The Mobile Economy North America 2019

The GSMA represents the interests of mobile operators worldwide, uniting more than 750 operators with nearly 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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www.gsmaintelligence.com

info@gsmaintelligence.com

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Executive Summary

North America will be a 5G leader, bolstered by significant operator investment

Following commercial launches by the four largest US mobile operators, 5G is now a reality. As coverage expands across the US, and with Canada expecting to deploy 5G in 2020, 5G adoption is expected to rapidly gather pace in North America. By the end of 2022, 24% of connections on the continent will be on 5G networks, rising to 46% by 2025 – equivalent to 200 million 5G connections.

2019 will be the first year when 5G accounts for more than half of operators' capex in North America, reflecting the shift from LTE to 5G deployments. This trend will continue through 2020-2025, with 87% of operator capex in North America to be allocated to 5G by the end of the period. Between 2018 and 2025, mobile operators will invest $353 billion in capex in the US, more than in any other country.

North America: the global benchmark for mobile revenue and adoption

High subscriber penetration coupled with historically high consumer spend on mobile services means the North American mobile market will be worth $280 billion in revenue in 2019. In this context, the US is the largest market for mobile worldwide – around 50% greater than China.

North America also has the highest levels of mobile broadband and smartphone adoption globally. Moreover, it has some of the strongest levels of mobile engagement across a plethora of use cases, underpinned by rapid 4G adoption, which accounted for more than 75% of total connections in Q2 2019.

Mobile contribution to North America's economy will reach $1.2 trillion by 2023

In 2018, mobile technologies and services generated 4.2% of GDP in North America, which amounted to $937 billion of economic value added. The mobile ecosystem also supported 2.3 million jobs (directly and indirectly) and made substantial contributions to the funding of the public sector, with almost $123 billion raised through taxation. By 2023, mobile's contribution to the North American economy will reach almost $1.2 trillion (4.8% of GDP) as the US and Canada increasingly benefit from improvements in productivity and efficiency brought about by the increased uptake of mobile services.

Opportunities in the 5G era

The main opportunities to capture incremental revenue are 5G-based fixed wireless access (FWA) and 5G-based services targeted at enterprises. 5G FWA rollouts are underway in select US cities and will gain traction as more operators deploy 5G as an alternative to fixed broadband connectivity.

Initial enterprise 5G deployments are likely to focus on faster data speeds and enhanced capacity. The release of new standards will then introduce additional 5G features, such as ultra-reliable low-latency communications (URLLC), to support further enterprise applications.

Enabling policies for 5G leadership

A key priority of the Federal Communications Commission's (FCC) strategy under its 5G FAST Plan (Facilitate America's Superiority in 5G Technology) is to make additional spectrum available for 5G services. The US has been quick to allocate high-frequency spectrum bands for 5G networks; however, operators also need timely and sufficient availability of spectrum in mid-range bands for 5G to realise its full potential.

Infrastructure policy review is another part of the 5G FAST Plan. Given 5G's need for network densification, operators require access to public sites (e.g. buildings and street lights) to deploy network equipment such as small cells, which are expected to be widely utilised in 5G rollouts.

North America

Unique mobile subscribers

2018

321m

83% PENETRATION RATE (% of population) 85%

CAGR 2018–25

345m 1.0%

2025

Mobile internet users

2018

282m

73% PENETRATION RATE (% of population) 80%

CAGR 2018–25

326m 2.1%

2025

SIM connections

Excluding licensed cellular IoT

2018

400m

103% PENETRATION RATE (% of population) 108%

CAGR 2018–25

438m 1.3%

2025

Operator revenues and investment

Total revenues

2018

$272bn

2025

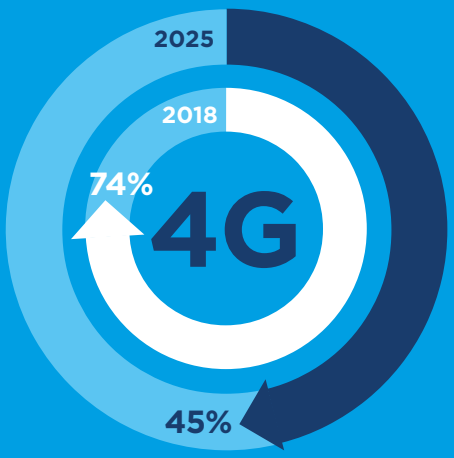
$317bn

Operator capex of $384 billion for the period 2018-2025

Smartphone adoption
(% of total connections)

2018	82%
2025	90%

4G adoption
(% of connections)*



Internet of Things connections

2.3bn 2018

5.9bn 2025

5G connections in 2025
(46% of total connections)* **200m**

*Excluding licensed cellular IoT

Mobile industry contribution to GDP

4.2% of GDP **$937bn** 2018

4.8% **$1.2tn** 2023

Public funding

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

2018

$123bn

Employment

2018

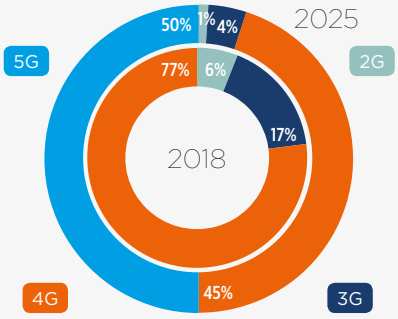
820,000 Jobs

directly supported by the mobile ecosystem

Plus 1.5m indirect jobs

US

TECHNOLOGY MIX



SUBSCRIBER PENETRATION

2018 — 2025

85% 86%

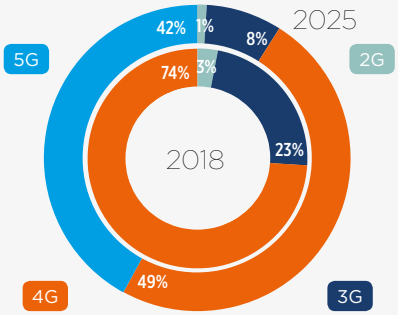
SMARTPHONE ADOPTION

2018 — 2025

83% 92%

Canada

TECHNOLOGY MIX



SUBSCRIBER PENETRATION

2018 — 2025

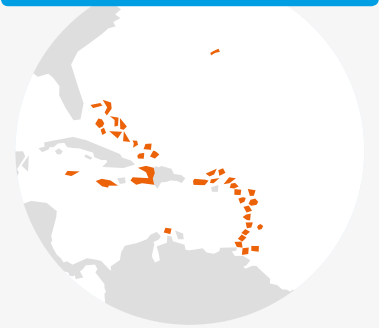
78% 82%

SMARTPHONE ADOPTION

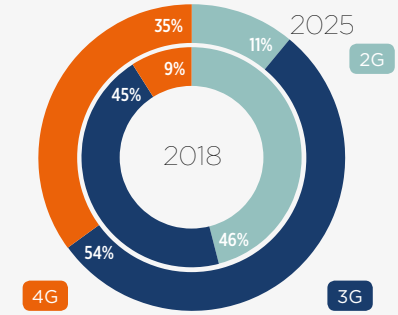
2018 — 2025

78% 81%

Caribbean



TECHNOLOGY MIX



SUBSCRIBER PENETRATION

2018 — 2025

66% 72%

SMARTPHONE ADOPTION

2018 — 2025

56% 72%

Defining the Caribbean

Countries included: Anguilla; Antigua and Barbuda; Aruba; Bahamas; Barbados; Bermuda; Cayman Islands; Curacao; Dominica; Grenada; Guadeloupe; Haiti; Jamaica; Martinique; Montserrat; Puerto Rico; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Trinidad and Tobago; Turks and Caicos Islands; British Virgin Islands; US Virgin Islands

01
The mobile market in numbers

1.1
345 million subscribers in North America by 2025

Figure 1 Source: GSMA Intelligence

Subscriber growth continues to slow, but there will still be almost 25 million new subscribers by 2025

Million

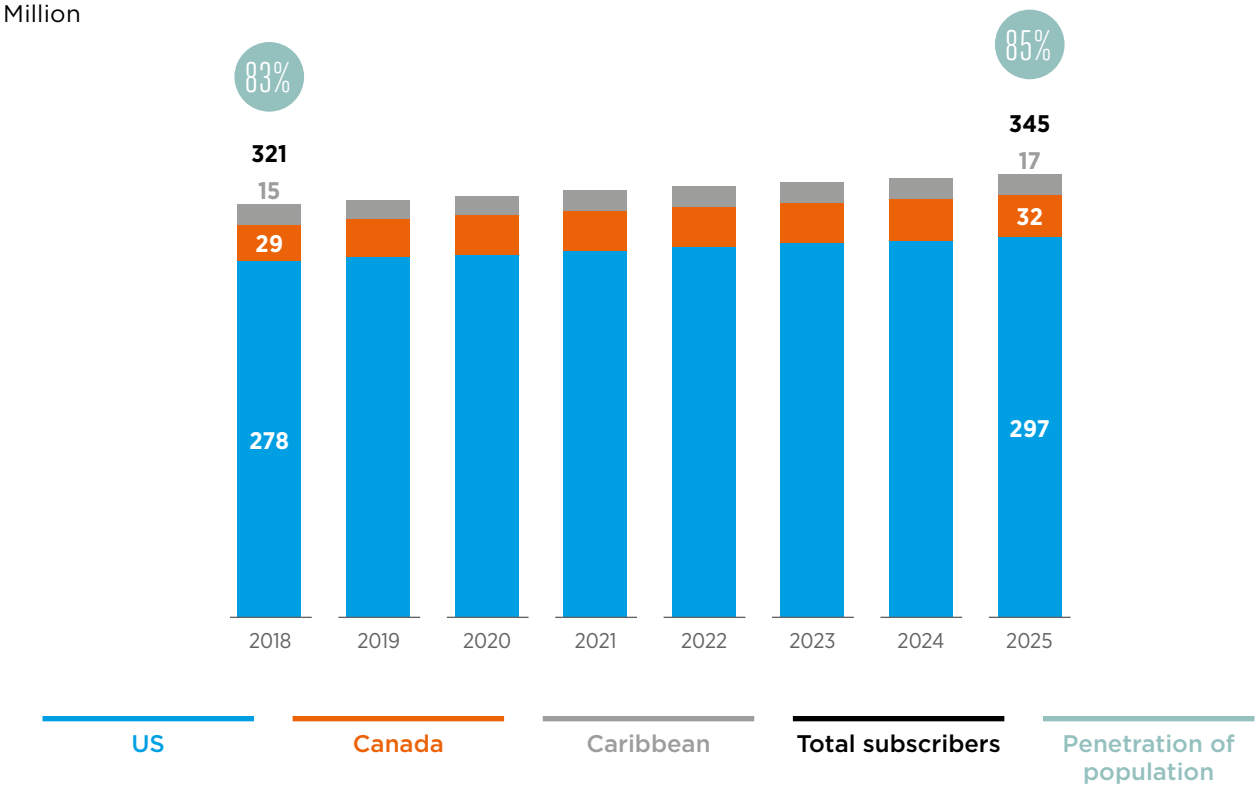
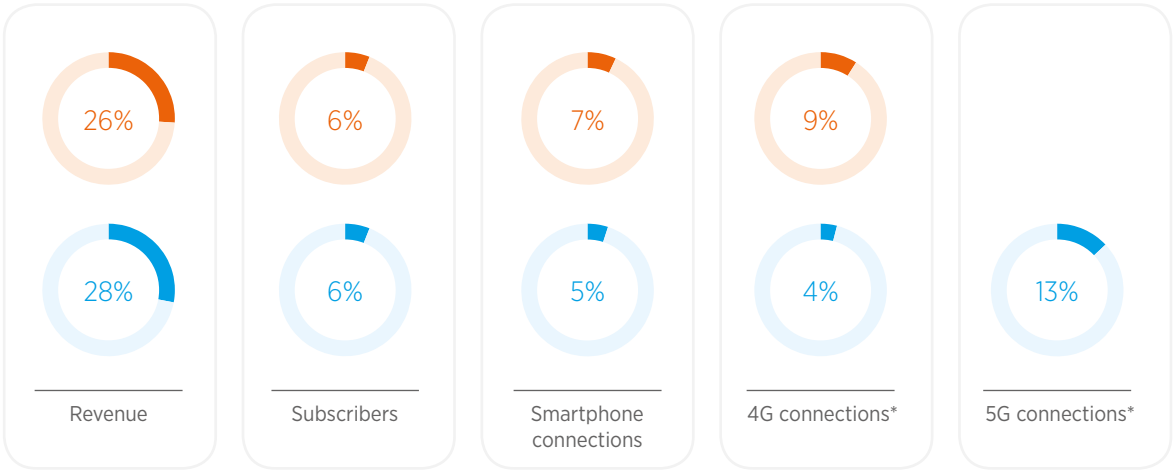


Figure 2 Source: GSMA Intelligence

Over a quarter of global mobile revenue stems from North America

North America's share of the global mobile industry



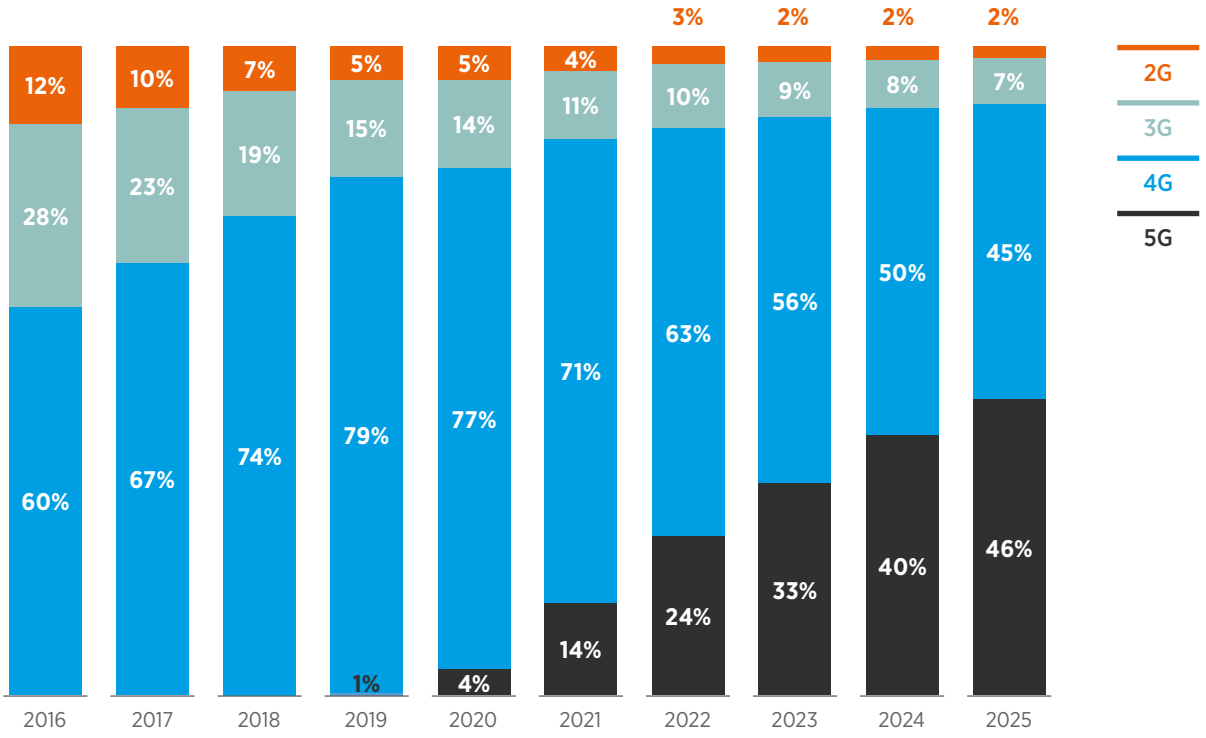
Excluding licensed cellular IoT

1.2
North America will be a leader in 5G adoption

Figure 3 Source: GSMA Intelligence

4G to remain the dominant technology in North America until 2025, when 5G connections will surpass 4G connections

% of connections



Migration to 4G and 5G networks accelerates, as legacy network shutdown continues

Some operators in North America have already begun to shut down 2G and 3G networks to refarm spectrum and provide additional data capacity on 4G networks. This trend will continue as operators in the region deploy 5G networks using a mix of low-, medium- and high-band spectrum. As legacy networks shut down, circuit-switched voice networks will be upgraded to all-IP core networks using voice over LTE (VoLTE) technology.

Figure 4 Source: GSMA Intelligence

5G coverage will grow quickly, laying the foundations for strong 5G uptake in North America

Connections (million)

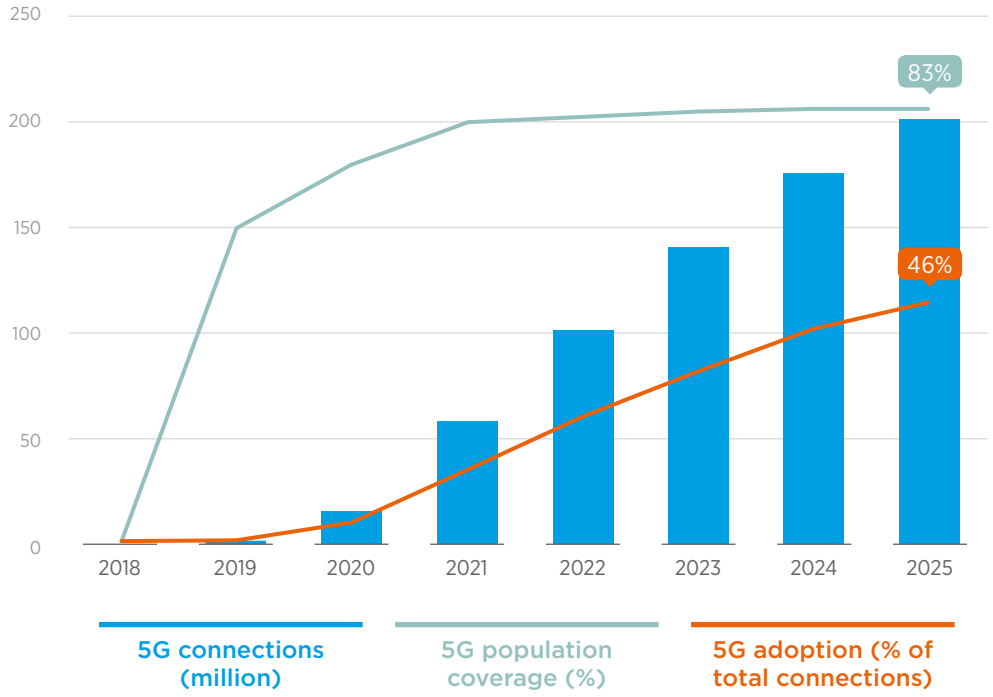
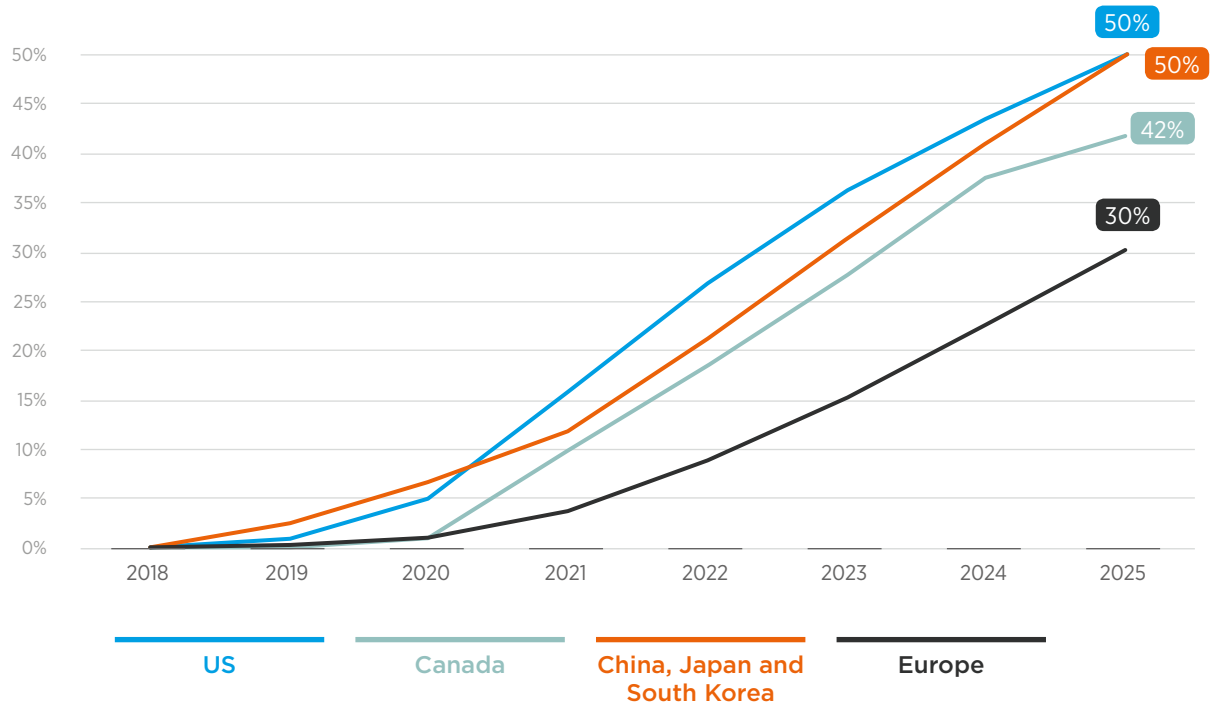


Figure 5 Source: GSMA Intelligence

The US is vying for global 5G leadership with China, Japan and South Korea

5G as a percentage of total connections



5G in Canada and the Caribbean

Mobile operators in Canada are making significant progress towards bringing 5G services to the country. For instance, Telus has undertaken 5G trials using mid- and high-band spectrum and plans to launch 5G in September 2020. Though Bell and Rogers have yet to formally announce launch dates, both operators undertook 5G network trials in 2019.

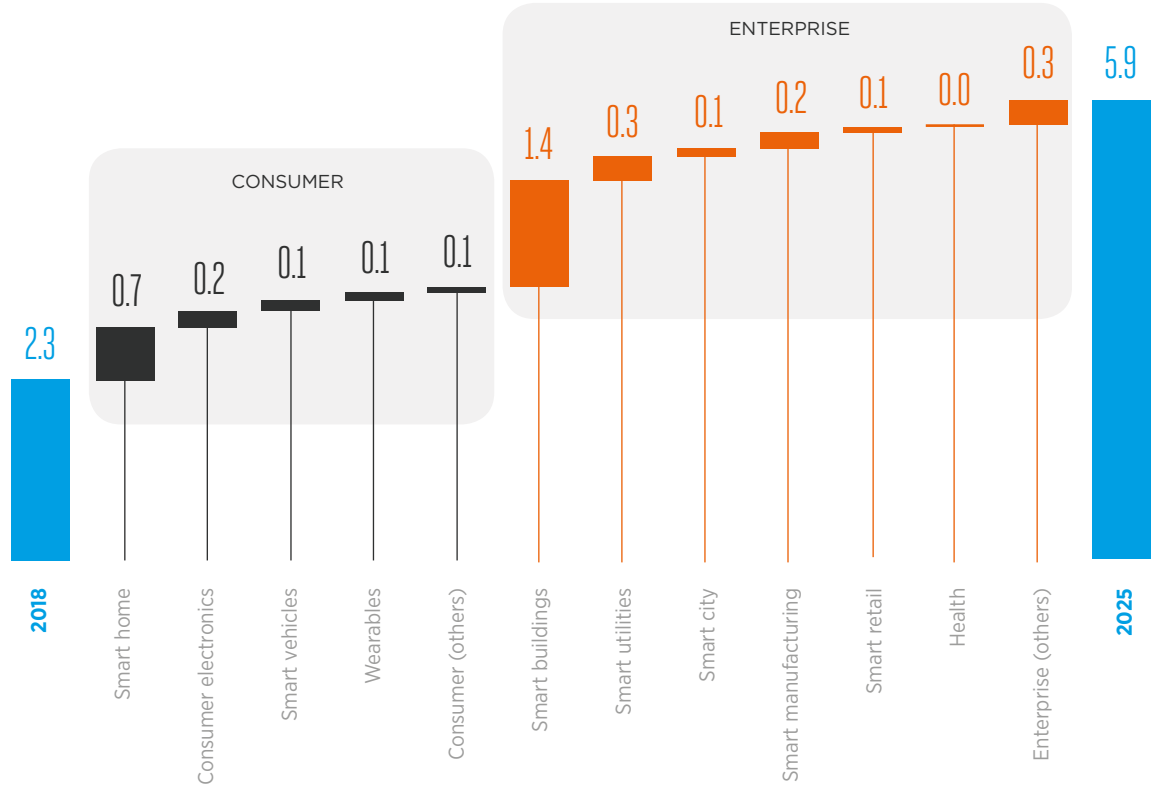
In the Caribbean, Flow (Liberty Latin America) recently conducted 5G trials in Antigua and Barbuda, while SFR (Outremer Telecom) began trials in Guadeloupe and Martinique. However, 5G is a longer-term technology for the region, as the 4G investment cycle is ongoing and consumer adoption is still in the early stages. Consequently, the majority of the Caribbean's 5G launches are not expected until the middle of the next decade, after significant improvements in device and infrastructure economies of scale.

Figure 6

Source: GSMA Intelligence

IoT will benefit from enhanced 5G capabilities, with 3.6 billion additional IoT connections expected in North America by 2025

Connections (billion)



Consumer (others) includes trackers for children, the elderly and pets, as well as drones and robots
Enterprise (others) includes fleet management and applications in agriculture, oil, mining and construction

1.3
Growth in digital consumers

Figure 7 Source: GSMA Intelligence Consumer Insights Survey 2018

Consumer engagement is rising across almost all smartphone activities in the US, fuelled by enhanced networks and unlimited price plans

% of US smartphone users engaging with certain use cases each month

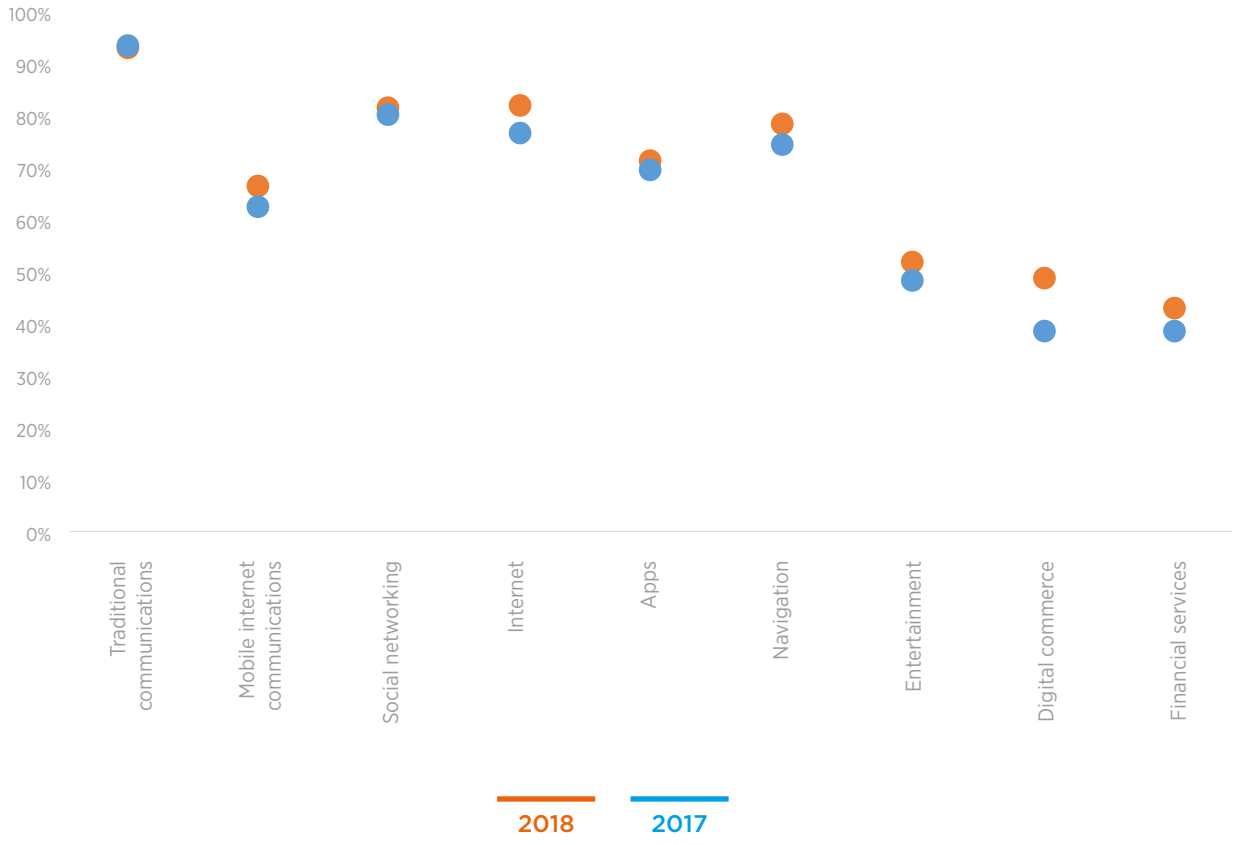
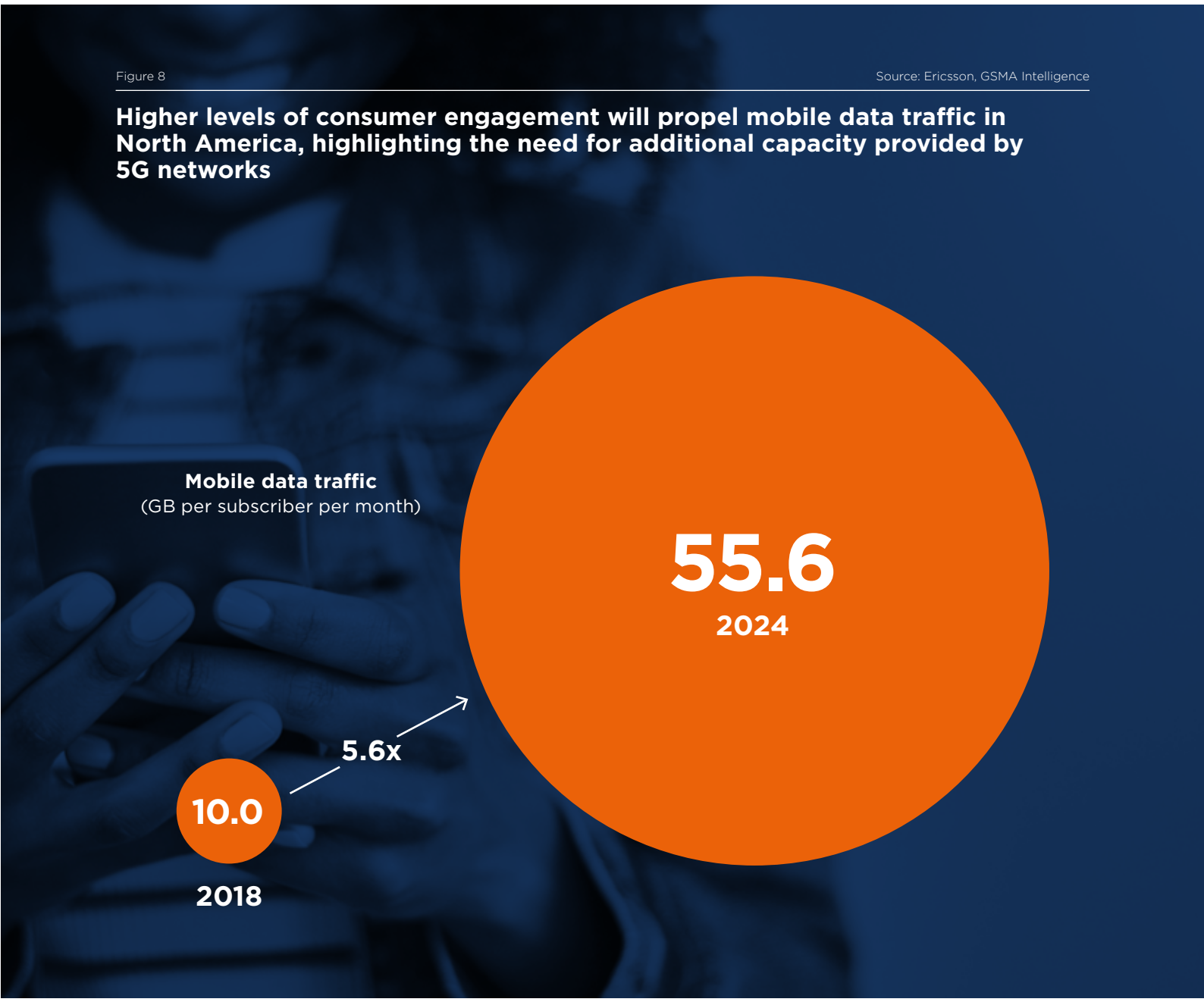


Figure 8

Source: Ericsson, GSMA Intelligence

Higher levels of consumer engagement will propel mobile data traffic in North America, highlighting the need for additional capacity provided by 5G networks



Rogers goes unlimited, causing a surge in customer data usage

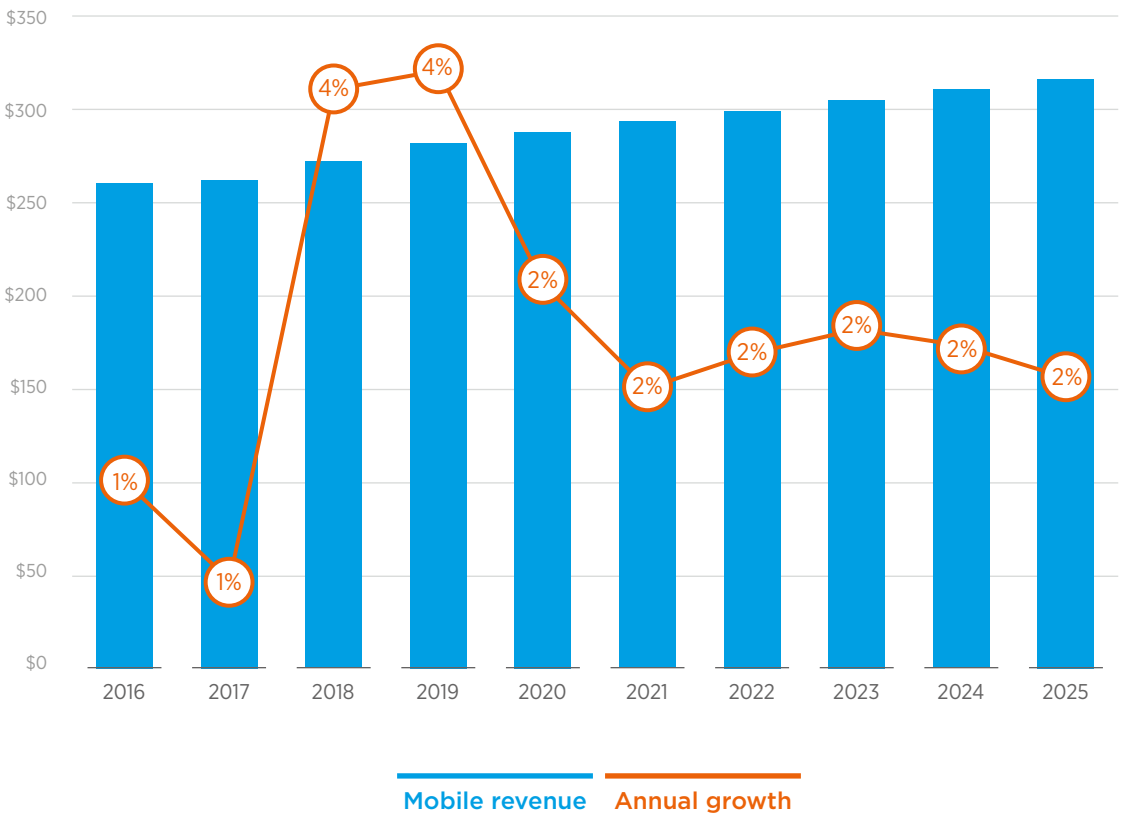
In June 2019, Rogers became the first national mobile operator in Canada to offer an unlimited LTE service plan. Rogers stated that after six weeks, data usage among unlimited customers had increased by 50%, with 365,000 customers (around 3% of its total subscriber base) on the new plans. Bell and Telus have already responded by launching their own unlimited price plans, while smaller regional players (including SaskTel and Freedom Mobile) have ramped up marketing efforts on their unlimited data plans following the moves by national operators.

1.4
A modest financial outlook as 5G investment gathers steam

Figure 9 Source: GSMA Intelligence

Following a period of intense competition, revenue growth recovered in 2018, driven by increased uptake of higher-value unlimited plans in the US

Billion



T-Mobile and Sprint's merger will help deliver 5G

On 29 July, the US Department of Justice provided clearance for the merger of T-Mobile and Sprint into an entity called New T-Mobile. This will potentially create a mobile operator with the scale and investing power on level with the country's two largest mobile operators (AT&T and Verizon), which will be pivotal for T-Mobile and Sprint as 5G investment expands.

As part of the transaction, T-Mobile will acquire Sprint's 2.5 GHz holdings, which will allow it to increase capacity in dense urban areas. This should translate into better quality service for customers streaming HD videos and, eventually, new services using augmented reality (AR) and virtual reality (VR). The company is targeting an ambitious 15× speed upgrade compared to LTE on average.

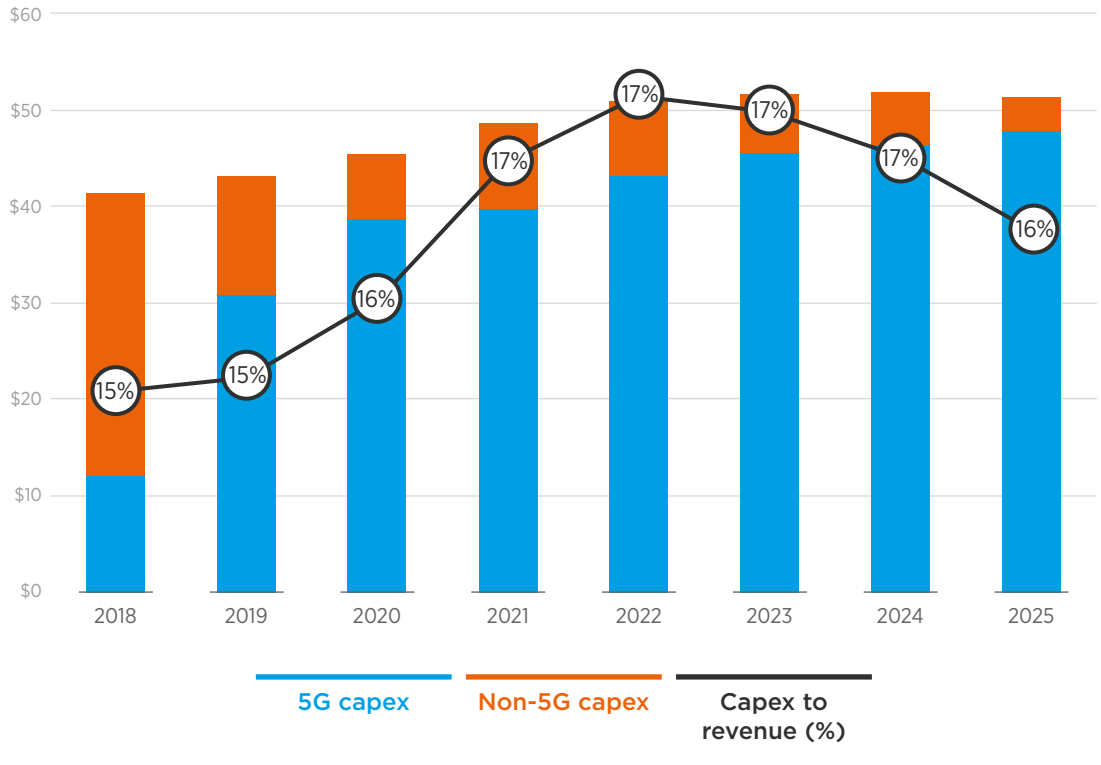
The other area of opportunity is 5G FWA for home broadband. Again, the 2.5 GHz spectrum is crucial. In comparison with high-frequency spectrum, the greater propagation characteristics of 2.5 GHz reduce the number of small cells which need to be deployed, although this comes at the expense of data speed.

As a condition for the merger to proceed, Sprint is divesting its prepaid business (Boost Mobile) and a portion of spectrum to Dish Network for $5 billion, ostensibly to ensure that the US remains a market with four national infrastructure-based operators in the long term.

Figure 10 Source: GSMA Intelligence

North American 5G capex will rise rapidly in 2019 to fund coverage expansion

Billion



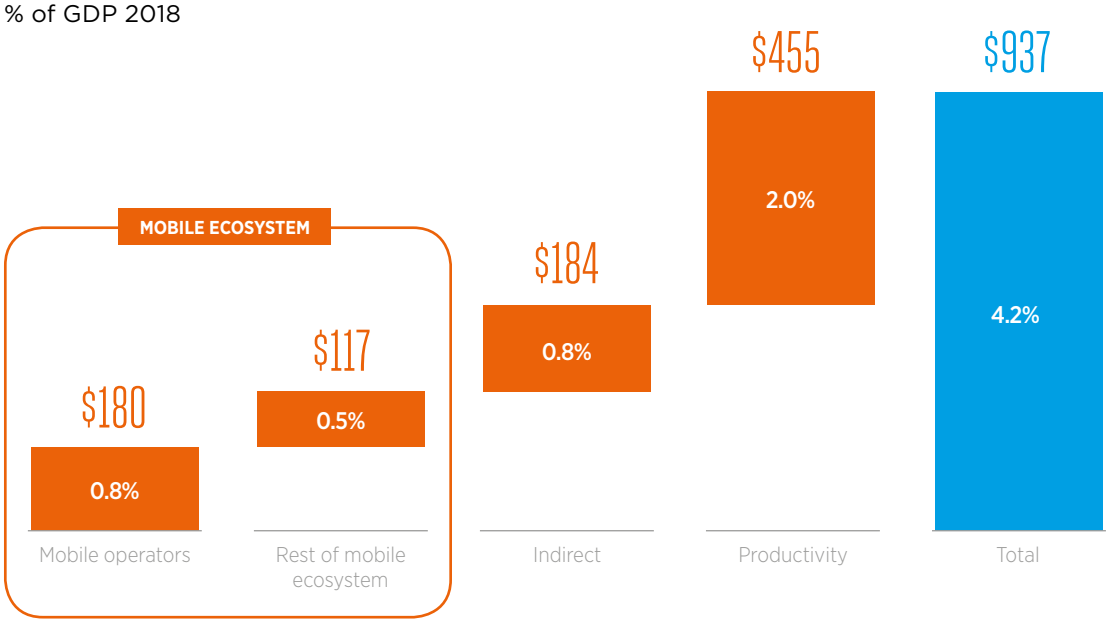
02
Mobile contributing to economic growth and addressing social challenges

2.1
Mobile's contribution to economic growth

Figure 11 Source: GSMA Intelligence

The mobile ecosystem contributed $937 billion to the North American economy in 2018

Billion, % of GDP 2018



Note: totals may not add up due to rounding.

Figure 12 Source: GSMA Intelligence

The direct economic contribution is mainly driven by mobile operators

Billion, % of GDP 2018

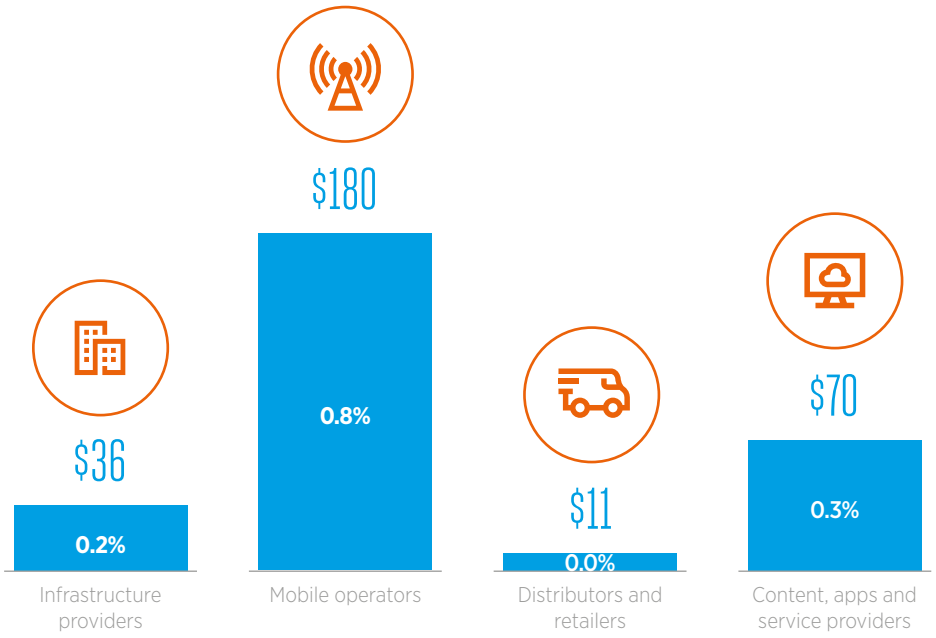
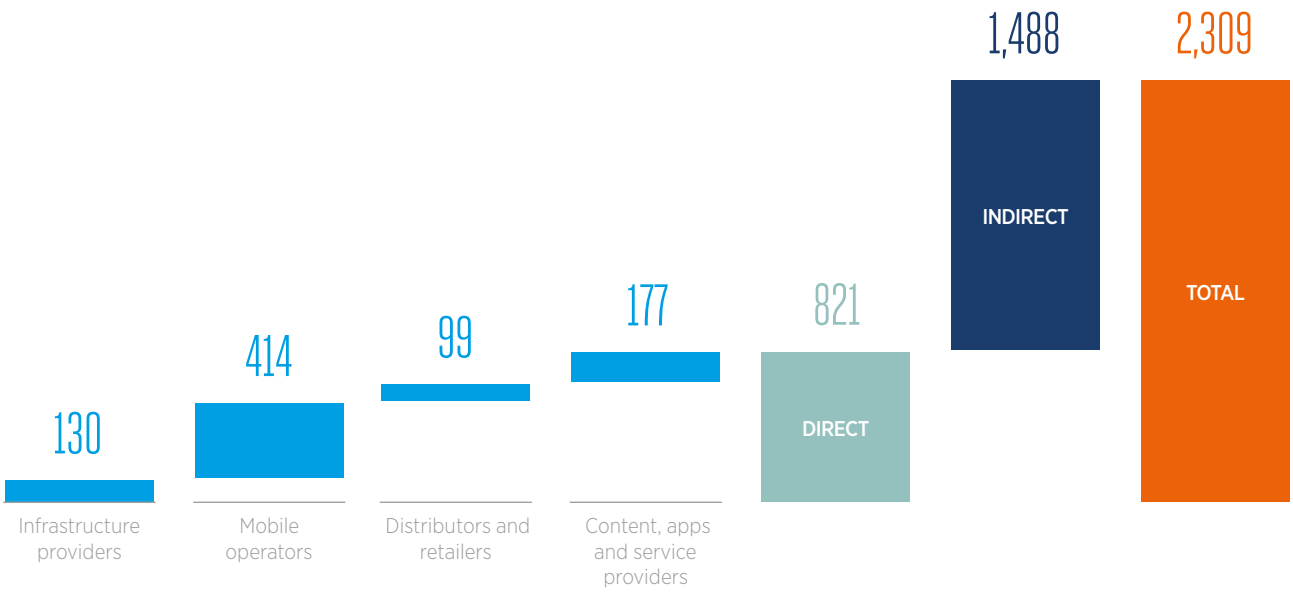


Figure 13 Source: GSMA Intelligence

The mobile ecosystem directly employs 820,000 people in North America and supports another 1.5 million jobs indirectly in other parts of the economy

Employment impact (jobs, thousands)

Just over half of the jobs created directly by the mobile ecosystem are created by mobile operators

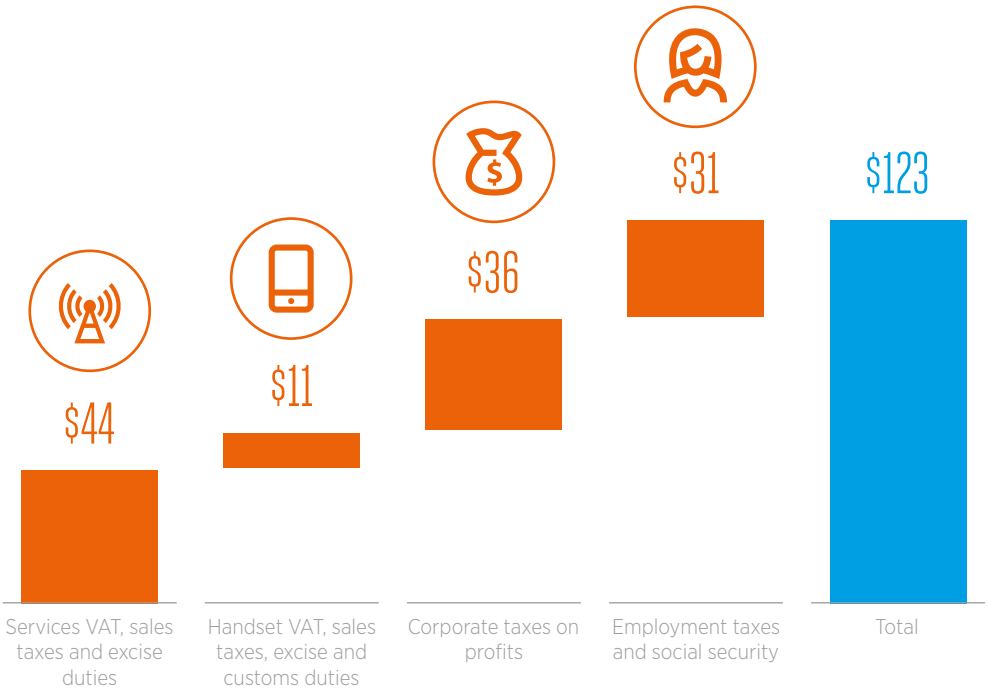


Note: totals may not add up due to rounding.

Figure 14 Source: GSMA Intelligence

In 2018, the mobile ecosystem contributed around $123 billion to the funding of the public sector through consumer and operator taxes

Billion



Note: totals may not add up due to rounding.

Figure 15

Source: GSMA Intelligence

Driven by direct, indirect and productivity gains, the economic contribution of mobile in North America will increase to almost $1.2 trillion in 2023

$ Billion, % of GDP

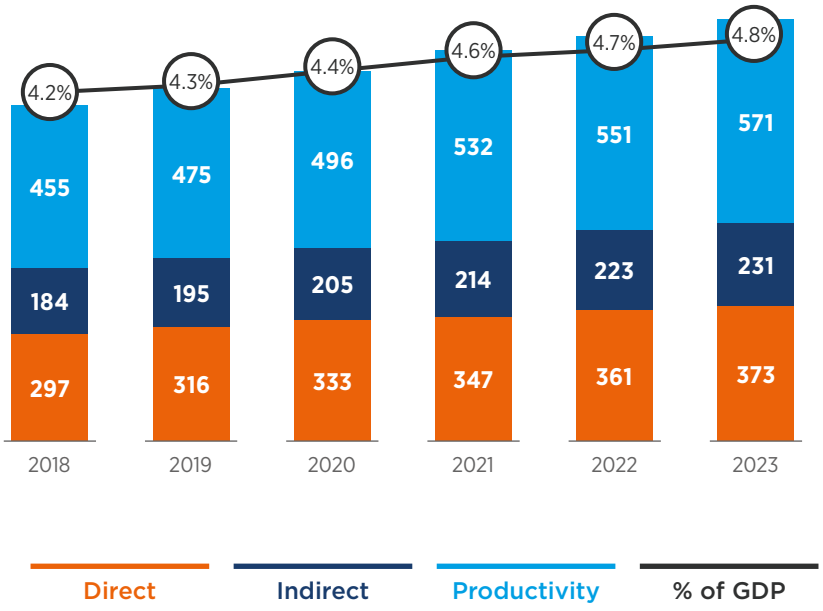
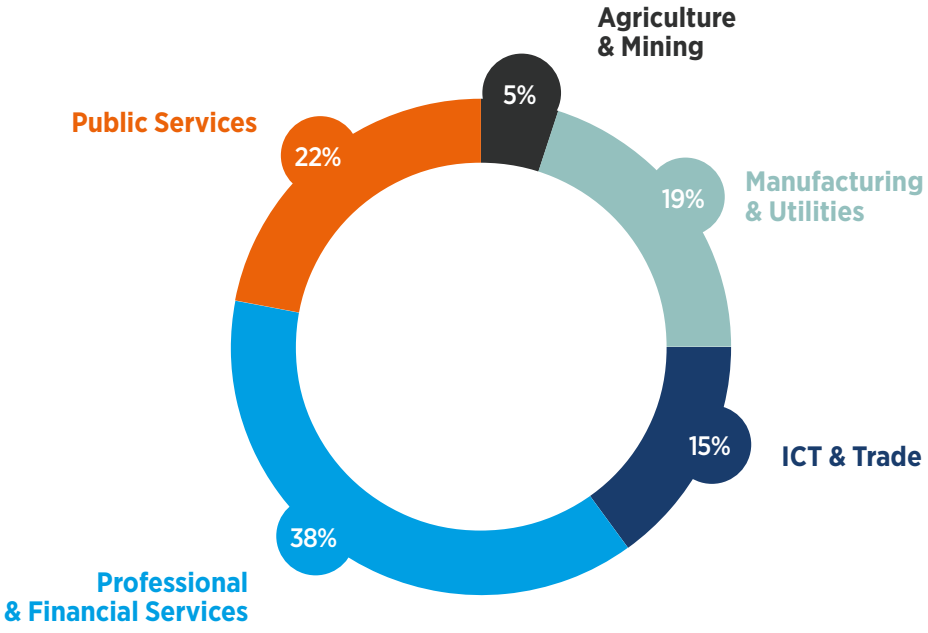


Figure 16

Source: GSMA Intelligence

5G will contribute $657 billion to the North American economy over the next 15 years

5G's contribution to GDP over the next 15 years by sector (%)



Note: totals may not add up due to rounding.

2.2
Mobile technology and climate change

The mobile industry is not the largest contributor of carbon emissions, but collaboration is nevertheless needed to limit the industry's emissions and maximise its potential to help other sectors reduce their emissions. In support of this, the GSMA has announced an industry-wide plan for disclosure and emissions target setting and, along with many of its members, has committed itself to be net zero by 2050.

Enabling the transition to a zero-carbon economy

Mobile technology's biggest impact on climate change comes from its ability to enable other sectors of the economy to reduce their greenhouse gas (GHG) emissions. Operators in North America are providing connectivity for digital solutions that reduce GHG emissions, such as by reducing energy use or travel and transport. For example:

- **Connected health:** Mobile solutions are expanding access to medical and health services. Using solutions such as remote patient monitoring, patients can lessen the number of trips they take to see a medical provider, saving time and reducing fuel usage and hospital emissions. In 2018, Verizon avoided 147,023 tonnes of CO2e[1] by helping to cut down both travel and days spent in hospital through remote patient monitoring.[2]
- **Remote working:** Smartphones and mobile connectivity enable remote working and collaboration, decreasing the need for travel and thereby reducing GHG emissions. For AT&T, its mobile work tools and virtual collaboration technology were its largest source of technology-enabled carbon reduction in 2018.[3]
- **Smart logistics:** Mobile connectivity facilitates the collection of vehicle data, which can be used to improve route planning, optimise loads and enhance driver behaviour. US operators have deployed fleet management solutions, such as T-Mobile's partnership with Roambee to reduce fuel consumption and associated GHG emissions.
- **Smart traffic management:** Mobile connectivity enables more efficient traffic flows; this eases congestion and lowers vehicle pollution. By using intelligent asphalt with embedded sensors that monitor traffic flow, Verizon is helping cities adjust traffic signals to shorten commute times and cut carbon emissions.

1. Carbon dioxide equivalent, the standard unit for measuring carbon footprints
2. Corporate Responsibility Report, Verizon, 2018
3. "Progress to 2025 — 10x Goal Update", AT&T, 2019

Ambitious goals to enable emissions reductions

In recent years, a growing number of mobile operators have been setting ambitious enablement impact goals. Mobile operators in North America are already reporting good progress:

- As a member of the Net Positive Project,[4] 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. By the end of 2018, AT&T had enabled GHG savings that were equal to approximately double the footprint of its operations.
- In 2018, Verizon's solutions enabled the avoidance of 8.2 million metric tons of CO2e, equivalent to taking 1.6 million cars off the road. The emissions avoided were 1.68 times greater than the emissions generated by Verizon's operations.
- For its substantial use of renewable energy, Bell received an 'A' rating for climate change in the 2018 CDP (formerly the Carbon Disclosure Project) global disclosure system. Bell generated 170,000 kWh from solar and wind power sources in 2018.[5]

Cutting down emissions and improving energy efficiency

Operators recognise the urgency of the climate crisis and are striving to minimise their own climate impact in three main areas:

- **Energy efficiency:** Energy efficiency initiatives help operators decouple energy consumption from data traffic growth, stabilising the former despite huge increases in the latter. Operators in North America are mobilising the deployment of software-defined networks, which harbour great potential for tackling carbon emissions.
- **Sourcing renewable energy:** Progressing towards absolute-zero emissions necessitates that the industry makes big strides in increasing its use of renewable energy. T-Mobile, for example, has a target of using 100% renewable electricity by 2021.[6]
- **Working with stakeholders to decrease value chain emissions:** Mobile operators have the potential, and responsibility, to positively influence emissions levels across the value chain. For example, AT&T is working with its largest suppliers to set and track goals for GHG emissions through its Supplier Sustainability Scorecard.

Guiding the mobile industry towards net zero by 2050

As part of its efforts to fulfil the delivery of the UN Sustainable Development Goals (SDGs), the mobile industry is making a specific commitment to SDG 13: Climate Action, reflecting the urgent need to accelerate action to limit global warming to 1.5°C by 2050.

While many operators have been supporting climate action efforts for some time, the GSMA is bringing the industry together to develop a collective approach and create a long-term climate action roadmap. The mobile industry, together with the ICT sector, will be among the first industries to develop its own sector pathway to net-zero GHG emissions by 2050.

In 2019, a group of mobile operators – including AT&T, Bell, Telus, T-Mobile and Verizon – took the first step on this journey by committing to disclosing climate impacts, energy use and GHG emissions. The next phase will involve developing a decarbonisation pathway for the mobile industry that is aligned with the Science Based Targets initiative (SBTi).[7]

4. https://www.netpositiveproject.org/
5. Corporate Responsibility Report, Bell, 2018
6. "Magenta Goes Green: T-Mobile Commits to 100% Renewable Energy", T-Mobile, 2018
7. https://sciencebasedtargets.org/

03
Key trends shaping the mobile ecosystem

5G has now arrived in the US, bringing with it the promise of an array of new services and applications. The main opportunities for US operators to generate incremental revenue in this new era are 5G FWA and 5G-based services targeted at the enterprise sector. To realise this enterprise opportunity, operators must expand their IoT capabilities beyond connectivity to capture value in adjacent areas. This will also require computing power to be distributed to the edge of the network to support services requiring higher performance. As a result of this rapid advancement in technology, everyday activities will increasingly be conducted online; this reinforces the responsibility of companies to maintain the online security and privacy of their customers, and new authentication services will be integral to this.

3.1
5G is here: expectations versus reality

5G arrives in the US alongside high consumer expectations

The US reached a major milestone in the first half of 2019 with the four largest mobile operators all launching mobile 5G services. Initial price plans allude to the historical unwillingness of consumers to pay for higher speeds alone and demonstrate that operators recognise value will instead come from multiple sources, including capacity offload, fixed wireless and enterprise market opportunities. 5G price plans will, however, evolve as coverage expands and the range of compatible devices and 5G applications increases.

Figure 17 Source: GSMA Intelligence, operator websites

The four largest mobile operators in the US have all launched commercial mobile 5G networks

	Frequency	Type	Vendors	Compatible 5G smartphones
AT&T	39 GHz	Mobile	Ericsson, Nokia	Samsung Galaxy S10 5G
Sprint	2.5 GHz	Mobile	Ericsson, Nokia, Qualcomm, Samsung	LG V50 ThinQ 5G OnePlus 7 Pro 5G Samsung Galaxy S10 5G
T-Mobile	28 GHz	Mobile	Ericsson, Nokia	Samsung Galaxy S10 5G
Verizon	28 GHz	Fixed wireless, mobile	Ericsson, Samsung	LG V50 ThinQ 5G Motorola Moto Z4 Samsung Galaxy S10 5G Samsung Galaxy Note10+ 5G

Table correct as of 10/10/2019

Consumer expectations for 5G are higher in the US than other markets; focussed messaging will therefore be key to meeting expectations. This is especially pertinent considering that most 5G services in the US currently rely on mmWave spectrum, which allows US operators to offer vastly improved mobile data speeds but limits the potential of 5G to improve coverage because of weaker signal propagation (improved coverage being an expectation of more than half of US consumers).

US operators are also exploring the use of 5G as a last-mile technology to provide fixed broadband connectivity – a proposition that more than a quarter of US consumers expect to improve fixed broadband. Verizon is leading in this field, having launched 5G FWA, based on its proprietary 5G Technical Forum standard, in four cities in October 2018. Its future 5G FWA rollouts will use standards-compliant equipment and could reach up to 30 million US households.

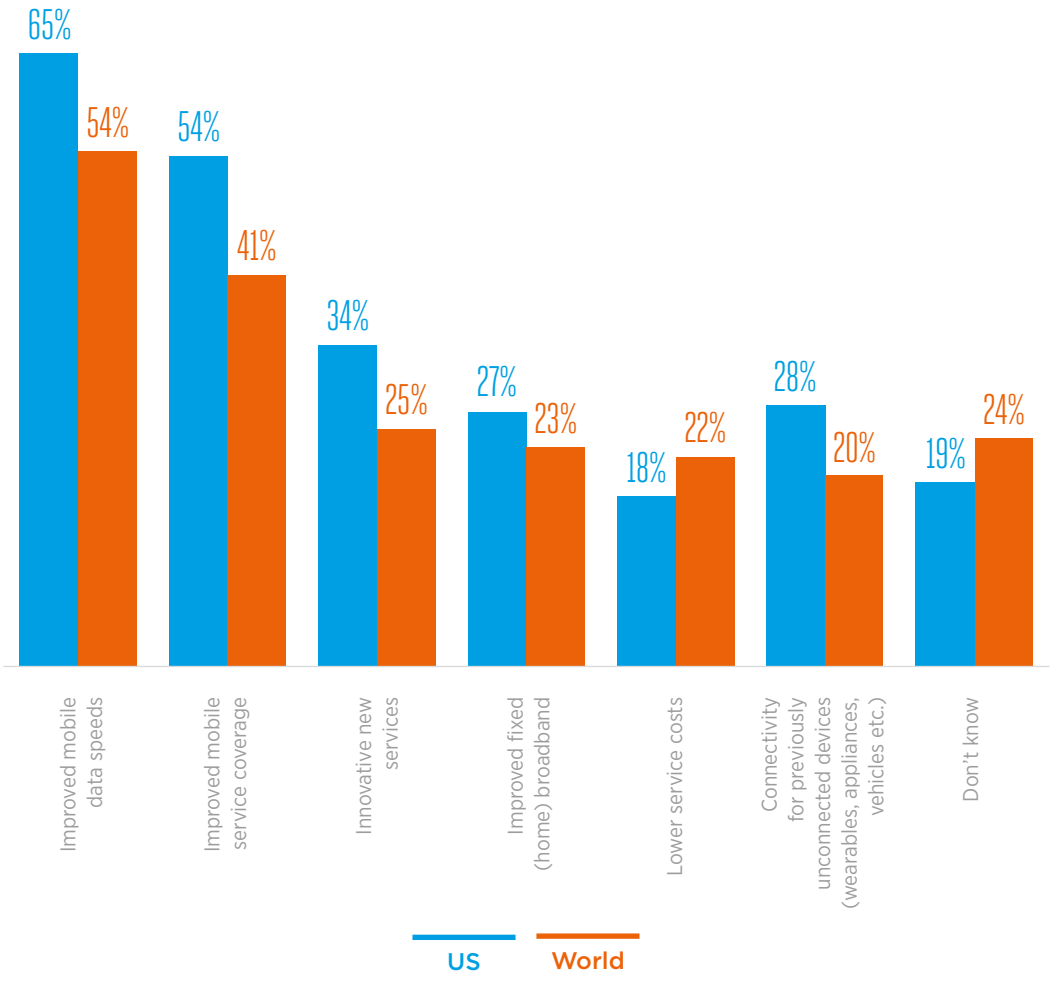
Other US mobile operators will also deploy 5G FWA services. For example, T-Mobile plans to offer 5G FWA to 52% of US zip codes by 2024. Operators intend to position 5G FWA as an alternative to cable, which accounts for nearly two thirds of US fixed-broadband connections. This will provide a platform for mobile operators to launch further in-home services, such as video streaming and smart-home functions.

Figure 18 Source: GSMA Intelligence Consumer Insights Survey 2018

Respondents in the US are more optimistic about the benefits of 5G compared with other regions

From what you know of 5G, what do you expect it will deliver?

% of respondents agreeing with each statement



Improved data speeds drive 5G enterprise deployments

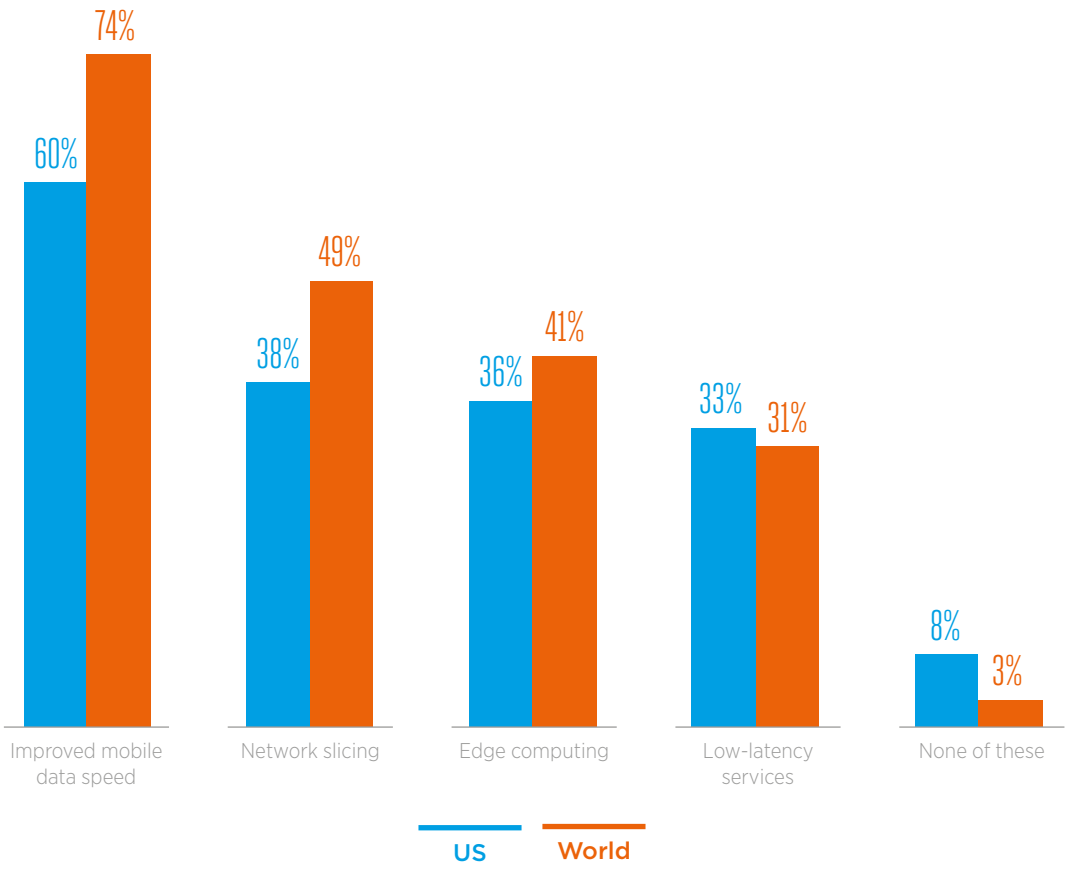
The largest opportunity for incremental revenue in the 5G era is from services aimed at the enterprise sector. Initial enterprise 5G deployments are likely to focus on faster data speeds, which enterprises identify as the most compelling feature of 5G. 5G networks can also provide additional capacity to support large-scale IoT deployments in verticals such as manufacturing and utilities. As new 5G capabilities are added in the release of future standards, other features will increase in importance: for instance, 5G will support enhanced quality of service and lower latency, enabling applications that require URLLC and time-sensitive networking. This will be crucial for industrial IoT manufacturing processes, including closed-loop robotic control, automated guided vehicles and AR/VR.

Figure 19 Source: GSMA Intelligence Enterprise Survey 2018

US enterprises across all verticals find speed the most compelling 5G capability

Which of the following 5G capabilities would make it compelling for your organisation to use 5G for future IoT deployments?

% of respondents agreeing with each statement



Network slicing: the requirement for a specific network slice to meet defined service-level agreements on throughput, latency, security, speed etc.
Edge computing: the requirement for storage/computing resources at the edge (e.g. device, gateway)

AT&T has geared its 5G launch towards the enterprise market, which accounts for more than 40% of the company's total revenue and nearly 60% of EBITDA, and its enterprise 5G deployments are targeting key industry verticals. For example, AT&T is providing 5G services to Rush University Medical Center in Chicago, supporting patient intake and ambulatory care; it has also partnered with Samsung to test 5G-enabled smart factory applications in Austin.

Private LTE networks will pave the way for future enterprise 5G use cases

Previously, private network deployments (dedicated slices of bandwidth allocated for the sole use of a specific customer) were reserved for mission-critical services, such as emergency response and air traffic control. However, enterprises have recently expressed their interest in private networks as a means to digitise operations through LTE-M or NB-IoT. This grants mobile operators the chance to move beyond providing connectivity to also delivering managed services, while simultaneously using private LTE networks as a test bed for future enterprise 5G use cases.

However, operators developing private LTE solutions must compete in an increasingly complex market. In the US, there are signs that enterprises are considering their own private network deployments by securing shared spectrum through the Citizens Broadband Radio Service (CBRS) initiative.[8] This includes private venues, utility companies and manufacturers that want to deploy location-specific networks e.g. at stadia, factory sites or campuses.

8. CBRS opens up 150 MHz of spectrum in the 3.5 GHz band (3550-3700 MHz) using a spectrum management approach, which supports three tiers of access. The top tier consists of incumbents (e.g. the US military); the second tier is for Prioritised Access Licence holders, who will pay to use a portion of the spectrum when it is not in use by incumbents; and a third tier that is available to anyone but comes with the least protection.

3.2
IoT: beyond connectivity

Scaling IoT

The advent of 5G strengthens the development of the IoT market in North America, which will increase by 3.6 billion connections to a total of 5.9 billion connections by 2025.

Though short-range technologies (e.g. Wi-Fi and Bluetooth) will retain a dominant presence, licensed cellular technologies[9] will provide connectivity for an increasingly large number of trusted connections. Underpinned by operator deployments, LTE-M and NB-IoT will both experience robust growth. In 2018, Bell rolled out LTE-M and NB-IoT in Canada, while AT&T and Verizon launched NB-IoT in 2019 to complement their existing LTE-M networks. This emphasises the low incremental cost of deploying both standards and the desire of operators to provide connectivity solutions that meet the needs of all use cases.

Figure 20 Source: GSMA Intelligence

The different feature sets of NB-IoT and LTE-M mean the technologies have complementary use cases

	NB-IoT	LTE-M
Features	High latency	Low latency
	Low data rates	Medium data rates
	Limited mobility	Full mobility
	Excellent indoor coverage	Good indoor coverage
	Excellent battery life	Good battery life
	Low-cost modules	Medium-cost modules
Use cases	• Agricultural monitoring • Environmental monitoring • Street lighting • Smart buildings • Smart parking • Waste management • Water and gas metering	• Asset tracking • Fleet tracking • Home security • Industrial sensors • Retail and point-of-sale systems • Remote health monitoring • Wearables

9. Licensed cellular includes a mix of technologies, including cellular M2M provided over existing 2G, 3G, 4G and, in the future, 5G networks, and licensed LPWA, which includes NB-IoT and LTE-M.

Capturing value beyond connectivity

Despite continued growth in IoT connections, connectivity will remain only a small fraction of total IoT revenue: mobile operators would need to increase volumes by double digits just to maintain revenues at current levels. For instance, Verizon reported IoT revenue that exceeded $1 billion for the first time in 2016, having acquired telematics groups Fleetmetrics and Telogis that year, and grew on average by 46% in 2016 and 2017. However, its IoT revenue growth slowed in 2018 to 11%, pointing to the end of the operator's acquisition spree and the deflationary nature of data unit pricing.

Operators are therefore expanding their capabilities beyond pure connectivity to maintain relevance and grow revenue. There are a number of opportunities for operators to expand their role in the IoT value chain; North American operators are growing their IoT platform capabilities to offer additional IoT services such as security, data analytics and professional services.

Figure 21 Source: GSMA Intelligence

Applications, platforms and services revenue will grow over 20% year-on-year between 2018 and 2025 in the US

Billion

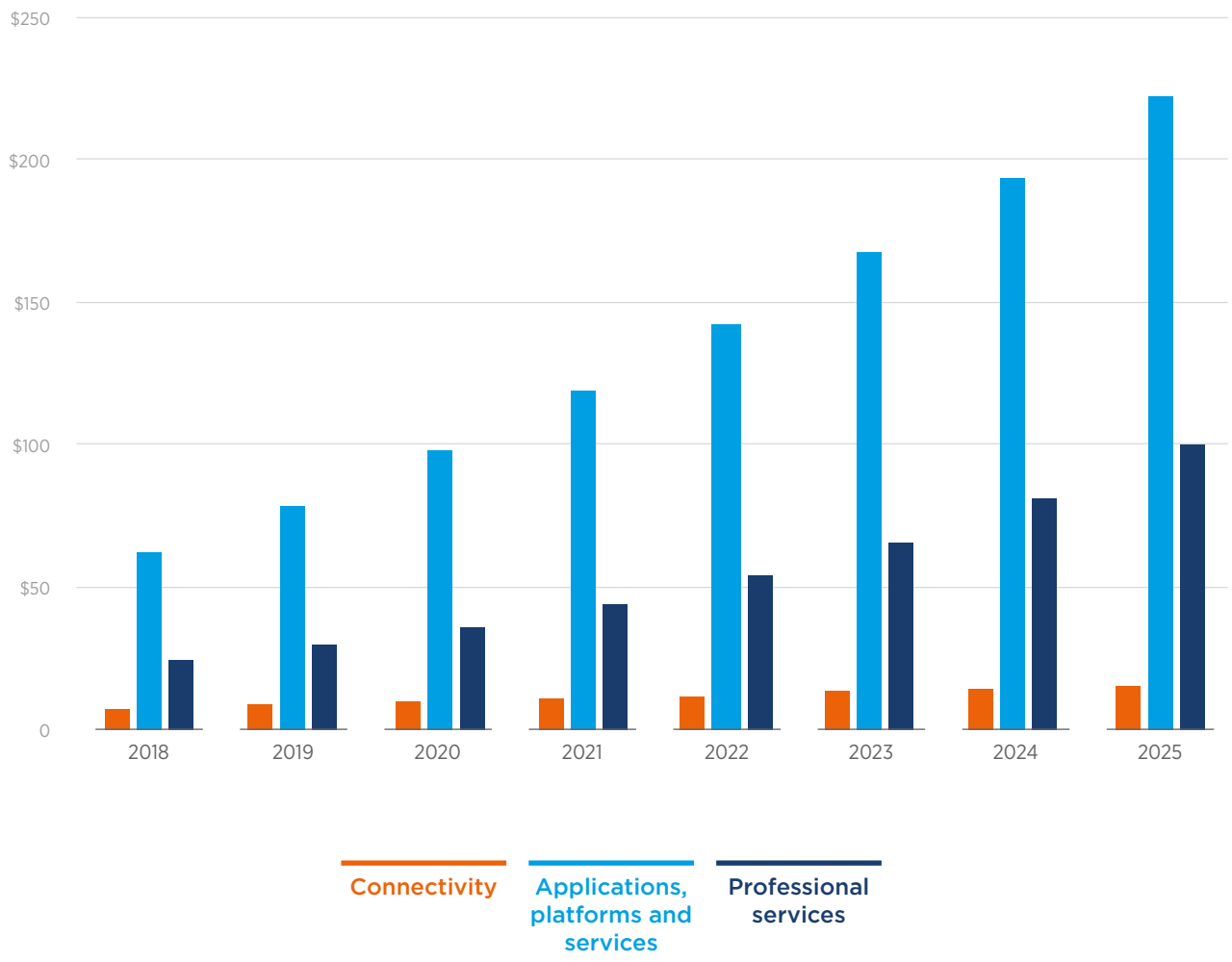


Figure 22

Source: GSMA Intelligence

The value of future IoT platforms lies in the device management and application enablement layers

	Purpose	Capabilities	Platform revenue 2018	Platform revenue 2025
Connectivity management platform (CMP)	Allows customers to manage IoT connections through a portal or application programming interface (API)	• SIM provisioning and management • Usage control and management • Network analytics		
Device management platform (DMP)	Provides remote configuration and updates for connected devices	• Device provisioning • Device monitoring, alerting and management • Device lifecycle management		
Application enablement platform (AEP)	Enables the IoT ecosystem to innovate quicker through delivering faster proofs of concept and bringing solutions to market sooner	• Application development and tools • Application lifecycle management • Integration with third-party development tools		

In the US, mobile operators have adopted different approaches to developing IoT platforms. Sprint's Curiosity platform marks an ambitious move to reach developers and enterprises by offering a range of IoT services; Verizon attempted a similar strategy with its ThingSpace platform before narrowing its focus to connectivity management. The challenge for operators is to balance leveraging their core connectivity strength with committing sufficient resources towards additional IoT services for higher revenue generation in the future.

Sprint's Curiosity IoT platform achieves initial success

Sprint unveiled its Curiosity platform – covering the connectivity and device management layers – in late 2018. Curiosity is powered by Ericsson using a dedicated virtualised IoT core which supports Sprint's nationwide LTE-M network and the Curiosity operating system. This enables Sprint to offer service-level agreements for availability and latency, allowing it to launch differentiated IoT solutions for enterprise verticals based on network characteristics.

Partnerships are a central pillar of Sprint's strategy to expand the functionality of the Curiosity platform. A deal with Amazon adds storage services to the platform, while an agreement with Softbank-owned ARM improves the scalability and security of Curiosity. Potential future collaborations with Softbank-owned companies (such as Boston Dynamics and Uber) would allow Sprint to maximise the value of Curiosity by creating new IoT use cases and discovering untapped insight-based opportunities.

The impact of Curiosity on Sprint's IoT performance has been immediate: IoT sales increased by 500% in the six months following the platform's launch, with 70% of these customers new to Sprint.

Verizon revamps its ThingSpace platform to focus on connectivity management

In 2015, Verizon launched ThingSpace as a connectivity, device and application management platform. It experienced initial success, attracting 16,000+ developers who built applications to support Verizon's IoT initiatives. However, Verizon has since adopted a new strategy for ThingSpace, noting developers' preference for public cloud platforms.

ThingSpace no longer provides application enablement; the focus has instead shifted to connectivity management. By teaming up with Amazon Web Services (AWS), Verizon allows developers to manage applications in a public cloud environment while still being able to connect directly to ThingSpace.

3.3
Edge computing: enabling 5G

Edge computing architectures distribute computing power closer to the end user than traditional service provider core networks or data centres. Services requiring higher performance will need computing power to be delivered to the extreme edge (within a user device or at user premises), whereas other services only require compute to be located marginally nearer, such as at the aggregation point in the transport network.

Figure 23 Source: GSMA Intelligence

Defining the network edge

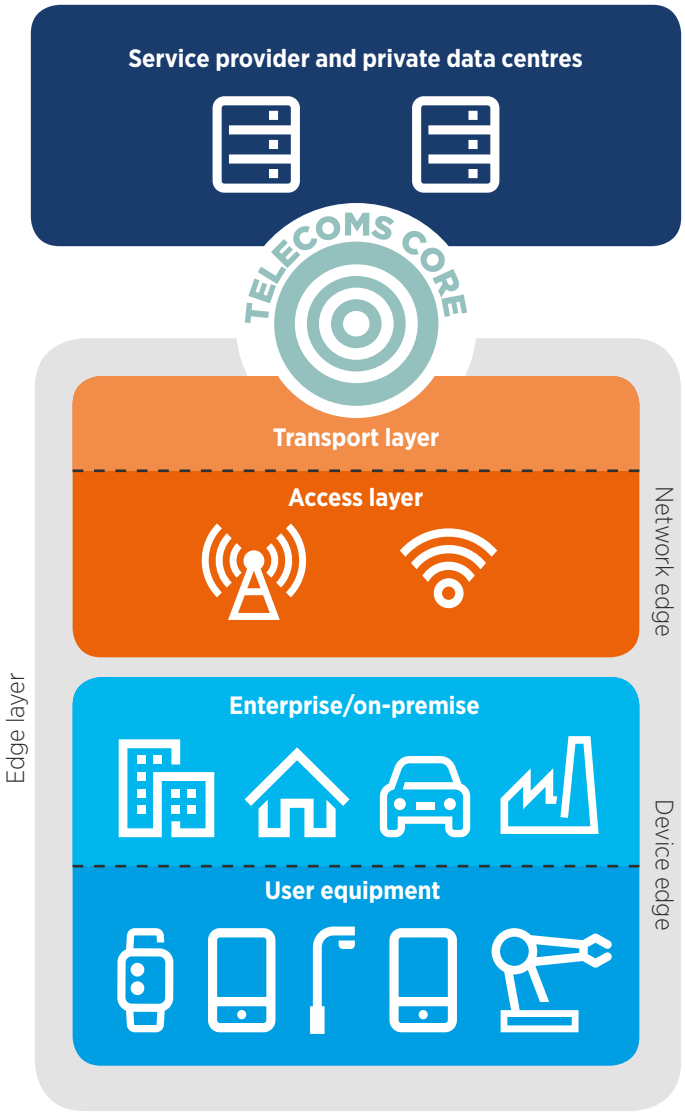


Figure 24

Source: GSMA Intelligence

Edge nodes may need to be closer to the user depending on requirements

Demand-side drivers

Application latency

Latency impacts user experience, especially for time-sensitive applications, such as emergency services and AR/VR. Edge architectures reduce latency by placing application support closer to the user.

Transport offload

Backhaul costs rise as traffic to core or cloud nodes increases. Delivering services from the network edge minimises backhaul traffic.

Processing offload

Heavy application processing can strain devices, negatively affecting user experience and battery life. Processing data at the network edge enables processing to take place off-device without impacting user experience.

Supply-side drivers

Centralised versus decentralised compute

The use of standard IT platforms for telecoms functions enables the scaling down of the mobile core, allowing distributed (out to edge) siting which facilitates new edge use cases.

Software-defined networks

The shift to software-defined networks, along with the use of virtualisation and open networking tools, enables the use of standard software and hardware platforms. This allows the development of scalable edge nodes and flexible siting (putting applications on any hardware).

Application extensibility

Capitalising on the demand for edge computing, web-scale companies are expanding edge assets for their public cloud businesses. Operators aiming to capture enterprise demand will need to follow suit.

Operators are increasingly using software-defined networks to maximise network efficiency

Software-driven technologies such as software-defined networks (SDN) and network functions virtualisation (NFV) are gaining momentum across North America. Operators are looking to use these to unlock a variety of benefits, including cost savings, service scalability and automation, increased speed of service deployment, and reduced energy consumption.

To facilitate deployment across the entire telecommunications stack, from infrastructure to virtual network functions (VNF), the GSMA and the Linux Foundation recently announced a partnership to create a common industry framework for NFV infrastructure (NFVi).

By following a common approach and framework, operators can significantly reduce the time and costs associated with integration and accelerate adoption and deployment. This framework can also help to advance edge deployments since software-based networks can be scaled to the edge more easily.

Edge computing use cases

Edge computing has received much attention, in part because 5G will require network transformation in which edge capabilities can be integrated and because edge assets will be key to supporting 5G use cases. For example:

- **Connected cars:** Operators in North America have been keenly exploring connected-car opportunities for some time now; Sprint's blockchain-based security system is the latest connected car platform to be launched by an operator in the region. Edge computing further enables opportunities for operators: for example, it can deliver lower latencies (by siting autonomous driving functionality at the network edge) and improve the quality of experience for in-car entertainment services (by storing and optimising content closer to the end user).
- **Edge cloud for enterprises:** Edge computing allows operators to meet key enterprise requirements, including latency, quality of experience and regulatory compliance. Edge-cloud use for enterprises involves siting nodes within an enterprise or delivering enterprise-specific services from an edge node in the network. These might be targeted applications (e.g. industrial automation and IoT analytics) or broader enterprise services.
- **Cloud gaming:** The low latencies and backhaul efficiencies enabled by edge computing will support the development of upcoming cloud gaming services that let users stream games from cloud-based servers to multiple devices (as opposed to playing on dedicated hardware). This will be important for Google's cloud-gaming service (Stadia), which launches in the US and Canada in November 2019, as well as Microsoft's Project xCloud, which commences public trials this year. Microsoft recently announced a multiyear partnership with AT&T – combining the global scale of Microsoft's Azure cloud with AT&T's domestic 5G capabilities – to expand edge deployments to more locations and accelerate the development of edge computing use cases, such as cloud gaming.
- **Media and entertainment:** Edge computing's ability to improve latency and backhaul efficiency is valuable across the media value chain, from broadcasting to hardware innovation (e.g. storing AR/VR content closer to the user). These use cases are likely to be of particular interest to AT&T, given its extensive content assets from the acquisition with Time Warner, and Verizon's RYOT content studio.

Verizon builds an edge computing platform to test new use cases in New York

Verizon is building its own edge computing platform, which will host commercial services by the end of 2019. The operator is currently testing the platform in New York, where it has recorded sub-10 ms latency. Replicating this in other locations, however, will require edge assets to be deployed across the network, with the trade-off being that costs will increase. Verizon has said its edge-computing deployment will primarily be located in urban and industrial areas, using a mix of its own and third-party data centres.

To monetise its edge-computing capabilities, Verizon is working closely with enterprise customers and local start-ups at innovation centres and incubation labs, where it is developing applications to utilise the reduction in latency.

3.4
Mobile identity: boosting online security

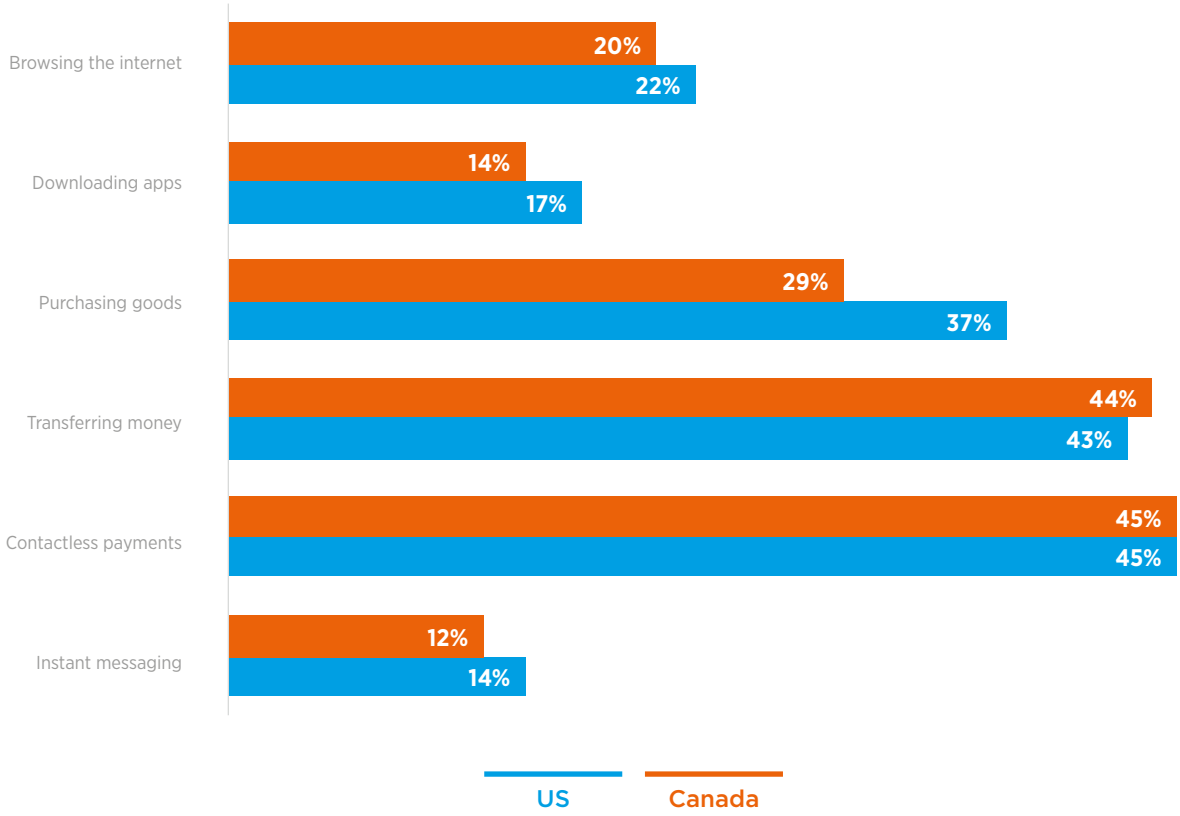
From e-commerce to online banking, online services provide myriad benefits, such as increased convenience and access to cheaper products. However, it also exposes consumers to privacy and data protection risks. In 2018, there were 1,244 data breaches in the US, which revealed nearly 450 million records – a 100% increase compared to 2017.[10] Rising cybercrime is fuelling consumer privacy and security concerns, which are the primary reasons for inactivity online.

10. Statista

Figure 25 Source: GSMA Intelligence Consumer Insights Survey 2018

Privacy and security concerns are a barrier to greater services engagement on smartphones

% of respondents citing privacy and security as a barrier to using smartphones for each service
Base: those who never use or only occasionally use each service



In the US and Canada, nearly half of respondents who never use, or only occasionally use, financial services on smartphones cite privacy and security concerns as a barrier to usage. It is therefore vital for companies to secure and retain the trust of their customers, as well as the population at large. This entails implementing rigorous cybersecurity and data protection practices to keep personal details secure; identity verification is crucial for this. In the US, 70% of adults say that identity verification methods influence their choice of financial institution, up from 56% in 2018.[11] For this reason, companies are evaluating new ways to deploy secure identity verification using an individual's attributes.

The ubiquity of smartphones – particularly in North America, where adoption reached 82% of total connections in 2018 – gives rise to mobile technology solutions. The GSMA has worked with operators to develop Mobile Connect, a federated identity management system which links a person's electronic identity and attributes while providing simple, secure and convenient access to digital services.

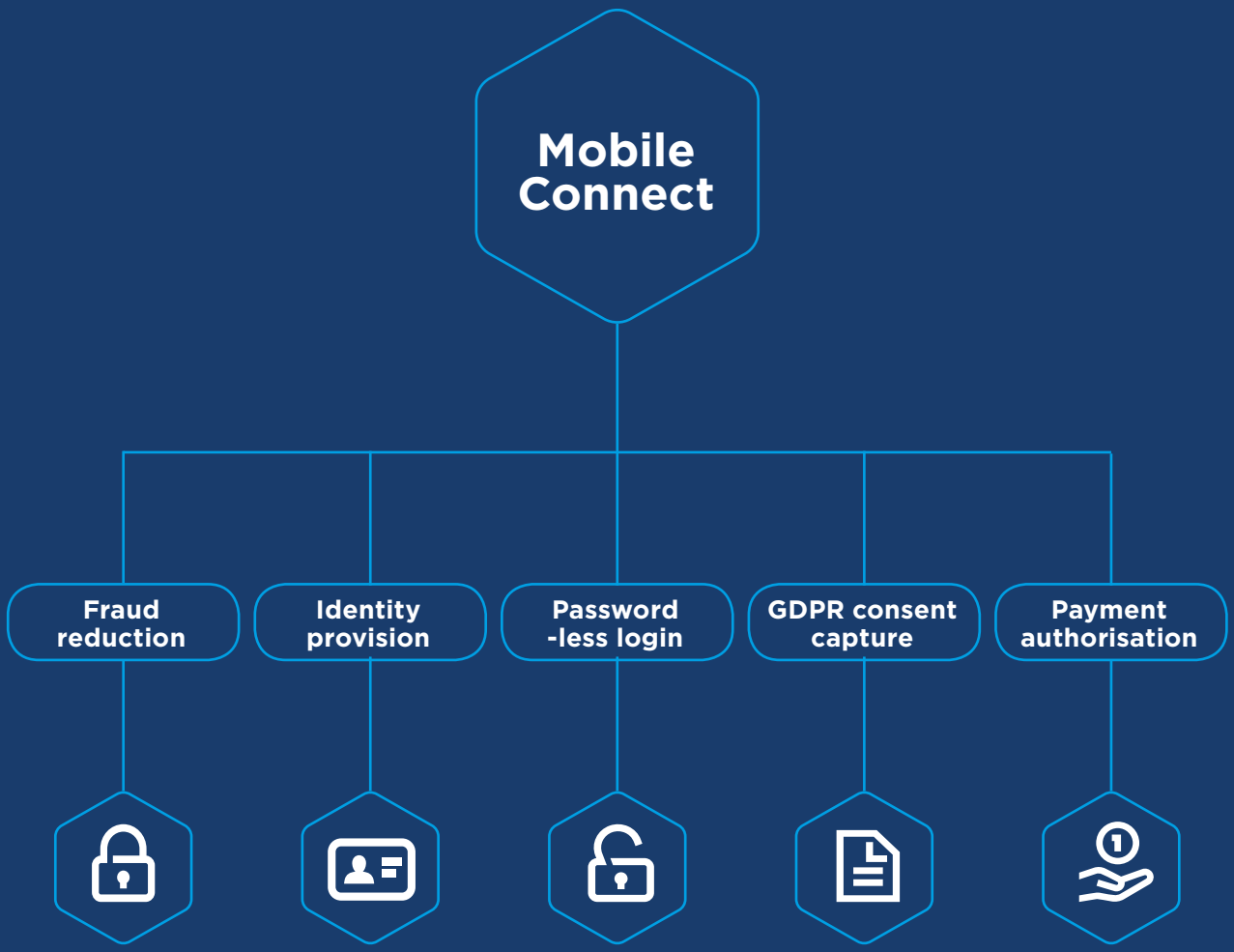
Mobile Connect can support two-factor authentication (in place of a code sent by email or text that can be intercepted) or replace the traditional login process entirely. Not only does it provide additional security by matching an individual to their mobile phone and reduces the length of time it takes to register new accounts or log in to existing accounts when credentials have been forgotten.

11. Annual Consumer Digital Identity Study conducted by IDology based on 1,499 respondents in January and February 2019.

Figure 26

Source: GSMA

Value added by Mobile Connect



US mobile operators introduce single sign-on service

The four largest mobile operators in the US (AT&T, Sprint, T-Mobile and Verizon) have worked together to build a secure, multi-factor identity authentication platform. The beta launch for the solution, known as ZenKey (formerly Project Verify), will be at MWC19 Los Angeles. ZenKey allows users to log in to online services without the need for a password, instead verifying users through multiple unique mobile network data elements.

Distributed ledger technology (DLT) and keyless signature infrastructure (KSI) – commonly known as blockchain – could also help to allay security concerns. Especially if designed with privacy in mind, blockchain technology should address security fears in complex, multiparty transactions because the decentralised nature of the technology makes it difficult to hack and grants users greater control over what – if any – personal information they share with third parties.

Blockchain continues to gain traction in North America, with most use cases currently related to financial services. For instance, Facebook's recently announced Libra, which enables people to store, spend and transfer money across international borders with minimal transaction fees, is underpinned by a blockchain system. However, blockchain-based initiatives face increasing scrutiny from governments and policymakers, underscored by regulators' concerns over Libra's potential to combine personal data and financial information.

04
Policy spurring investment and protecting consumers

4.1
Laying the regulatory groundwork for 5G

The US is one of the first countries in the world to allocate high-frequency spectrum bands for 5G networks and applications. Having already allocated mmWave spectrum in multiple bands during 2016 and 2017, the US began the 28 GHz spectrum auction in November 2018, followed immediately by an auction for the 24 GHz band. Further mmWave spectrum auctions will take place in 2019, starting with Auction 103, which includes the 37, 39 and 47 GHz bands. The allocation of mmWave has enabled US operators to combine 5G and high-frequency spectrum to pioneer a new level of mobile performance, with ultra-high speeds and low latencies facilitating new applications in areas such as immersive reality.

US mobile operators also need timely and sufficient availability of mid-range spectrum for 5G to achieve its full potential. This spectrum range provides a healthy mix of coverage and capacity benefits, allowing operators to extend 5G services to more people. Because 5G requires larger contiguous blocks of spectrum, each operator needs access to 80-100 MHz of contiguous spectrum in mid-range bands.

It can be challenging to meet this target in the US and similar countries where there are incumbent users of prime 5G mid-range bands. It is imperative that regulators do everything in their power to make this spectrum available for 5G use. This is central to the FCC's 5G FAST Plan, which focusses on three essential mid-range bands: 2.5, 3.5, and 3.7-4.2 GHz.

In the US, consultations are ongoing with incumbent users of the 2.5 GHz band (Educational Broadband Service) and the 3.7-4.2 GHz band (currently used for satellite operations). Meanwhile, the 3.5 GHz band will be allocated via a spectrum-sharing model as part of the CBRS initiative. This offers a large number of users access to spectrum, while preserving the rights of incumbent users, but limits the amount of licensed spectrum that is available. Only 70 MHz of the 3.5 GHz band will be assigned via auction, with each licence covering 10 MHz blocks, making it less suitable for 5G services.

Under its 5G FAST Plan, the FCC is also reviewing infrastructure policy, and small-cell reviews are a key part of this. The FCC recently adopted rules that will streamline the review of small cell deployment applications by federal, state and local policymakers; this is important, as complex planning procedures involving several stages of approval can significantly delay 5G site deployments, which require a denser distribution of base stations, small cells and advanced antenna systems. Small cells meeting predefined criteria should, considering their low visual impact, be permitted with minimal administrative burden and be exempt from planning requirements.

Governments should facilitate access to buildings and street furniture for operators to deploy network equipment, and this should be done without charging operators excessive fees. The FCC has introduced a $270 limit on the amount a municipality can charge for the installation of required wiring for cell sites. Previously, operators were commonly charged at much higher rates; this has led to several municipalities filing lawsuits to challenge the FCC's ruling.

4.2
Halting the surge in robocalling with operator-led initiatives

In 2018, US consumers received an estimated 26.3 billion calls from automated machines, a 46% rise on 2017. Known as robocalls, these have become the number one complaint to the FCC, with consumers frustrated by the frequency of calls and telephone-based fraud attempts.

To help tackle this problem, all mobile operators have automatic in-network systems to block robocalls. Operators also provide customers with free services that provide additional layers of protection:

- **AT&T's Call Protect** detects and blocks robocalls, labels presumed unwanted calls as 'suspected spam', and allows subscribers to maintain a personal block list.
- **Verizon's Call Filter** provides an alert when a call is likely to be spam, reports unsolicited numbers, and automatically blocks robocalls based on customers' preferred levels of risk.
- **T-Mobile's Scam ID and Scam Block** flag suspected robocalls as suspicious, letting customers block future calls from the same numbers.

With these initiatives, the mobile industry collectively stops more than 1 million robocalls every day.[12] This figure will continue to rise as these services become enabled by default, following the FCC's ruling that customers no longer need to opt-in to block robocalls.

Operators are also implementing services based on FCC-backed authentication frameworks known as STIR (secure telephone identity revisited) and SHAKEN (signature-based handling of asserted information using tokens).[13] T-Mobile's Caller Verified is the first call-blocking service based on STIR/SHAKEN. Additionally, T-Mobile and AT&T have an agreement to use the framework for identifying legitimate calls placed between their networks, before sending a verification message to the recipient's handset.

12. "How to Stop Robocalls", CTIA
13. STIR and SHAKEN use digital certificates, based on common public key cryptography techniques, to ensure the source of a call is legitimate and secure.

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GSMA HEAD OFFICE
Floor 2
The Walbrook Building
25 Walbrook
London EC4N 8AF
United Kingdom
Tel: +44 (0)20 7356 0600
Fax: +44 (0)20 7356 0601