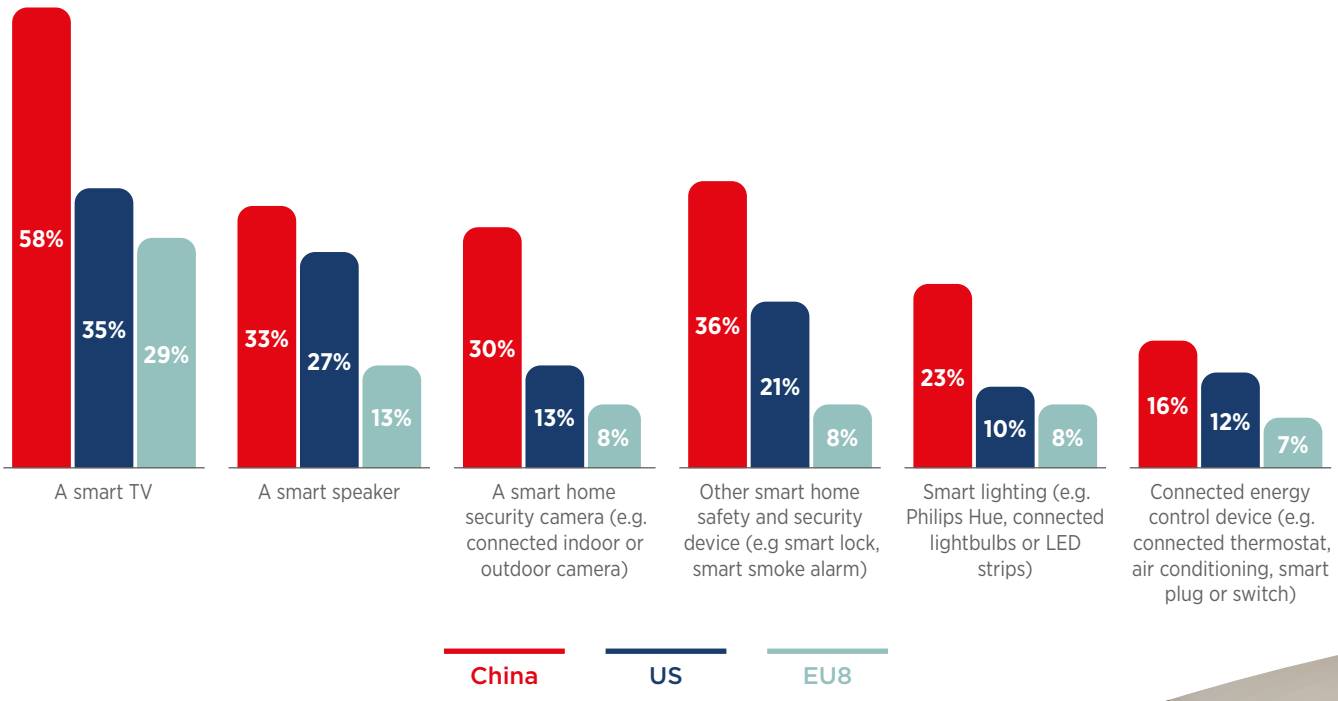
However, there are early signs that smart speakers could be at the centre of a smart home revolution in 2020 (see Figure 28).[2]

Figure 27

Source: GSMA Intelligence Consumer Insights Survey 2019

The smart home market has three tiers: China, the US and everyone else

Device ownership (% of households)



EU8 = France, Germany, Great Britain, Italy, Netherlands, Poland, Spain and Sweden

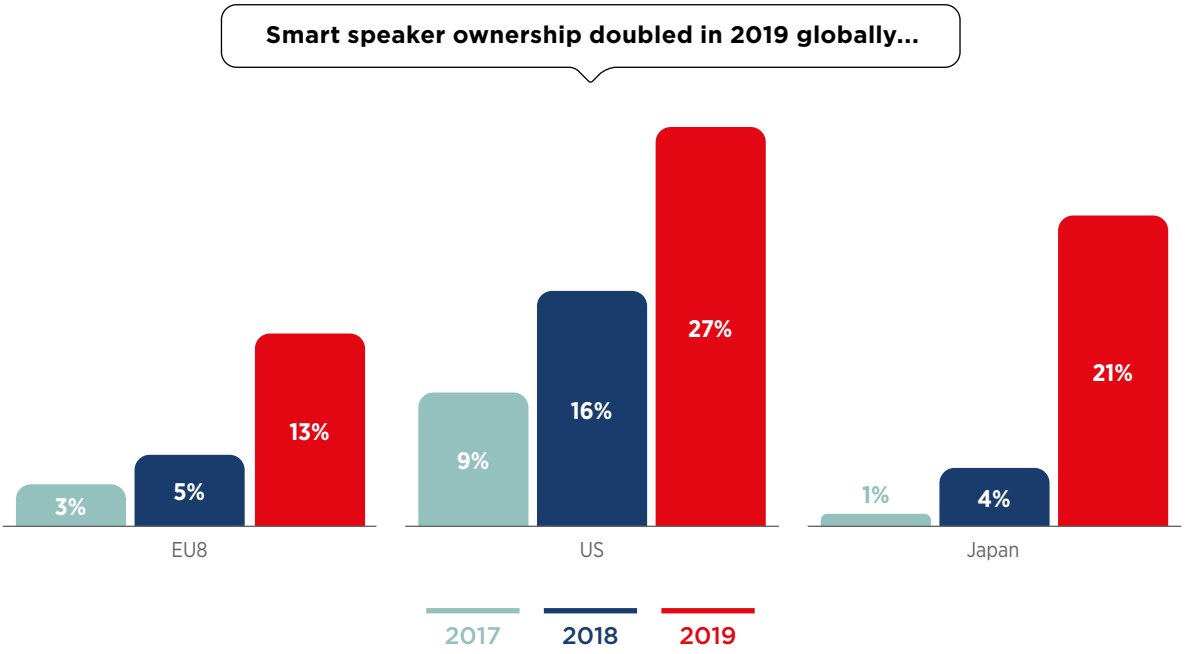
2. For more information, see Future of Devices: 5G and the China effect

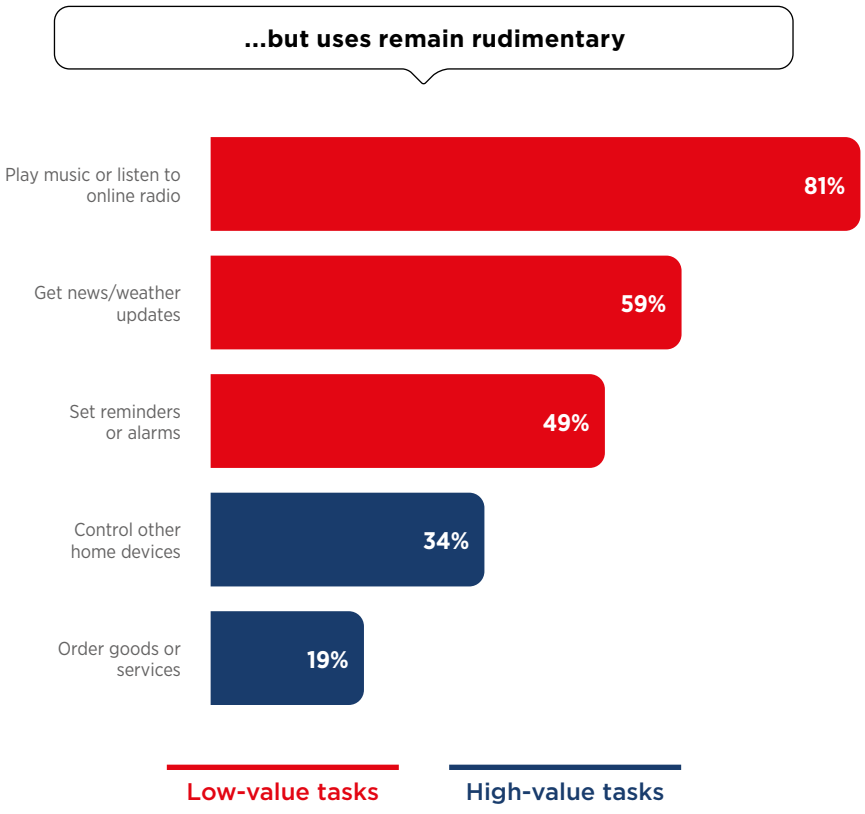
Source: GSMA Intelligence Consumer Insights Survey 2019

Figure 28

Smart speakers show much potential, but they are still in the very early stages

% of households



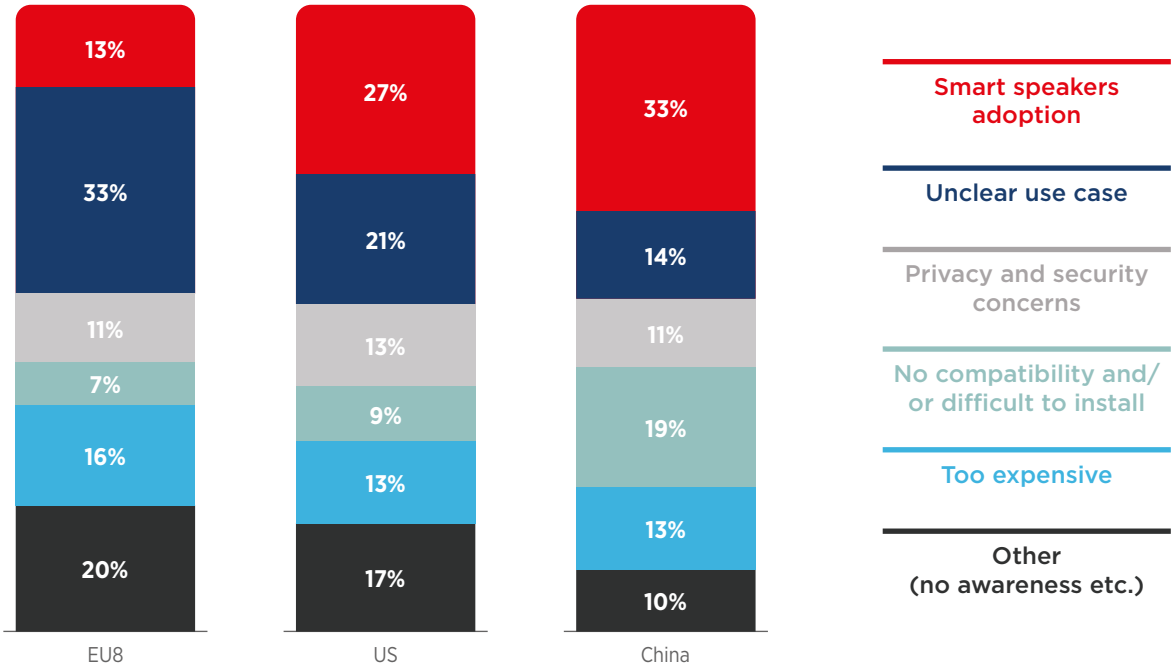


- Uptake of smart speakers has grown over the last 12 months to around 30% of households in the US and 15% in Europe.
- Amazon (Echo) and Google (Home) are the two principal competitors in these markets. Their strategies are to establish a stronghold in the home and for speakers to act as a conduit for consumers to access their e-commerce and search ecosystems.
- However, most consumers still only use speakers for basic functions such as listening to music or setting reminders.
- High-value functions such as serving as a control point for other home devices or buying goods online remain underused. This indicates a need to add more third-party integration and the lack of integration with other home devices.
- The greater hurdle is AI algorithm sophistication. For speakers to really take off, virtual assistants need to be able to do more than execute binary commands.

Source: GSMA Intelligence Consumer Insights Survey 2019

Figure 29

Lack of value/utility is the biggest reason why people do not own a smart speaker



- The lack of value/utility is the greatest obstacle to smart speaker ownership. For smart speakers to hit the mass market, consumers must feel feel their lives are being made easier and that they're not just purchasing a gimmick.
- Cheaper pricing may help, but there is a clear need for device manufacturers to offer genuinely new use cases beyond what smartphones can do. However, new services/experiences often require more data, which in turn has an impact on privacy and security concerns.
- Integration/compatibility is a huge challenge. Even Google and Amazon fail to generate economies of scale when linking with multiple manufacturers (Siemens, Philips, Sony etc.), each of whom has multiple product lines in multiple countries.

2.4
What else does the decade ahead have in store?

Figure 30

Source: GSMA Intelligence

Predictions for the next 10 years

	By 2025		By 2030
1.	One of the GAFA companies (Google, Apple, Facebook and Amazon) is broken up.	1.	The world's first autonomous mobile network becomes commercially active.
2.	AR eye glasses reach the mass market with a form factor from at least one global OEM.	2.	Global internet penetration inflects to reach 90% (50% in 2019).
3.	5G becomes the first generation in the history of mobile to have a bigger impact on enterprise than consumers.	3.	Data hubs are established to facilitate public access to commercial IoT data.
4.	Private enterprise networks explode and become a battleground between telcos and cloud companies.	4.	China becomes the world's largest mobile market by revenue (US = $247 billion, China = $163 billion in 2018).
5.	Health wearables become part of the solution to overburdened public health systems. Over 50% of people in high-income countries aged 55+ acquire a connected health device prescribed by their doctor (in 2019, this figure was 5%).	5.	Autonomous vehicles take hold, with 35% of annual new car sales in the US being Level 4 by 2030.

03

Mobile contributing to economic growth and addressing social challenges

3.1
Mobile contribution to economic growth

In 2019, mobile technologies and services generated 4.7% of GDP across the globe – a contribution that amounted to $4.1 trillion of economic value added. The mobile ecosystem also supported 30 million jobs (directly and indirectly) and made a substantial contribution to the funding of the public sector, with $490 billion raised through general taxation. By 2024, mobile's contribution will grow by $820 billion (approaching $5 trillion), accounting for 4.9% of GDP, as countries around the world increasingly benefit from the improvements in productivity and efficiency brought about by the increased take-up of mobile services.

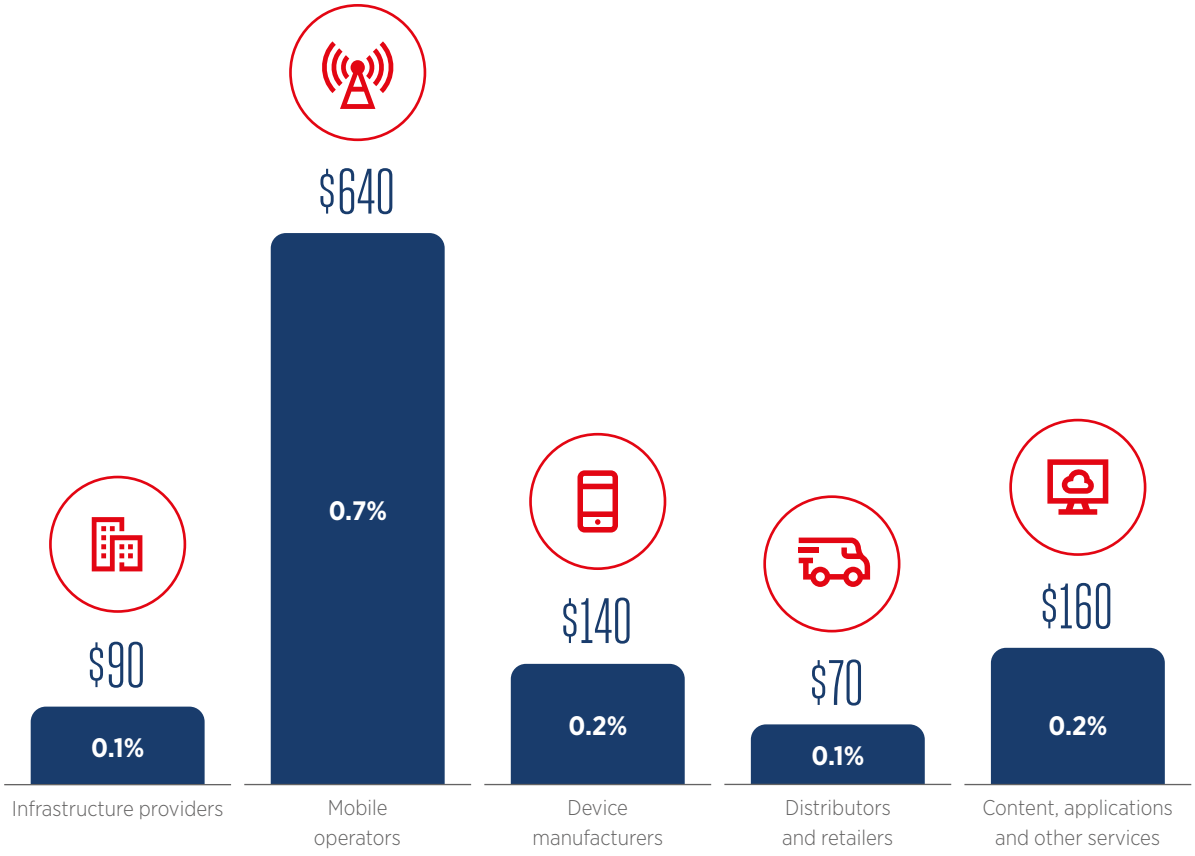
Further ahead, 5G technologies are expected to contribute $2.2 trillion to the global economy between 2024 and 2034. Crucial sectors such as manufacturing/utilities (particularly in China) and professional/financial services (especially in MENA and North America) will benefit the most from the new technology.

Source: GSMA Intelligence

Figure 31

The global mobile ecosystem directly generated $1.1 trillion of economic value in 2019, with mobile operators accounting for over half

Billion, % of GDP

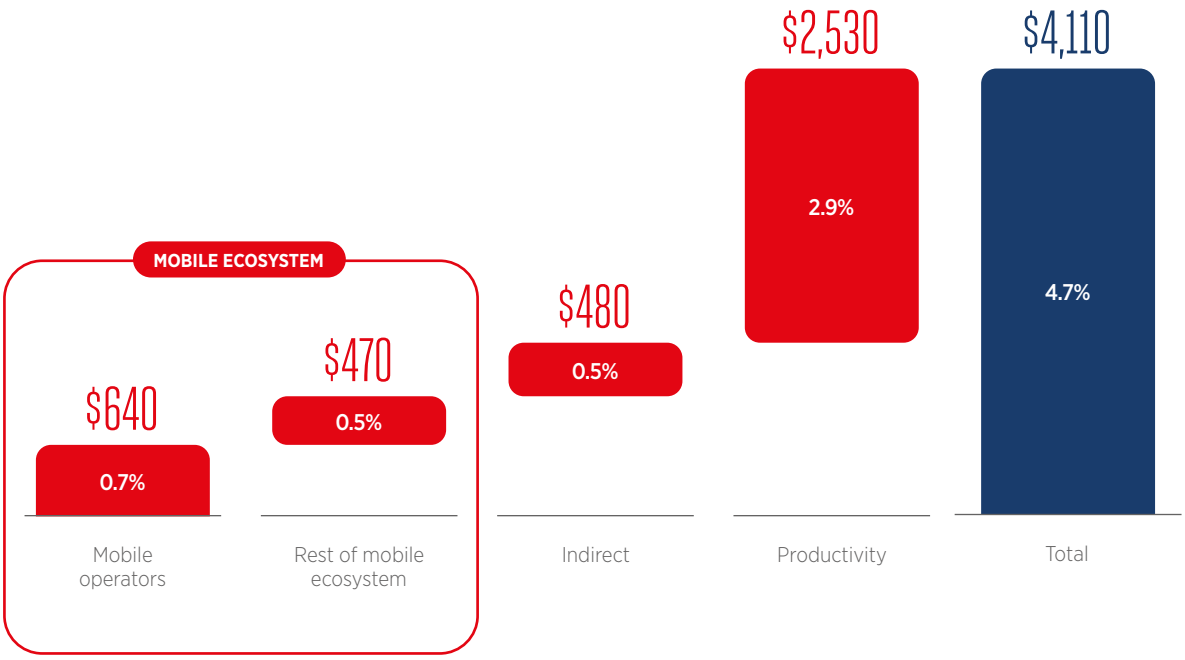


Source: GSMA Intelligence

Figure 32

Additional indirect and productivity benefits bring the total contribution of the mobile industry to $4.1 trillion (4.7% of GDP)

Billion, % of GDP



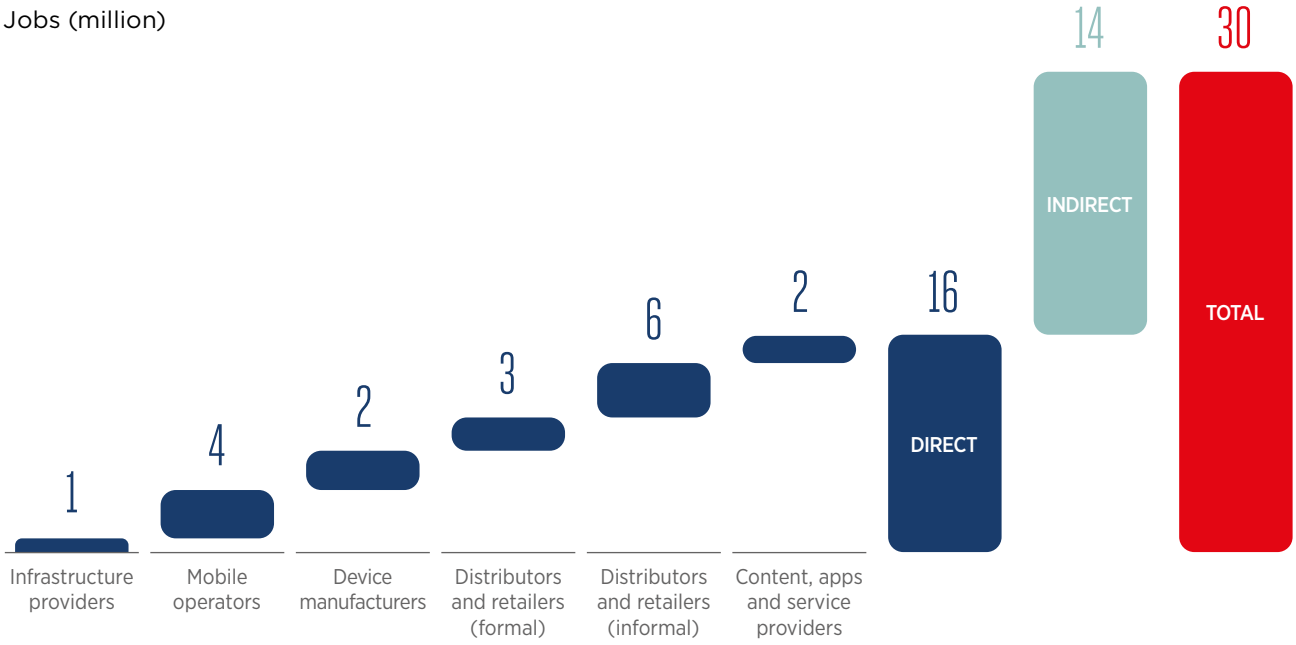
Note: totals may not add up due to rounding

Source: GSMA Intelligence

Figure 33

The global mobile ecosystem directly employs 16 million people, plus another 14 million indirectly through adjacent industries

Jobs (million)



Note: totals may not add up due to rounding

Figure 34

Source: GSMA Intelligence

In 2019, the global mobile ecosystem contributed almost half a trillion dollars to the funding of the public sector through general taxation

Billion

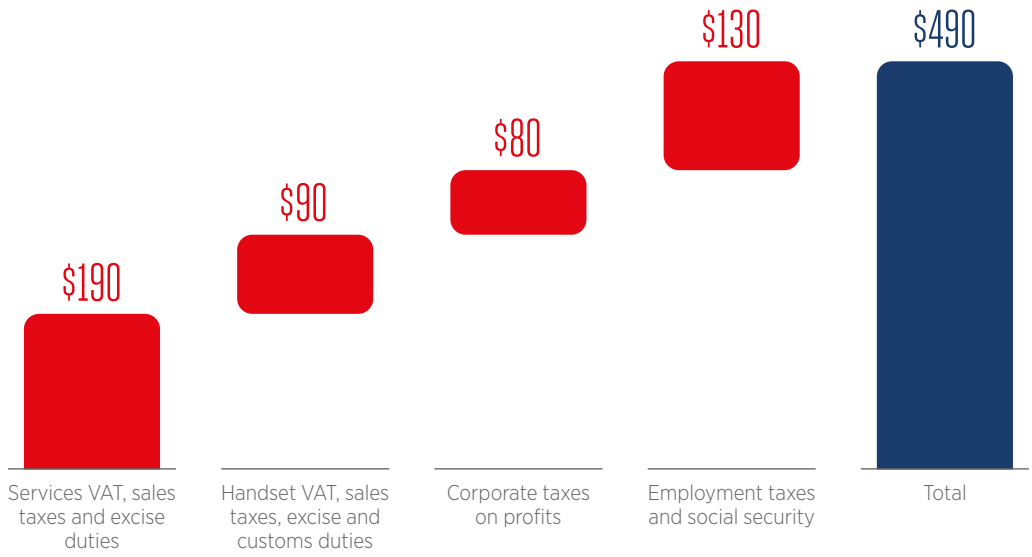


Figure 35

Source: GSMA Intelligence

Driven mostly by productivity gains, the global economic contribution of mobile will increase by $820 billion by 2024

Billion

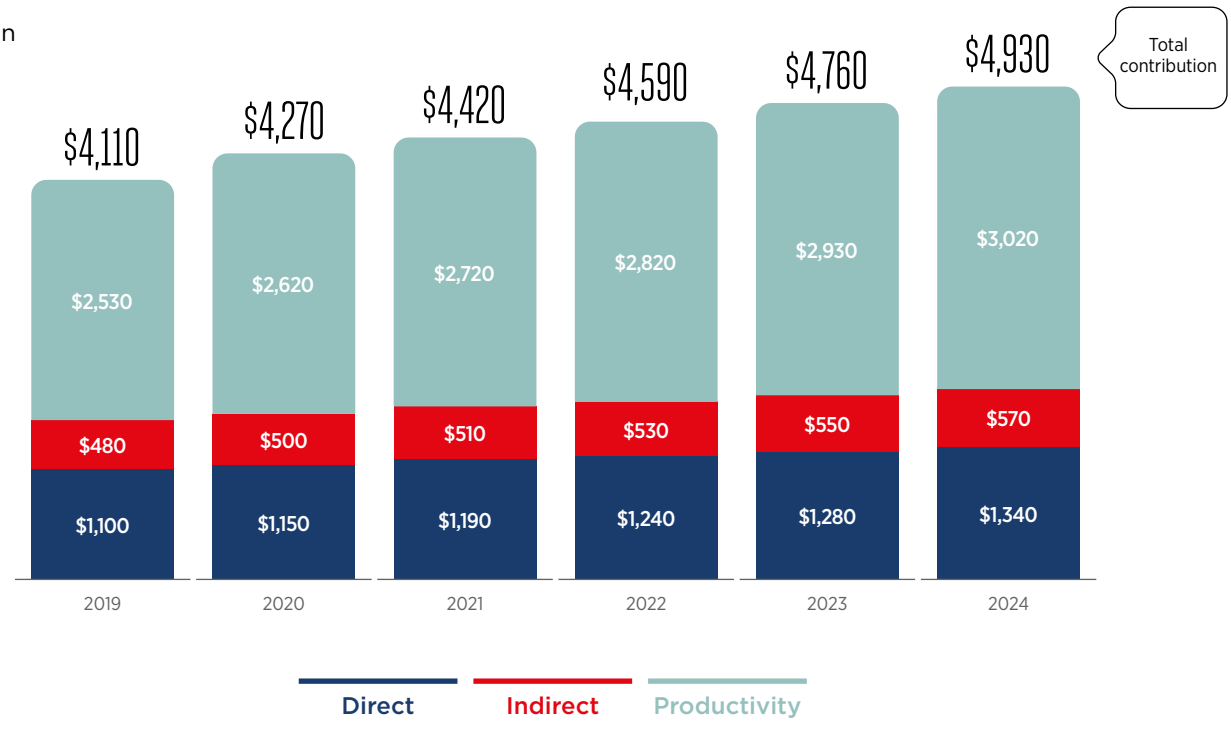
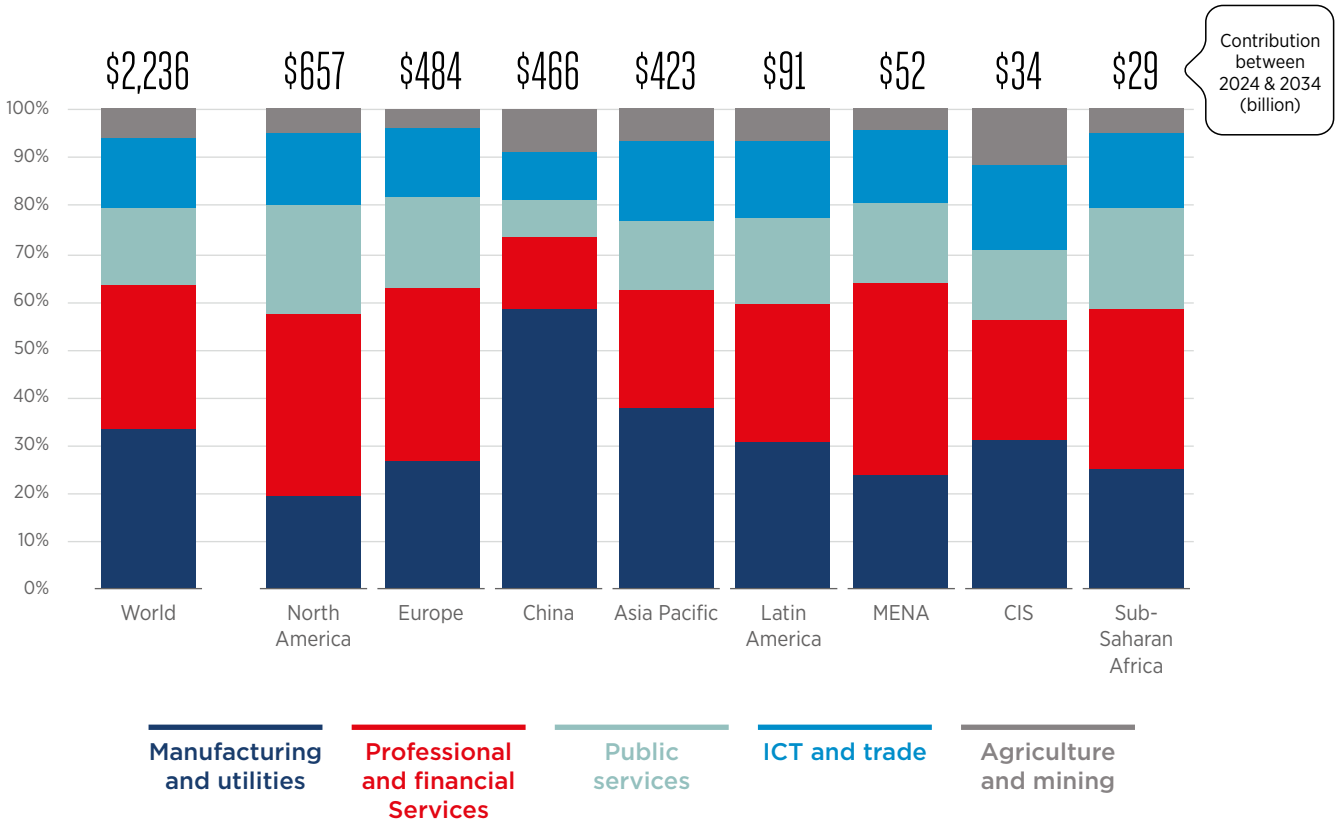


Figure 36

Source: GSMA and TMG

5G will contribute $2.2 trillion to the global economy between 2024 and 2034: Europe and North America stand to benefit the most



3.2
Expanding the benefits of mobile internet

Mobile internet access continues to grow. In 2019, 260 million people connected to the mobile internet for the first time, bringing the total to just under 3.8 billion people globally (49% of the population). However, this growth has not been equally distributed. While three quarters of the population are connected to the mobile internet in North America and Europe, penetration is only around 40% across Asia Pacific and MENA, and as low as 26% in Sub-Saharan Africa.

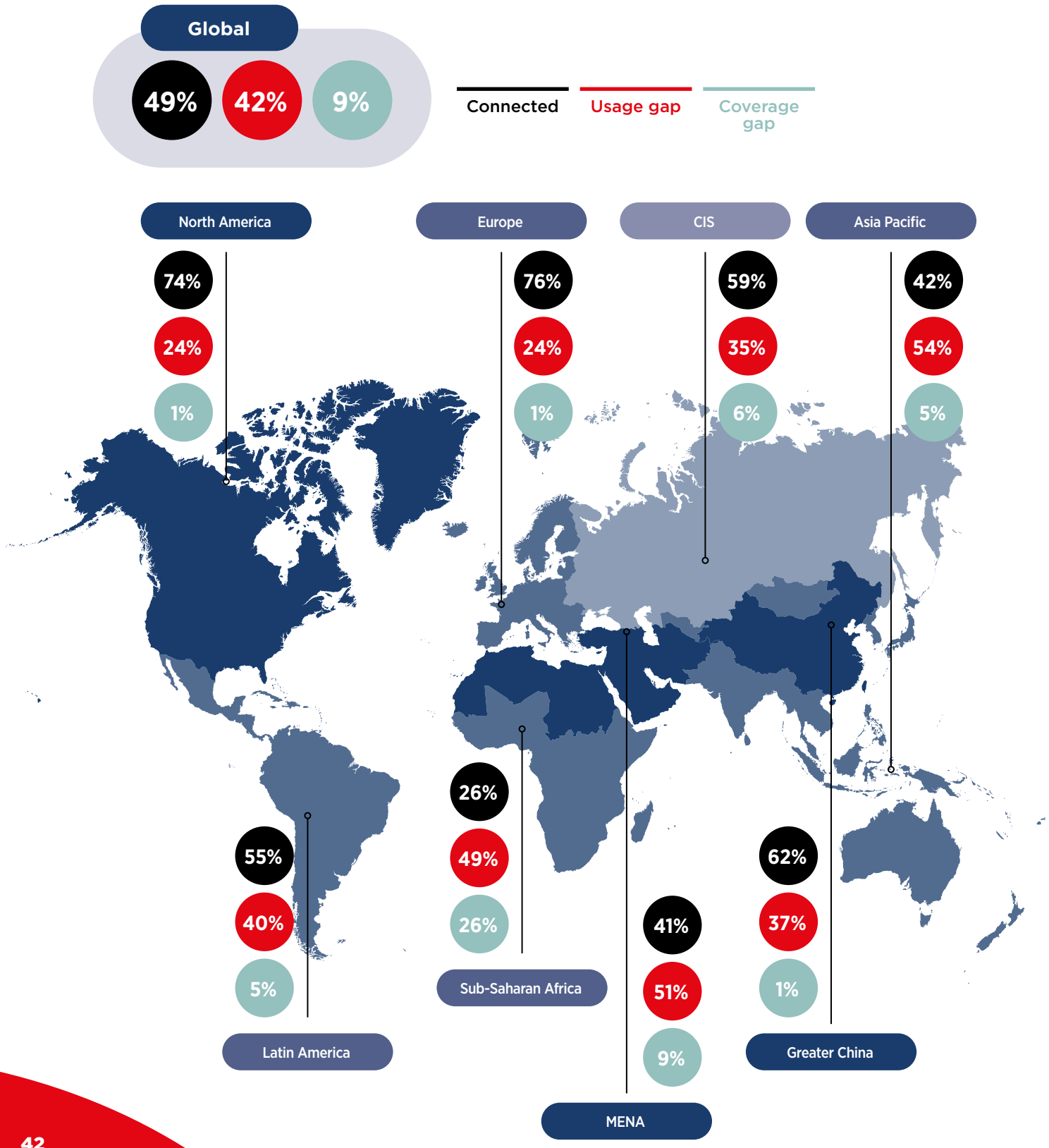
Those that are not connected can be split into two groups: the 'uncovered' and the 'covered but not connected'. The 'uncovered' are those with no access to a mobile broadband network (3G and above): this is the coverage gap. The 'covered but not connected' are those who live within the footprint of a mobile broadband network but are not using mobile internet services: this is the usage gap.

Figure 37

Source: GSMA Intelligence

State of global mobile internet connectivity by region, 2019

Base: Total population



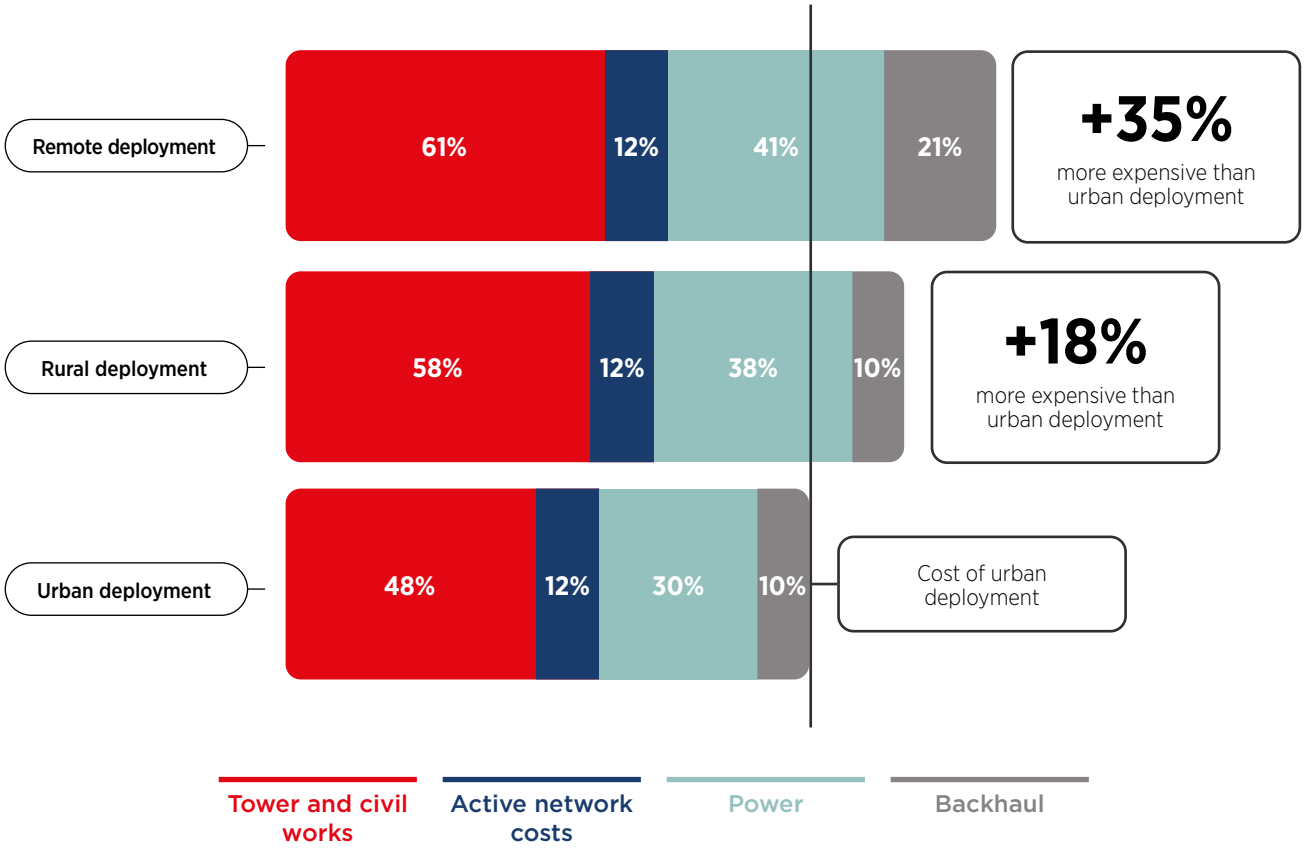
The coverage gap halved between 2015 and 2019, falling from 18% to 9% of the global population. This equates to almost 1 billion additional people covered by mobile broadband networks during this period. However, as of the end of 2019, 670 million people remain outside of mobile broadband coverage, 40% (270 million) of which live in Sub-Saharan Africa. Individuals living in remote and sparsely populated areas in particular are less likely to be covered by mobile broadband networks, but for economic (not technical) reasons.

Figure 38

Source: GSMA Intelligence[3]

Covering 'not spots' is an economic, not technical, challenge

Annualised cost of mobile coverage sites in rural and remote locations (relative to urban), by major component



Despite the progress outlined above, the fact that the usage gap is more than four times larger than the coverage gap emphasises that factors other than just infrastructure are holding back the adoption of mobile internet, namely affordability, consumer readiness, and availability of locally relevant content and services.

The GSMA Mobile Connectivity Index[4] measures the performance of 165 countries (representing 99% of the global population) against these key enablers of mobile internet adoption. The tool shows how countries have progressed over the years in their journeys to becoming fully digital economies and highlights the regions in which specific enablers need the most development.

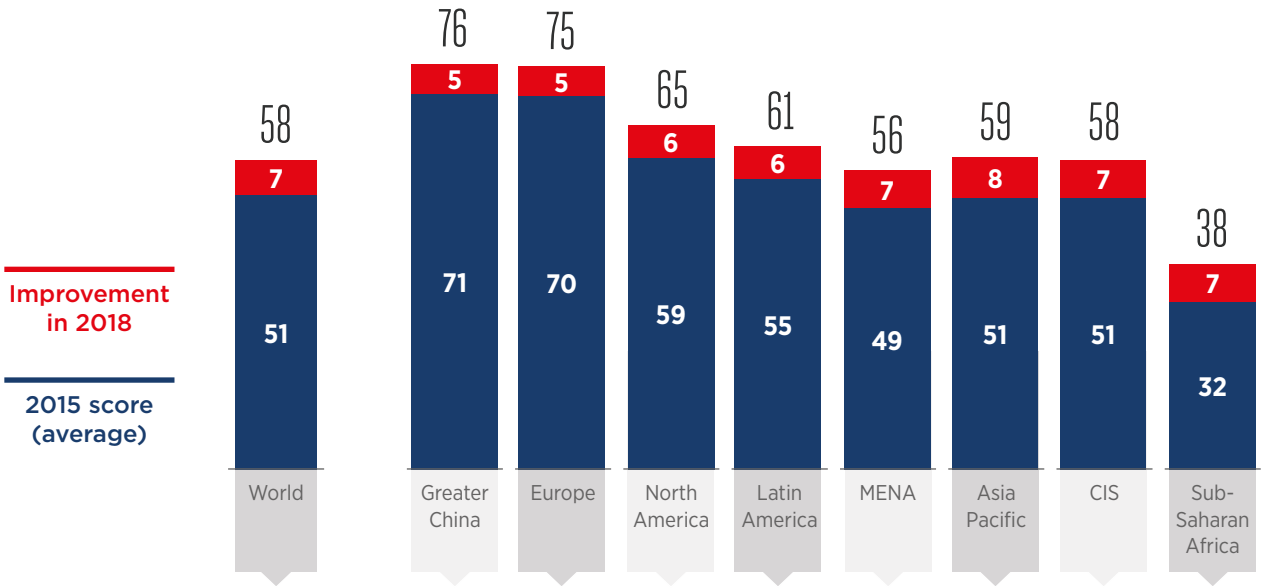
3. How Innovation Can Drive Rural Connectivity, GSMA, 2019
4. Available at www.mobileconnectivityindex.com

Figure 39

Source: GSMA

Asia Pacific and CIS have made the most progress thanks to significant improvements in infrastructure and content and services

GSMA Mobile Connectivity Index scores



	World	Greater China	Europe	North America	Latin America	MENA	Asia Pacific	CIS	Sub-Saharan Africa
Infrastructure	+13	+9	+11	+13	+16	+14	+15	+13	+13
Affordability	+3	+3	+1	+3	+0	+5	+5	+4	+4
Consumer readiness	+2	+1	+1	+1	+1	+2	+2	+1	+3
Content & services	+6	+7	+7	+5	+4	+6	+7	+8	+6

Note: totals may not add up due to rounding

The barriers to mobile internet connectivity – infrastructure, affordability, consumer readiness, and availability of locally relevant content and services – are particularly prominent in low- and middle-income countries (LMICs),[5] where over two thirds of the unconnected population live. As highlighted in the 2019 edition of the Mobile Connectivity Index,[6] there have been several important developments in global mobile connectivity:

- The infrastructure enabler has grown strongly, fuelled by the expansion of 4G coverage and mobile broadband coverage in Sub-Saharan Africa. Network quality has also improved substantially; the vast majority of countries now have average broadband speeds that allow reasonable quality internet browsing (greater than 2 Mbps).

5. Countries are classified over time according to the World Bank Country and Lending Groups
6. The State of Mobile Internet Connectivity 2019, GSMA Intelligence, 2019

- While mobile data has become more affordable across all regions, device affordability remains a significant barrier to mobile internet access in LMICs, particularly for the poorest 20% of the population.
- Lack of skills and a large gender gap are major obstacles to mobile internet adoption in South Asia, Sub-Saharan Africa and the Middle East and North Africa. For example, adult literacy is 63% in Sub-Saharan Africa and 68% in South Asia compared to 95% in East Asia and the Pacific. Measuring digital skills across countries is also a challenge because of a lack of high-quality comparable data.
- Mobile penetration, which is the main driver of consumer readiness, has increased across all regions, but low levels of mobile phone ownership are limiting mobile internet adoption, especially in South Asia and Sub-Saharan Africa, where mobile penetration rates are 53% and 45% respectively.
- Followed by the Middle East and North Africa, Latin America generally has much higher scores for content and services than other regions. In part, this reflects the fact that most countries in these regions have a widely shared spoken language, presenting a strong opportunity for localised internet products or services. However, Latin American countries have the lowest average score for online security.
- Social media and networking have heavily contributed to LMICs experiencing considerable improvements for content and services across all regions, particularly in East Asia and the Pacific. Social media penetration on mobile doubled in LMICs from 20% in 2014 to 40% in 2018.
- The proportion of mobile applications being developed in LMICs has risen significantly. Content developers in LMICs were responsible for 25% of active mobile applications in 2018, compared to 15% in 2014.

3.3 Mobile delivering social impact

With more than 5 billion unique subscribers worldwide, and more than 7 billion people covered by a mobile network, mobile is increasingly being used to access an array of life-enhancing services that contribute to and catalyse the achievement of the UN SDGs.

Globally, SDG 9 (Industry, Innovation and Infrastructure) remains the most impacted goal: since 2015, an additional 900 million people have been covered by a 3G network (currently 90% global coverage), while an additional 2.2 billion have been covered by a 4G network (now 80% global coverage). This underscores the role of mobile networks in providing critical infrastructure to spur inclusive and sustainable development, as well as greater innovation. Meanwhile, the industry achieved its most improved score on SDG 4 (Quality Education), which is also the second most impacted goal: 1.4 billion mobile subscribers use their phone to improve their education or that of their children – an increase of 140 million users since 2017.

In addition, mobile has had an enormous impact on financial inclusion, which cuts across multiple SDGs, including SDG 1 (No Poverty), 2 (Zero Hunger), 3 (Good Health and Well-being), 8 (Decent Work and Economic Growth) and 10 (Reduced Inequalities). Mobile money has helped reduce the financial exclusion gap in low- and middle-income countries, with 1 billion registered accounts at the end of 2019.[7]

Despite the global reach of mobile, much more can be done to leverage its power and support the delivery of the SDG 2030 targets. Crucial to this will be helping people realise the full benefits of using mobile and mobile internet services in terms of accessing health information, public services and digital payments, both in developed and developing countries. New technologies that are supported by IoT also need to achieve scale if mobile operators are to maximise their impact on the SDGs – for example, solutions in smart cities that can reduce pollution, and smart buildings and homes that can increase energy efficiency.

7. State of the Industry Report on Mobile Money 2019, GSMA

Figure 40

Source: GSMA

Rank of SDG impact scores by region, 2018

	Asia Pacific	CIS	Europe	Latin America
Highest				
Lowest				
Most improved				
Least improved				
Comment	Growth in the adoption of mobile financial services in the region promotes financial inclusion and economic empowerment. Literacy rates are growing because of a higher usage of mobile to view educational resources, read the news and access government services.	Increased cellular IoT utility connections enable companies to better understand and maintain their infrastructure network, reducing waste and improving efficiency. Consumers are increasingly using phones to improve their health or that of their family through mobile health applications.	Operators in Europe continue to improve the quality of their infrastructure through network upgrades, with high levels of coverage already achieved. More individuals are monitoring their health through wearable devices, such as fitness trackers.	Latin American operators have played an important role in improving gender equality through their operational activities and industry collaboration, such as through the GSMA's We Care campaign. There has been greater take-up and use among subscribers of life-enhancing services, such as mobile education and health applications.

	MENA	North America	Sub-Saharan Africa
Highest			
Lowest			
Most improved			
Least improved			
Comment	The deployment of IoT solutions to enable smart cities and smart vehicles reduces the adverse environmental impact of cities. Improvements to the quality and resilience of networks enable operators to maintain communications services in disaster-stricken areas.	More operators in North America are putting in place management systems, metrics and controls to improve performance with respect to climate change mitigation. Improved IoT take-up drives the efficient use of resources in industry, such as smart manufacturing and smart utilities.	Expansion in network coverage in Sub-Saharan Africa provides more individuals with a tool to communicate and a platform to access transformative services. Rising mobile and mobile money adoption fuels the popularity of mobile-enabled solar pay-as-you-go solutions, which enable access to clean energy.

Despite an improved impact across all 17 SDGs in 2018, the mobile industry needs to act fast to fulfil its commitment by 2030.[8]

Deep dive on SDG 13: Climate Action

Climate change threatens sustainable development everywhere. Collaboration on a global scale is vital to mitigating the catastrophic impacts of the world's rising temperatures. While the mobile industry is not the largest contributor of carbon emissions compared to other sectors, it can be an important part of the solution. It can do this in three ways: enabling the global transition towards a zero-carbon economy; improving resilience to the effects of climate change; and reducing emissions and driving energy efficiency.

Helping to make net-zero a reality

Mobile technology's biggest impact on climate change is from its ability to enable other sectors of the economy to reduce their greenhouse gas (GHG) emissions. The mobile industry achieves this by providing connectivity for digital solutions that reduce energy use, travel and transport, or otherwise lower GHG emissions (examples shown in Figure 41).

8. See 2019 Mobile Industry Impact Report: Sustainable Development Goals

The impact of mobile-based solutions is closely linked to improvements in connectivity, and operators' networks offer a scalable, secure and standardised way to connect assets across a variety of services in an economically sustainable manner. In recent years, an increasing number of mobile operators have been setting ambitious enablement or avoided emissions impact goals. Many have already been reporting good progress on enabling GHG emissions reductions through their mobile products and services:

- Having joined the Net Positive Project,[9] AT&T is seeking to harness the power of mobile technology to enable GHG emissions reductions that are 10 times greater than its own by 2025. At the end of 2018, AT&T enabled GHG savings equivalent to approximately double the carbon footprint of its operations.[10]
- By 2025, for each ton of CO2 it emits, Telefónica aims to avoid 10 tons of CO2 through its services. In 2018, Telefónica calculated that the emissions that its customers avoided through "digitalisation" were 1.15 times the sum of its scope 1 and 2 emissions (i.e. direct and indirect emissions).[11]
- Deutsche Telekom calculated that the "positive CO2 effects" it facilitated for its customers in Europe were 21% higher than its total emissions in 2018 (an enablement factor of 1.21).[12]

The mobile industry, along with the ICT sector, will be one of the first industries to develop its own sector pathway to net-zero GHG emissions by 2050. As a starting point on this journey, in 2019 a group of operators – which together account for more than two thirds of mobile connections globally – committed to disclosing climate impacts, energy use and GHG emissions. The next phase will be the development of a decarbonisation pathway for the mobile industry aligned with the Science Based Targets initiative (SBTi).[13]

This goes hand in hand with advancing mobile technology innovations in areas such as big data and IoT that can enable energy-efficient and environmental solutions across multiple sectors, including transport, manufacturing, agriculture and energy.

9. https://www.netpositiveproject.org/
10. Progress to 2025 – 10x Goal Update, AT&T, 2019
11. For more detailed descriptions, see Consolidated Management Report 2018
12. See 2018 Corporate Responsibility Report
13. https://sciencebasedtargets.org/

Figure 41

Source: GSMA[14]

How mobile is enabling a low-carbon future

Smart traffic management: This enables more efficient traffic flows, thereby easing congestion and lowering vehicle pollution. Verizon is using intelligent asphalt, with embedded sensors that monitor traffic flow, permitting cities to adjust traffic signals to reduce commuting times and carbon emissions.

Smart urban lighting: Intelligent street lighting can lower electricity demand by switching off when not required. Using IoT technology, in the city of Guadalajara, Spain, Vodafone connected 13,500 LED lights to a central management system, reducing street lighting energy consumption by 68%.

Smart parking: Mobile apps help drivers find available parking spaces, reducing congestion and GHG emissions. Deutsche Telekom's Park and Joy app shortens the time spent looking for a parking spot. In 2018, users could search around 30,000 parking spots in 45 cities with the app.

Smart logistics: Mobile connectivity allows the collection of vehicle data. This can then be used for optimisation of route planning, load optimisation, and improvement of driver behaviour. Smart vehicle or fleet management solutions reduce fuel consumption and associated GHG emissions. AT&T-enabled wireless fleet management technology allows fleet managers to use data to more efficiently deploy and route vehicles to help reduce delivery and idle time, improve mileage and reduce fuel costs.

Building energy management systems: Machine-to-machine (M2M) connectivity allows for the automation and monitoring of building systems remotely – for example, allowing systems to be switched on and off depending on occupancy or temperature. It can also apply analytical tools for predictive maintenance and more sophisticated building control policies, such as adjusting heating in line with the weather forecast and historical data. For example, Telefónica's big data service, LUCA, optimises energy consumption and forecasts future energy consumption costs.

Remote working: Smartphones and mobile connectivity enable remote working and collaboration, reducing the need for travel and therefore reducing GHG emissions. For AT&T, its mobile work tools and virtual collaboration technology represented its largest source of technology-enabled carbon reduction in 2018. Desk-based video conferencing using AT&T voice and data connectivity reduce the need for travel.

Sharing economy: Ride-sharing, car-sharing, bike-sharing and other exchange activities such as finding new owners for unwanted goods or offering unused space for accommodation help to reduce travel emissions or emissions from manufacturing new goods. In addition, smartphones can provide remote access to personal services such as mobile banking and smart home control, reducing energy consumption.

Smart grids: M2M technology is important for the functioning of smart grids to actively manage and monitor the generation and distribution of electricity. This enables greater amounts of renewable energy generation to be connected to the grid, as the greater decentralisation and intermittence of renewables needs different and more distributed management systems. Vodafone is helping utilities deliver electricity sustainably and efficiently through remote data management and monitoring capabilities, automation and control.

Connected health: Mobile solutions are expanding access to medical and health services. Using solutions such as remote patient monitoring, patients can reduce the number of trips to see a medical provider, saving time and reducing fuel usage and hospital emissions. In 2018, Verizon avoided 147,023 tonnes of CO_2e through remote patient monitoring and reduced travel and days in hospital.

Precision agriculture: This refers to the combination of monitoring crops with satellites, thermal imaging and sensors. Data collected can help farmers precisely optimise yields and reduce fertiliser and pesticide use, as well as improving water efficiency in irrigation, saving GHG emissions. For example, Telefónica is using big data to support small and medium-sized cattle ranchers in Ecuador.

14. 2019 Mobile Industry Impact Report: Sustainable Development Goals, GSMA, 2019

Improving resilience to climate change

Climate change has made weather patterns harder to predict and extreme events (such as droughts and floods) more frequent and severe, resulting in famine, hunger and displacement. The industry has an important role to play in adapting and responding to the effects of climate change. For example, mobile networks are facilitating access to information and coordinating assistance before, during and after climate-related emergencies. These efforts are often supported by operators' in-house disaster response teams,[15] while mobile technology has rapidly become an attractive delivery channel for many forms of aid.[16]

Mobile is also supporting and driving further innovations in climate adaptation. It plays a key role in the dissemination of valuable weather information, complementing broadcast media. Especially in the face of a changing climate, weather content via mobile agriculture information services (e.g. Ooredoo Myanmar's Site Pyo and Airtel's 321 service in Malawi) is highly valuable to smallholder farmers. Meanwhile, Orange Business Services and Dacom's smart agriculture service leverages big data analysis to allow farmers to better understand and adjust to climate change.

The industry is also increasingly bridging the data gap in weather monitoring and forecasting. For example, low-cost connected weather stations are being deployed at base stations for access to power, while mobile networks' microwave-links data is being utilised for accurate rainfall measurements. New mobile financial services, including digital weather index insurance,[17] are also emerging to strengthen the climate resilience of rural populations.

15. For example, the data analytics initiative by AT&T's response team. "AT&T dives deep into climate data", GreenBiz, April 2019
16. Partnership Guidelines: Building effective partnerships between MNOs and NGOs in complex environments and crises, GSMA, 2016
17. ACRE in Kenya by Syngenta Foundation in partnership with seed company Seedco and MNO Safaricom, and EcoFarmer in Zimbabwe, a partnership between Econet Wireless and Mercy Corps, are early examples of mobile weather index insurance products. See mAgri: Weather forecasting and monitoring: Mobile solutions for climate resilience

Driving energy efficiency

The mobile sector's annual emissions total approximately 220 MtCO2e,[18] representing about 0.4% of total global emissions. For many operators, the bulk of energy consumption (approximately 90%), and hence GHG emissions, within their own operations stems from the deployment and running of networks. Mobile operators are striving to minimise their own climate impact, embarking on an ambitious journey towards decarbonisation, but delivering a zero-carbon future will require timely and effective action in a number of areas:

1. **Energy efficiency:** As mobile usage continues to grow at pace, so does the demand for energy, particularly from network infrastructure. With the risk of energy cost inflation in the future, operators' targets for reducing energy use and GHG emissions are intrinsically linked to the implementation of energy efficiency practices.
2. **Renewable energy:** Progressing towards zero carbon necessitates the industry to make big strides in its migration to renewable energy sources, including wind, solar, biomass and hydropower. Against a backdrop of growing mobile data traffic, the switch to renewables also makes good business sense.
3. **Value-chain emissions:** Mobile operators have the potential, and responsibility, to positively influence emissions levels across the value chain. This means working with suppliers and customers to reduce emissions created in the production of goods (e.g. handsets and network equipment) and in the use of products by customers (e.g. the electricity used when charging mobile devices and other equipment).

Compared to the global carbon footprint of mobile networks themselves, the level of avoided emissions enabled by mobile communications technologies is 10 times greater.

The majority of these avoided emissions resulted from a decrease in electricity, gas, and fuel consumption, either through the use of IoT technologies or changes in behaviour stemming from the personal use of smartphones.

The majority of avoided emissions from IoT technologies are primarily in:

- buildings e.g. building management systems and smart meters
- transport e.g. facilitating the use of charging points and, through telematics, optimising routes/ vehicle fuel efficiency
- manufacturing e.g. storage and inventory management
- the energy sector e.g. smart grids.

The use of smartphones helps to avoid emissions by:

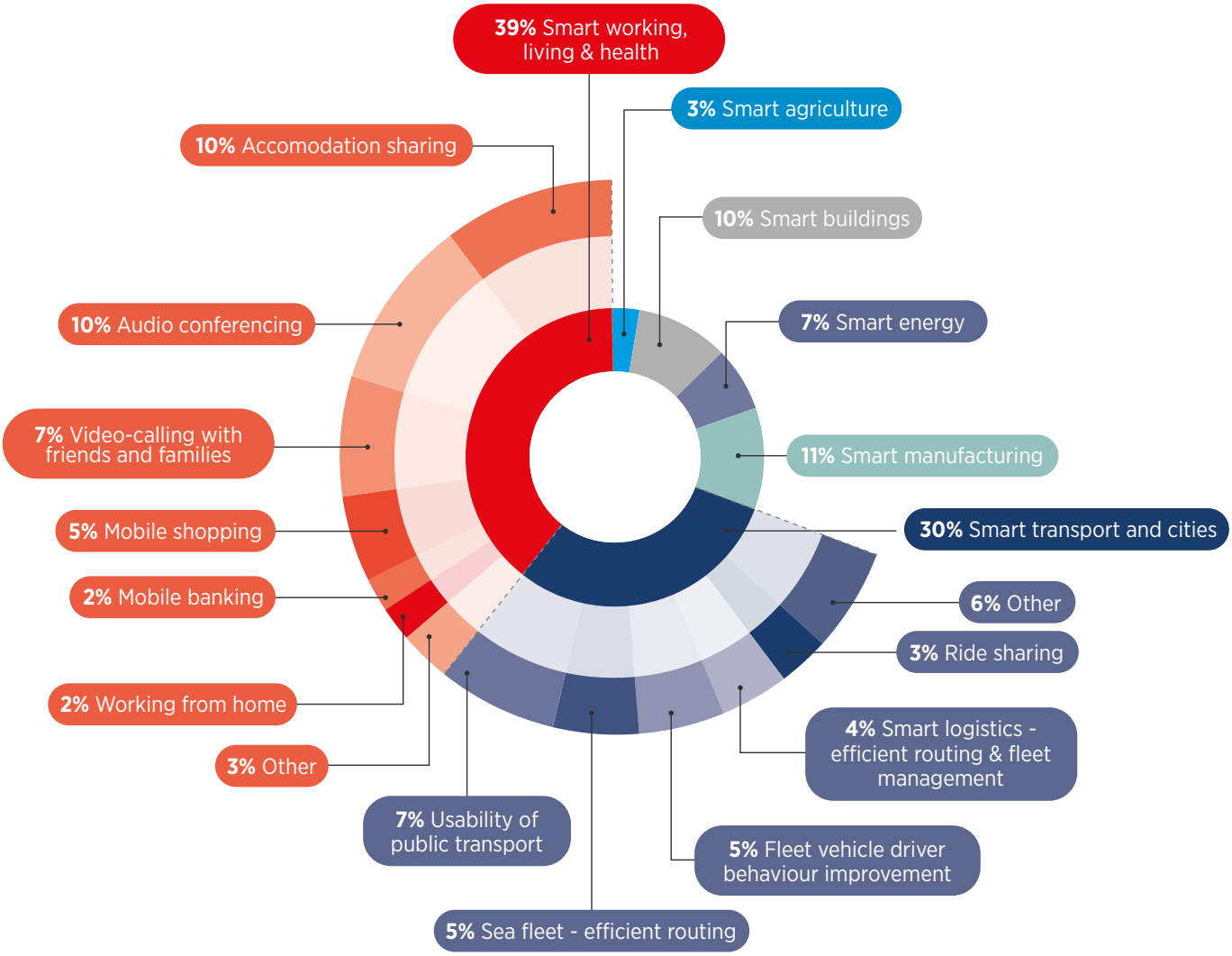
- reducing travel for commuting and leisure
- increasing the use of public transport with apps that provide real-time updates
- enabling accommodation-sharing for short stays and holidays
- reducing travel by use of mobile shopping and mobile banking apps.

18. Includes the energy to operate the networks, the embodied emissions of the networks and the emissions of handsets

Figure 42

Source: GSMA

Avoided carbon emissions enabled by mobile technology by category in 2018



Digitisation is expected to disrupt all parts of the economy over the next decade. If suitable policy is implemented and sufficient investment is received, digitisation has the potential to be a key driver of low-carbon development. Mobile network–enabled technologies form an important part of the decarbonisation solution, as they facilitate rapid emissions reductions while improving quality of life and supporting economic growth. By 2025, the growth in smartphone users and the number of IoT connections could result in a further doubling of the avoided emissions enabled by mobile technologies seen in 2018.[19]

19. For more information, see The Enablement Effect: The impact of mobile communications technologies on carbon emission reductions

04

Policies to accelerate digital development

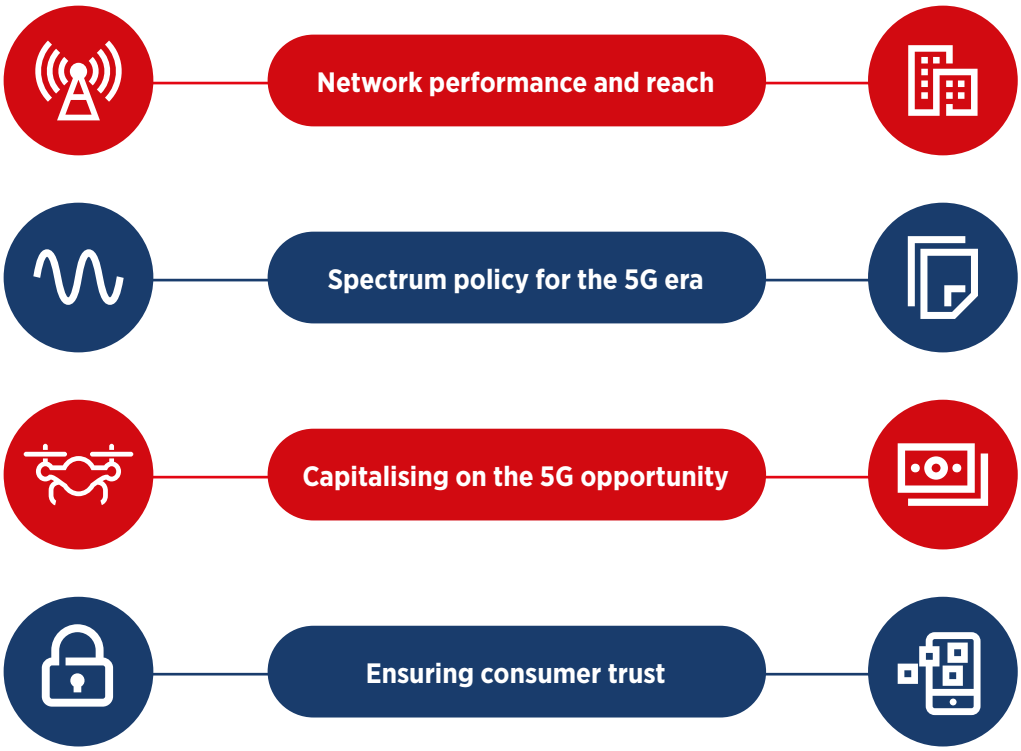
Mobile broadband generates vast benefits for society and the economy: innovative companies design and sell new connected products and services, creating jobs and economic value; citizens have more choice and enjoyment as a result of internet-enabled mobile devices; and entire industries are being transformed by new tools and processes made possible through connectivity.

However, the full potential of mobile technologies cannot be realised without the active participation of governments and regulatory authorities, working together with the private sector to enable vibrant, competitive markets and to help shape the digital environment citizens want.

Figure 43

Source: GSMA

Vital areas for progressive policies to accelerate digital development



Network performance and reach

Mobile connectivity, which relies on physical infrastructure and access to radio spectrum, requires continuous investment by operators to keep up with demand and provide the service consumers and businesses expect. In cities, mobile networks will increasingly consist of small cells — which means deploying antennas far more densely across the urban landscape. The cost of network densification is a challenge for all operators, and the process of securing antenna sites and planning permission can delay deployment and hold back new commercial service offerings.

In rural areas, gaps in mobile broadband coverage persist because of economic reasons. Rural infrastructure can be significantly more expensive to deploy as that in urban areas, while revenue opportunities are as much as 10 times lower due to the smaller population, making it a potentially risky or unprofitable proposition for operators. The mobile industry is innovating to drive down the cost of rural coverage, but many ideas are still in the design phase and have yet to be commercially trialled.

The priority for a growing number of policymakers is to expand the reach of commercially-sustainable, next-generation networks. Governments at all levels — municipal, local, regional and national — can take steps to support network deployment and expansion. As 4G networks continue to spread and 5G technologies begin to take root in urban areas, authorities need to find ways to simplify and standardise planning procedures and regulations for site acquisition, colocation and upgrades of base stations and small cells. They should offer a reasonable expectation of approval for voluntary network-sharing deals, but avoid implementing mandated sharing agreements. They should also adopt policies that reduce costs (e.g. taxation and fees) for operators while spurring investment.

Spectrum policy for the 5G era

Without access to sufficient radio spectrum in suitable frequencies, operators cannot deliver the connectivity people need and expect. For 5G, operators require a significant amount of new harmonised mobile spectrum, ideally 80–100 MHz of contiguous spectrum per operator in prime 5G mid-bands and around 1 GHz per operator in mmWave bands. For 5G to reach everyone, coverage spectrum in the bands below 1 GHz is also needed.

At the 2019 World Radiocommunication Conference (WRC), two new bands for internationally harmonised mobile service were identified: 26 GHz and 40 GHz. Two other frequency bands received mobile identification: 66 GHz (expected to be considered for unlicensed use by mobile) and 50 GHz (in designated countries). With these bands secured for mobile, a global ecosystem can now begin to develop equipment, devices and services that take advantage of these frequencies. As countries license spectrum for 5G services, governments and regulators should avoid inflating 5G spectrum prices (e.g. setting high auction reserve prices), as they risk limiting network investment and driving up the cost of services. In addition, regulators should not set aside spectrum (e.g. for vertical industries) that has been identified for mobile; alternative approaches, such as leasing access from mobile operators, can achieve the same purpose without jeopardising efficient use of this limited resource.

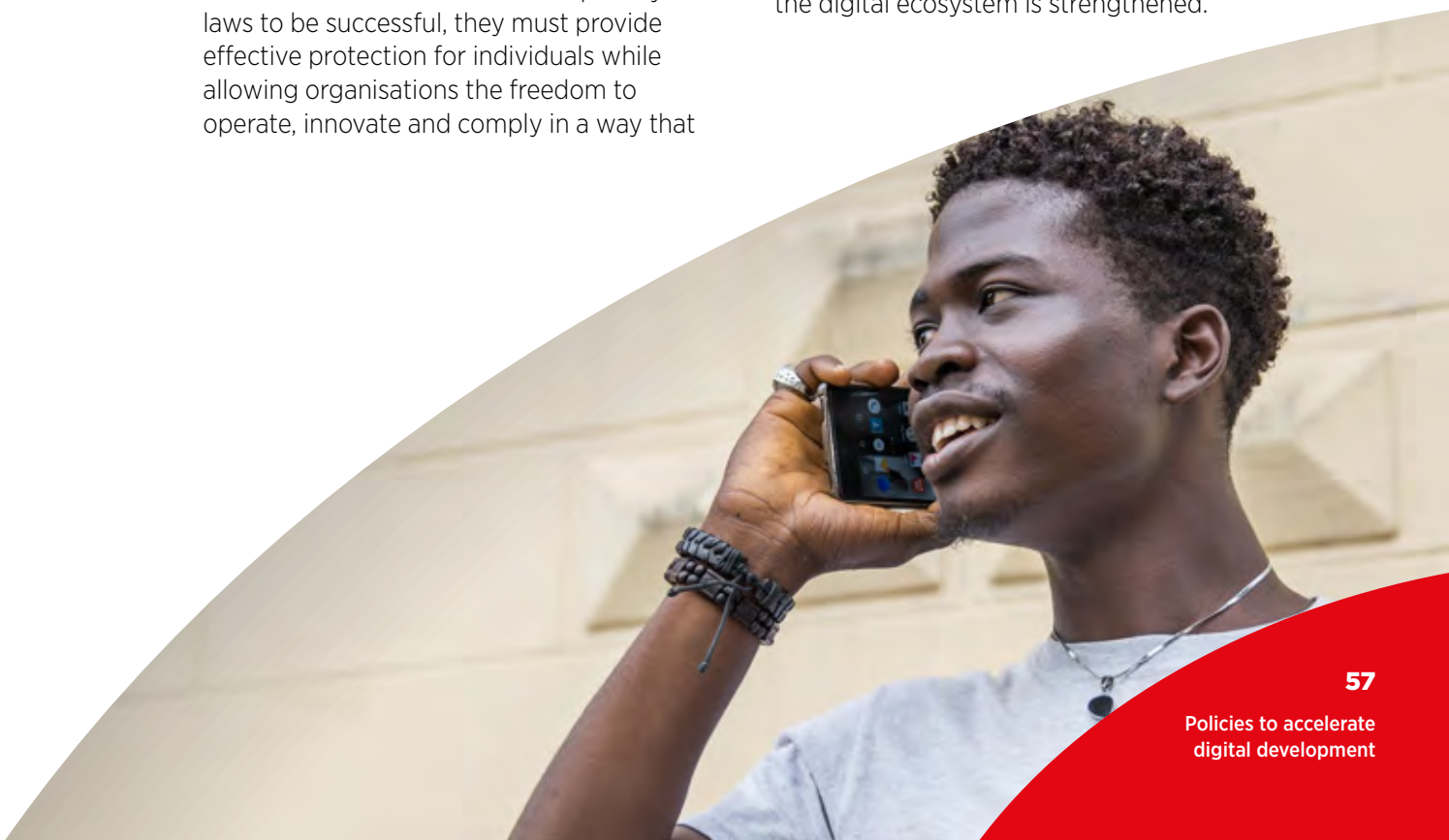
Capitalising on the 5G opportunity

5G will drive future innovation and economic growth, delivering greater societal benefit than any previous mobile generation and allowing new digital services and business models to thrive. Many countries have already launched 5G, but widespread commercial 5G services are expected in the post-2020 period, which will mark the start of the 5G era. 5G is developing in parallel with rapid advancements in both AI and IoT; the combination of these technologies will have a large positive impact, spawning innovations for consumers and enterprises defined by highly contextualised, on-demand and personalised experiences. To propel 5G into commercial use, governments and regulators must play their part and implement policies that encourage advanced technologies to be applied across all economic sectors.

Ensuring consumer trust

Erosion of trust in digital services was a major concern in 2019, which saw record levels of data breaches and disinformation campaigns, as well as startling revelations about the monetisation of consumers' personal information by internet companies. Governments are implementing new or revised rules to ensure their citizens are protected when they engage with digital technologies. Rules for the protection, management and processing of consumers' personal data vary greatly by sector, technology and country. This includes organisations' ability to transfer data within and between countries. For data privacy laws to be successful, they must provide effective protection for individuals while allowing organisations the freedom to operate, innovate and comply in a way that makes sense for their businesses and secures positive outcomes for society.

Rapid progress in digital technologies is not a guarantee. Operators in every country face obligations and constraints that slow down investment in mobile networks. To advance the mobile ecosystem and the digital economy overall, governments should strive, as much as possible, to lighten the regulatory load on the industry. When the business environment for mobile operators is less costly and more flexible, the performance and reach of mobile service expands, the pace of innovation increases and users' confidence in the digital ecosystem is strengthened.

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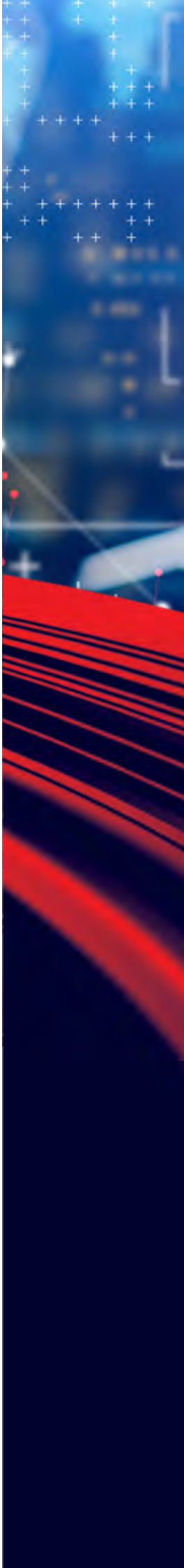

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