THE EVOLUTION OF GAMING THROUGH 5G

The new era of mobile networks and its impact on gaming

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5G: THE NEXT GENERATION OF MOBILE NETWORKS

Foreword

When 5G hits the mainstream, it will enable a whole new era of tech-driven solutions, with cloud gaming chief among them.

The fifth generation of mobile networks—5G—is undeniably one of the most exciting developments in mobile technology, offering users far faster speeds and more reliable connections than current options.

The 5G standard was first issued by ITU-R in 2015 and finished with new standalone specification in early 2018. After years of planning, 5G became a reality for consumers in 2019 with South Korea's three telecom companies—SK Telecom, LG Uplus, and KT—rolling out the world's first commercial 5G networks in early April. Many countries including the U.S., the U.K., and China followed suit. By the end of 2019, there were more than 20 countries in the world that had already laid down infrastructure for 5G (with commercial networks). Still, coverage is mostly limited to a select few cities or even specific neighborhoods. Even though the 5G rollout is still in the early stages, consumers are already eager to try out the latest mobile technology.

On the hardware front, leading mobile brands like Samsung, Huawei, Xiaomi, Vivo, and OPPO have already launched their first 5G models and are all set to introduce a full lineup of 5G devices in 2020. Apple is also rumored to launch a 5G iPhone in 2020.

Despite all the latest developments, 5G is still in its infancy. Drawbacks such as mmWave's short range are challenging engineers to construct an uninterrupted service. 5G must also provide a compelling use case.

While it might be too big a claim to say that 2020 will be "the year of 5G", it certainly marks the beginning of the market's transition toward the technology. In this report, we take a look at the history and current state of mobile networks, identify key players in the development of 5G, predict the growth in the 5G smartphone market, and dive deep into 5G's impact on gaming and beyond.

20Gbps

Peak data rate that 5G is targeting to reach.

TIANYI GU
Market Analyst

1

EVOLUTION OF THE GS

Development of mobile networks

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SMS WAS INTRODUCED THANKS TO 2G

A brief history of mobile 2G network development

1990

1995

... **TODAY**

1991
Radiolinja launched the **first 2G network** on the **GSM** (Global System for Mobile Communications) in Finland. 2G's major improvement over the previous generation of 1G cellular networks is that radio signals used by 2G networks are **digital** rather than analog.

1992
Short Message Service (SMS) was introduced to the public.

1995
GPRS (General Packet Radio Service), also known as **2.5G**, which supports packet switching, was introduced. GPRS could theoretically reach downlink speeds of up to **171Kbps**.

1997
EDGE (Enhanced Data Rates for GSM Evolution), also known as **2.75G**, was introduced. Data speeds were increased up to **384Kbps**, marking EDGE as an early preview of 3G.

Many mobile carriers across countries such as the U.S., South Korea, and Japan have already or will **shut down** 2G networks in the future to develop newer technologies.

MAJOR INNOVATIONS ENABLED BY 2G THAT REVOLUTIONIZED THE MOBILE WORLD

1. **SMS** text messages, which later developed into new forms like picture messages and multi-media messages.
2. Conversations are digitally **encrypted**.
3. **Roaming** supported.
4. **E-mails**.
5. **Web browsing**.

BREAKTHROUGH IN MOBILE DEVICE DEVELOPMENT

The iconic phone of the 2G era: **Nokia 3210**, launched in 1999.

The first camera phone: **Sharp J-Phone**, launched in 2000.

LAUNCH OF THE SMARTPHONES IGNITED A REVOLUTION

A brief history of mobile 3G network development

2000

2001
NTT DOCOMO in Japan launched the **first commercial W-CDMA 3G** mobile network. Data speeds could reach up to **2Mbps** for stationary or walking users, or 384Kbps for users in a moving vehicle.

2002
3G networks were consecutively set up in mature markets, including the U.K., the U.S., and South Korea.

2005

2008
Apple announced its first 3G smartphone **iPhone 3G** in June. Two months later, the first Android phone **T-Mobile G1** (manufactured by HTC) was released.

2009
The launch of **iPhone 3GS** helped enable various forms of entertainment on the mobile screen.

... TODAY

3G is still the mainstream mobile telecommunications technology around the world. According to Ericsson, by the end of 2018, approximately **95%** of the global population lived in areas coved by 3G mobile cellular networks.

MAJOR INNOVATIONS ENABLED BY 3G THAT REVOLUTIONIZED THE MOBILE WORLD

1. New generation of **smartphones**.
2. Large adoption of **mobile Internet**.
3. Web-based **applications** and **audio** and **video** files.
4. **Mobile gaming.**
5. **Video calls**.

BREAKTHROUGH IN MOBILE DEVICE DEVELOPMENT

The revolutionary phone of the 3G era: **iPhone 3GS**, launched in 2009.

Samsung's first high-end smartphone **Samsung Galaxy S**, launched in 2010.

4G BRINGS NEW FORMS OF ENTERTAINMENT TO MOBILE

A brief history of mobile 4G network development

2009

TeliaSonera from Sweden launched the world's **first commercial LTE** mobile services in Stockholm and Oslo. It was debatable, however, whether or not the network qualified as 4G LTE, as the data speeds (**100Mbps**) did not comply with ITU-R's requirement of 1Gbps.

2010

ITU-R recognized LTE-Advanced, WirelessMAN-Advanced, LTE, and WiMax as 4G. These technologies provided substantial performance and feature improvements over previous generations. The improvements mainly resulted from 4G's switch to **all-Internet Protocol (IP) based communication**, which allows mobile ultra-broadband (gigabit speed).

2012

YOTA from Russia announced the world's **first commercial LTE-Advanced (LTE-A) network**; yet, the terminals were not available until one year later. Data speeds went up to **300Mbps**. However, the first LTE-A compliant smartphone—Samsung Galaxy S4 LTE-A—was only introduced to the market in 2013.

SAMSUNG

... TODAY

4G is still the predominant cellular network today. According to Ericsson, by the end of 2018, around **75%** of the global population lived in areas coved by LTE networks. According to GSMA, in 2018, mobile technologies (dominated by 4G) and mobile services generated **$3.9 trillion of economic value (4.6% of GDP)** globally.

4G'S KILLER APPS

1. Social network.
2. Music streaming.
3. Video streaming.
4. Mobile services.

4G LTE's high bandwidth enables multimedia entertainment on the mobile screen. For example, photos no longer needed to be compressed on **social media**. High data speeds maximize the potential for photo and video sharing, which fulfills the optimal nature of social networks. **Music and video streaming** allows consumers to access content on-the-go. **Real-time mobile services** flourish on mobile, enabled by 4G.
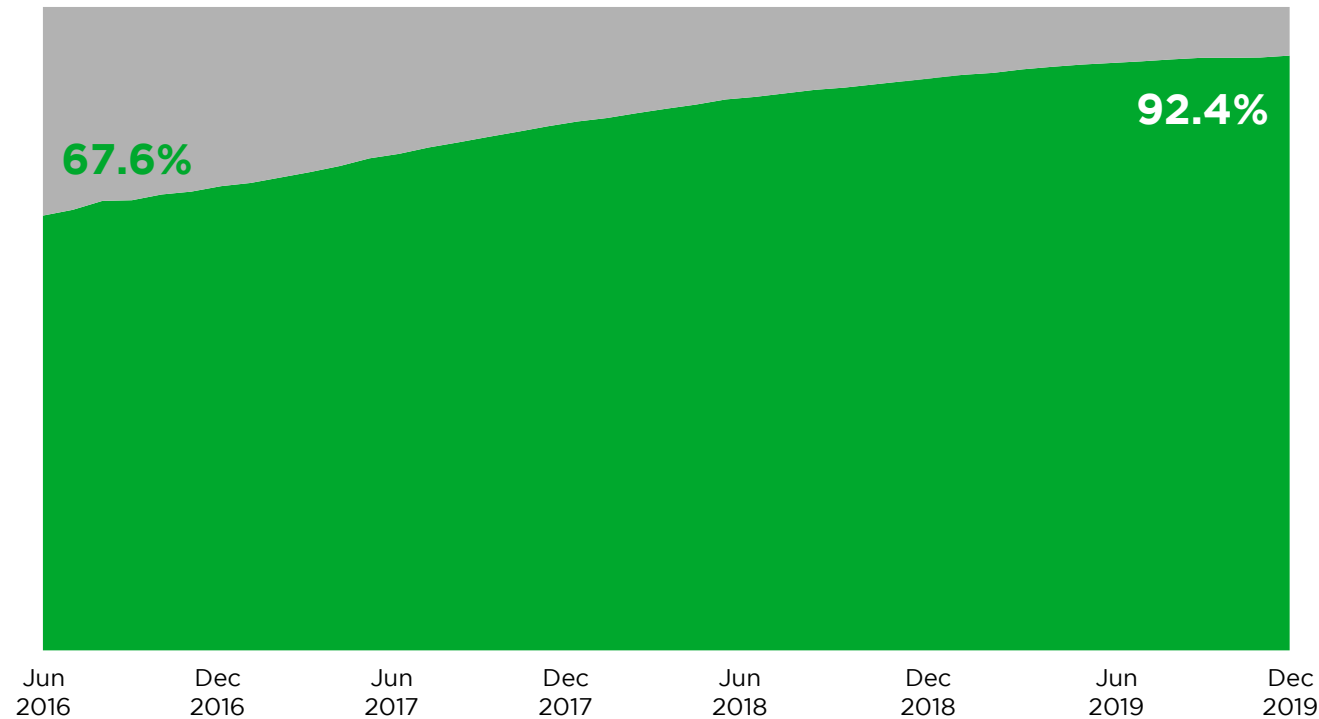
YouTube Spotify Uber
WhatsApp airbnb
Instagram facebook
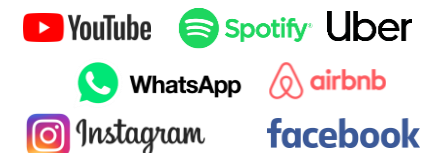
4G PHONES GROW STEADILY OVER THE PAST FEW YEARS

4G's killer apps remain the most popular apps on mobile

4G-COMPATIBLE SMARTPHONES

June 2016 – December 2019 | Global

67.6%

92.4%

Jun 2016 | Dec 2016 | Jun 2017 | Dec 2017 | Jun 2018 | Dec 2018 | Jun 2019 | Dec 2019

92.4%

of all active smartphones in December 2019 were 4G-compatible.

SOCIAL NETWORK

2.7Bn+ downloads on iOS & Google Play since 2015.

4.7Bn+ downloads on iOS & Google Play since 2015.

MUSIC-STREAMING

1.0Bn+ downloads on iOS & Google Play since 2015.

VIDEO-STREAMING

1.2Bn+ downloads on iOS & Google Play since 2015.

MOBILE SERVICE

0.8Bn+ downloads on iOS & Google Play since 2015.

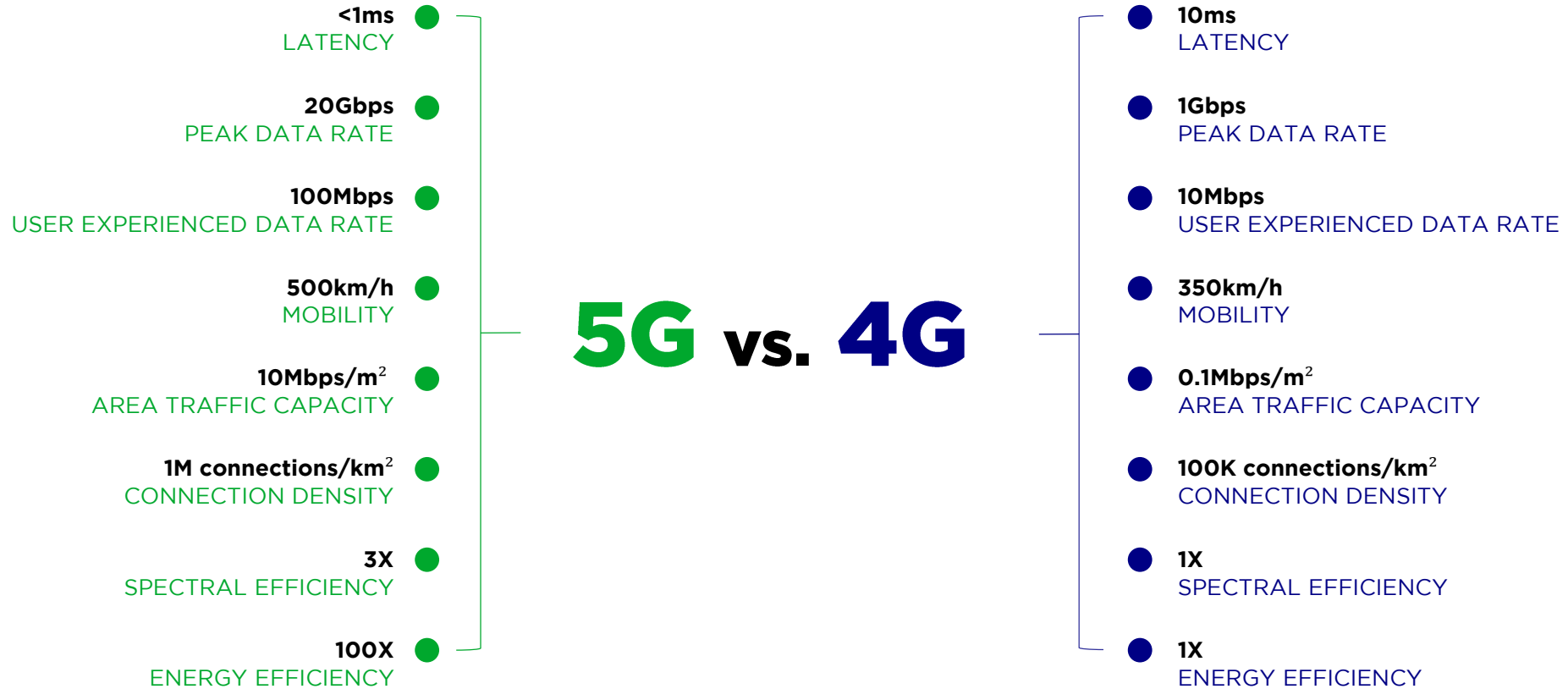**0.2Bn+** downloads on iOS & Google Play since 2015.

"Unlike 4G and previous generations of technology, 5G is very different. It is not just about radio. In fact, it stands across the full network from mobile access to cloud core, from software-defined networking to all forms of backhaul, front haul, IP routing, fixed networks, software, and more."

Rajeev Suri, Nokia President & CEO

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MAJOR IMPROVEMENTS FROM 5G TO 4G

Low latency and high data speeds are key improvements, but they are not the only ones

5G vs. **4G**

5G	4G
<1ms LATENCY	**10ms** LATENCY
20Gbps PEAK DATA RATE	**1Gbps** PEAK DATA RATE
100Mbps USER EXPERIENCED DATA RATE	**10Mbps** USER EXPERIENCED DATA RATE
500km/h MOBILITY	**350km/h** MOBILITY
10Mbps/m² AREA TRAFFIC CAPACITY	**0.1Mbps/m²** AREA TRAFFIC CAPACITY
1M connections/km² CONNECTION DENSITY	**100K connections/km²** CONNECTION DENSITY
3X SPECTRAL EFFICIENCY	**1X** SPECTRAL EFFICIENCY
100X ENERGY EFFICIENCY	**1X** ENERGY EFFICIENCY

THE 5G RACE RAMPS UP

Overview of commercial 5G development in key markets

Undeniably, 5G is one of the most exciting developments in mobile technology. In mature markets and many emerging markets, it will become the next standard for mobile network connectivity, offering users far faster speeds and more reliable connections than current options. In 2018, and even as recently as the beginning of 2019, many mobile businesses were unconvinced of 5G's readiness. While it might be too big a claim to say that 2020 will be the "year of 5G", it certainly marks the beginning of the market's transition toward the technology.

The world's mobile markets are racing to establish 5G networks. South Korea and the U.S. were the first two countries to launch commercial 5G networks in April 2019, followed by several Western markets including the U.K., Germany, Spain, Australia, and many countries in the Middle East including Qatar, Kuwait, and UAE.

China granted 5G licenses for commercial use to the country's three major telecom operators in June and started a national rollout at the beginning of November 2019. In all the markets where mobile 5G is currently available, however, coverage is generally limited to a select few cities, or even specific neighborhoods within cities.

Other countries are following suit, with Japan, Canada, France, and India all on track for 2020 5G launches. Most countries, however, are aiming for a full national rollout by 2025.

Three South Korean telecom companies, **SK Telecom**, **LG Uplus**, and **KT**, worked together to bring 5G to the country. The service became available to the public in April 2019, making South Korea the **first country to launch commercial 5G networks**. The service providers aim to reach 5G coverage for **93%** of the population by the end of 2019. According to the Ministry of Science and ICT, the country has accrued 3.98 million subscribers for 5G networks as of October 2019.

Verizon, **AT&T**, **Sprint**, and **T-Mobile** are the four telecom companies in the U.S. that have commercial 5G plans available for consumers in selected cities. **Nokia**, **Ericsson**, and **Samsung** are the leading 5G vendors in the U.S.

The first commercial 5G service was brought alive by **Swisscom** in **Switzerland** in April 2019. The U.K. followed suit—**EE** launched the country's first 5G network in May with **Vodafone** and **Three** joining the fray in July and August, respectively. At this point, 5G networks are also becoming available in Germany, Italy, Spain, Austria, Ireland, Finland, and Romania. Most European countries are kicking off their 5G rollouts in 2020.

China's three largest telecom companies—all state-owned—**China Mobile**, **China Unicom**, and **China Telecom** launched commercial 5G services in November 2019. China was previously aiming for a national rollout of commercial 5G in early 2020.

Leading telecom companies in Japan, such as **NTT DOCOMO**, **KDDI**, **SoftBank**, and **Rakuten,** are aiming for a 2020 rollout of 5G networks. **Intel**, partnering with **NTT DOCOMO**, will bring 5G technologies for the upcoming **2020 Olympic Games**, providing 360-degree and 8K high-resolution videos, VR viewing experiences, smart city applications, and AI-powered athlete training system.
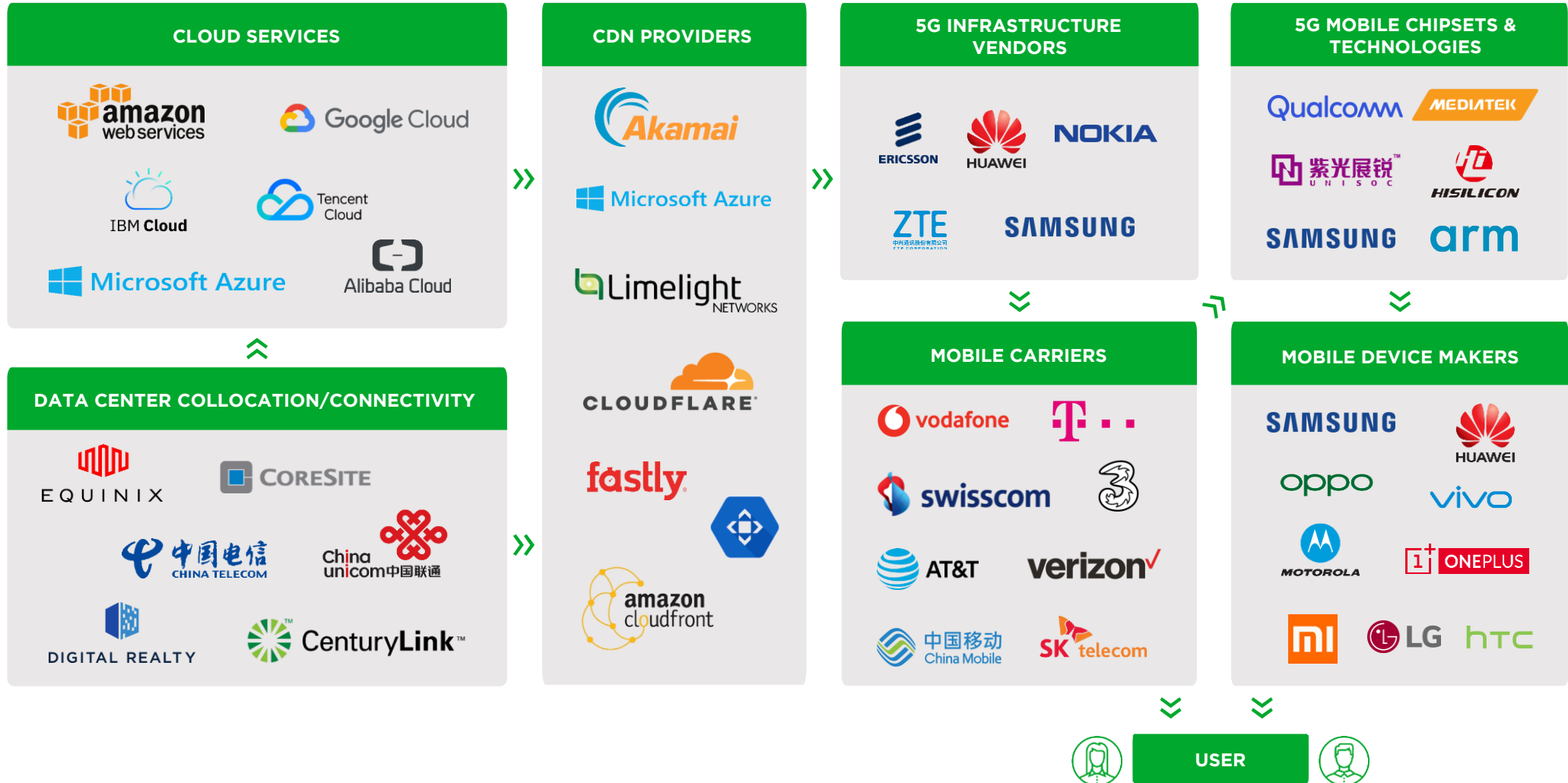
2 NEW ERA OF NETWORKS

Key players in 5G

KEY PLAYERS IN 5G

Delivering the technology to end consumers

CLOUD SERVICES

amazon web services · Google Cloud · IBM Cloud · Tencent Cloud · Microsoft Azure · Alibaba Cloud

DATA CENTER COLLOCATION/CONNECTIVITY

EQUINIX · CoreSite · 中国电信 CHINA TELECOM · China unicom 中国联通 · DIGITAL REALTY · CenturyLink

CDN PROVIDERS

Akamai · Microsoft Azure · Limelight NETWORKS · CLOUDFLARE · fastly · amazon cloudfront

5G INFRASTRUCTURE VENDORS

ERICSSON · HUAWEI · NOKIA · ZTE 中兴通讯股份有限公司 · SAMSUNG

MOBILE CARRIERS

vodafone · T · · swisscom · 3 · AT&T · verizon · 中国移动 China Mobile · SK telecom

5G MOBILE CHIPSETS & TECHNOLOGIES

Qualcomm · MEDIATEK · 紫光展锐 UNISOC · HISILICON · SAMSUNG · arm

MOBILE DEVICE MAKERS

SAMSUNG · HUAWEI · OPPO · vivo · MOTOROLA · ONEPLUS · mi · LG · htc

USER

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DATA DISTRIBUTION

Cloud services, data center collocation/connectivity, and CDN providers

CLOUD SERVICES

Widespread adoption of 5G will disrupt the cloud computing world. 5G's high data speeds and low latency will accelerate the development of many technological innovations such as artificial intelligence (AI) and XR (augmented reality (AR) and virtual reality (VR)) that require massive data storage and processing capacity. Undoubtedly, these technologies will be much more efficient when cloud-dependent. 5G, in turn, ensures seamless integration between cloud services and technologies.

DATA CENTER COLLOCATION/CONNECTIVITY

Data centers will play a key role in making 5G-enabled technology innovations happen. To enable the full value and transformational capabilities of 5G, data centers will have to improve their processes and infrastructure. Moreover, 5G's high bandwidth will drive the market's demand for low latency to the next level, which will naturally bring edge computing alongside it. To data centers, this means data will have to be stored and processed at different distributed storage centers rather than accumulated at a central data center. Essentially, 5G, coupled with edge computing, will require a higher number of local data centers.

CDN (CONTENT DELIVERY NETWORK) PROVIDERS

CDNs serve as a geographically distributed network of servers that share and load content from a data center to end-users' network edge. CDNs have been widely used in broadband, especially for video streaming content, to reduce latency. Naturally, 5G and edge computing will increase the demand for CDNs to ensure seamless connections to end users. In fact, key CDN providers like Akamai and Fastly are already mapping out their strategy to meet the 5G challenge by placing more powerful points of presence at strategic locations around the world.

CLOUD SERVICES

amazon web services · Google Cloud · IBM Cloud · Tencent Cloud · Microsoft Azure · Alibaba Cloud

DATA CENTER COLLOCATION/CONNECTIVITY

EQUINIX · CoreSite · 中国电信 CHINA TELECOM · China unicom 中国联通 · DIGITAL REALTY · CenturyLink

CDN PROVIDERS

Akamai · Microsoft Azure · Limelight NETWORKS · CLOUDFLARE · fastly · amazon cloudfront

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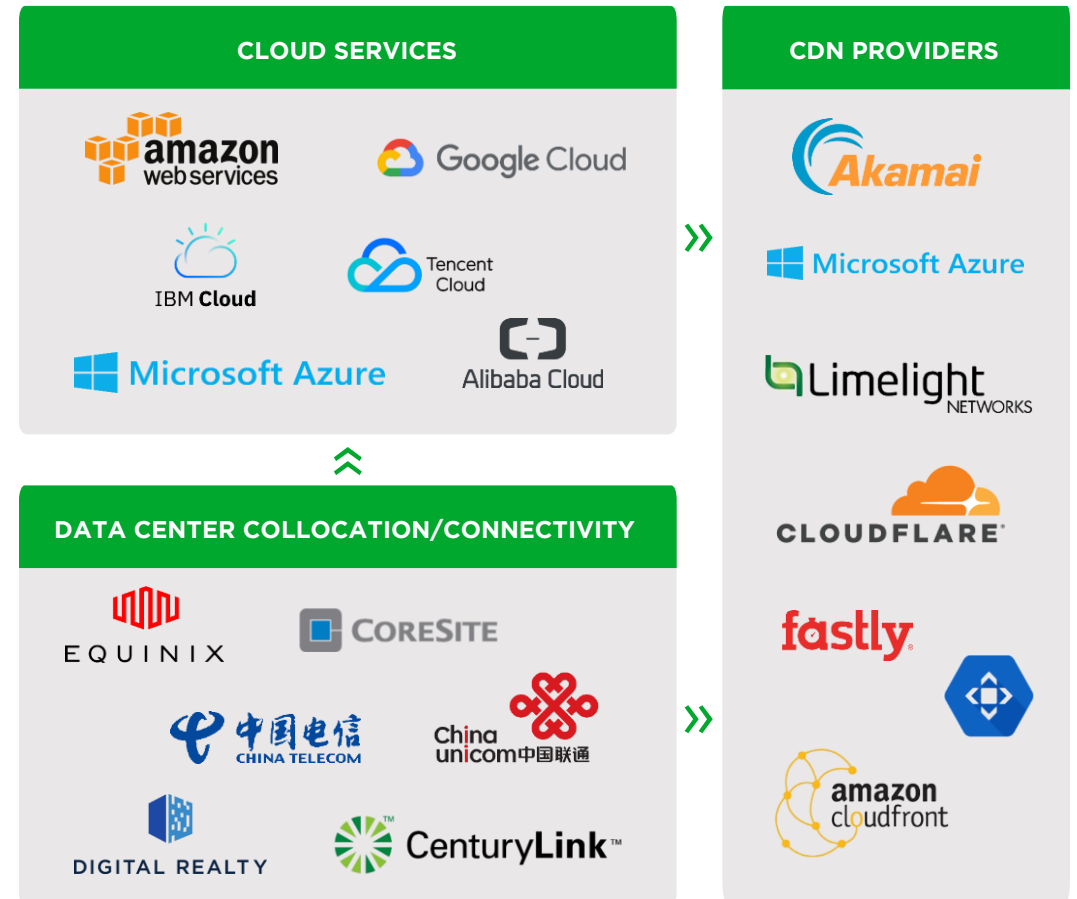
TELECOMMUNICATIONS
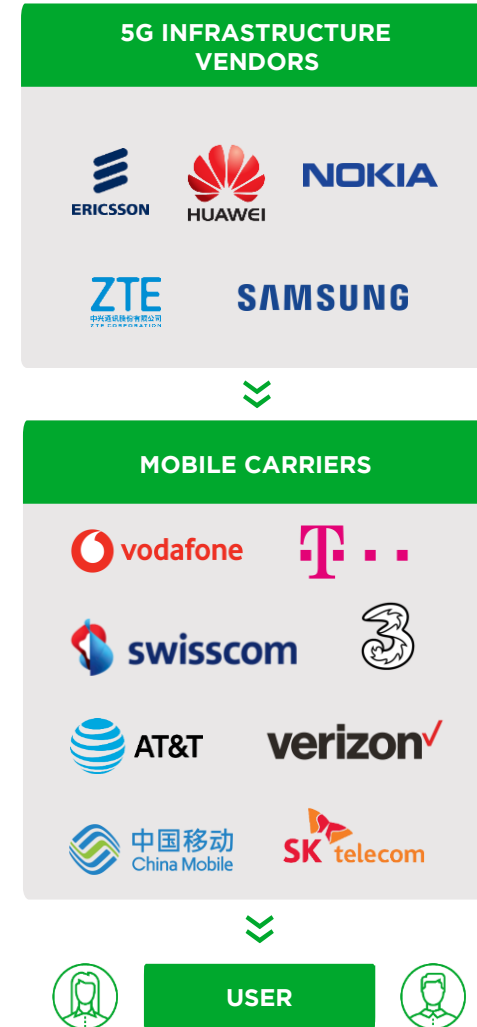
Network infrastructure and mobile carriers

5G INFRASTRUCTURE VENDORS

The concept of 5G was born as early as 2008. Since then, many network infrastructure providers have been proactively innovating their technologies to meet the new standards. So far, Ericsson, Huawei, Nokia, Samsung, and ZTE are the most recognized 5G infrastructure vendors across the world.

Ericsson, Nokia, and Huawei are reportedly the global market leaders (by number of signed commercial 5G contracts). In fact, Ericsson and Nokia have won 80 and 63 commercial 5G contracts, respectively (as of January 2020). While less is fully known about Huawei's 5G deals, the company reportedly had a total of 60 5G commercial deals signed outside China by September 2019.

MOBILE CARRIERS

Leading mobile telecom companies started to map out their 5G strategy as early as 2016. In April 2019, South Korea became the first country to adopt commercial 5G. Up until this point, mobile carriers in more than 20 countries have officially launched commercial 5G services (see the next slide #16), and many countries including Japan, Canada, France, and India are all aiming for 2020 launches (see slide #17); however, coverage is generally limited to a select few cites, or even specific neighborhoods within cities. At the moment, 5G only appeals to early adopters and many consumers are still questioning the price of the new service. Operators also have to increase the cost of their data packages to facilitate the return on infrastructure investments. Once 5G becomes mainstream to consumers, 5G-enabled mobile applications, such as cloud gaming, will naturally require a big jump in data consumption. This aligns with mobile telecom companies' core business model of selling larger data packages. On the other hand, these applications could mark the end for data caps in countries like the U.S..


5G INFRASTRUCTURE VENDORS

ERICSSON   HUAWEI   NOKIA

ZTE   SAMSUNG

MOBILE CARRIERS

vodafone   T···

swisscom   3

AT&T   verizon✓

中国移动 China Mobile   SK telecom

USER

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MAJOR CARRIERS WITH COMMERCIAL 5G AVAILABLE

Overview by regions | As of December 2019

MIDDLE EAST

UPCOMING 5G DEPLOYMENTS IN OTHER KEY MARKETS

Overview of carriers which are aiming for 2020 5G launches

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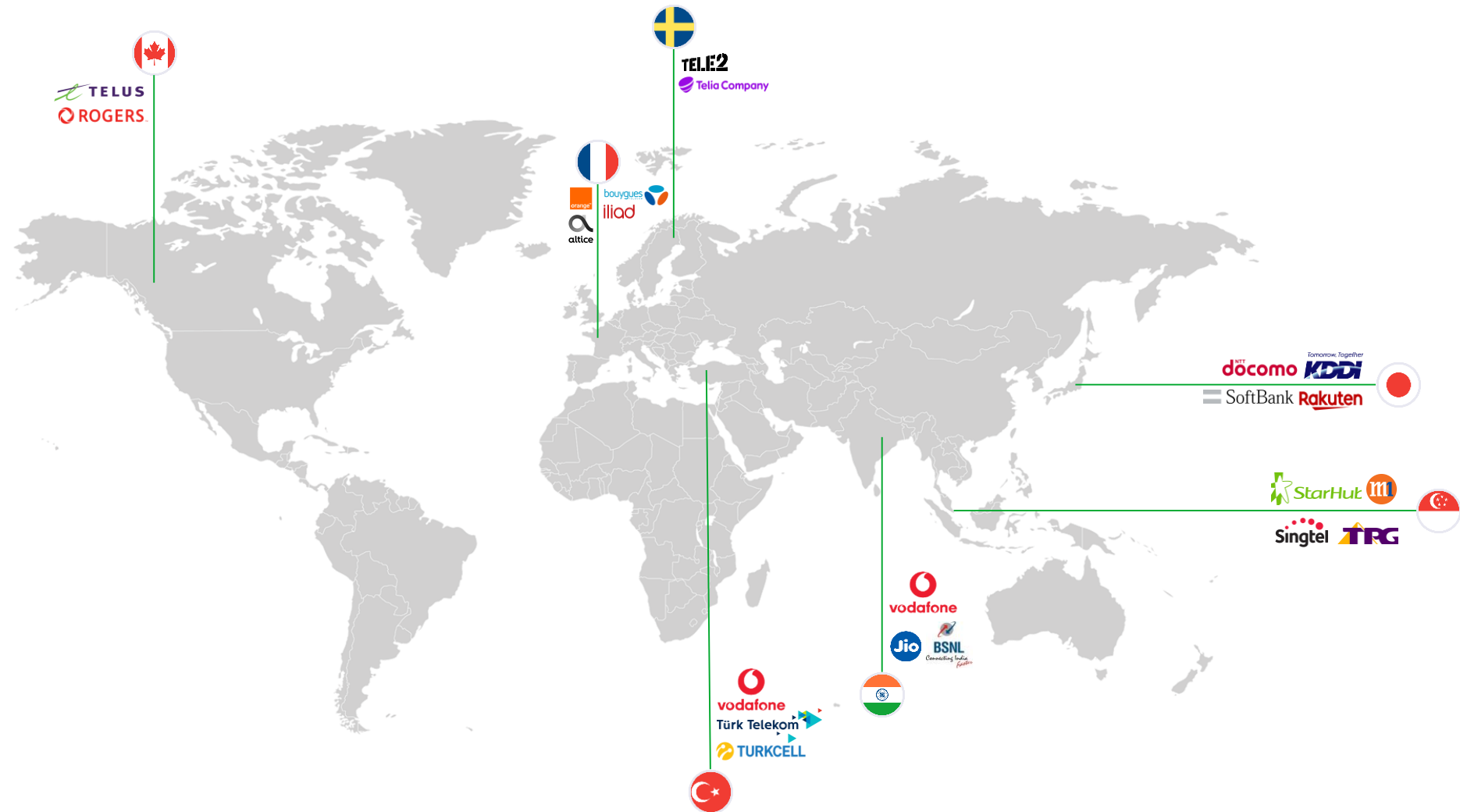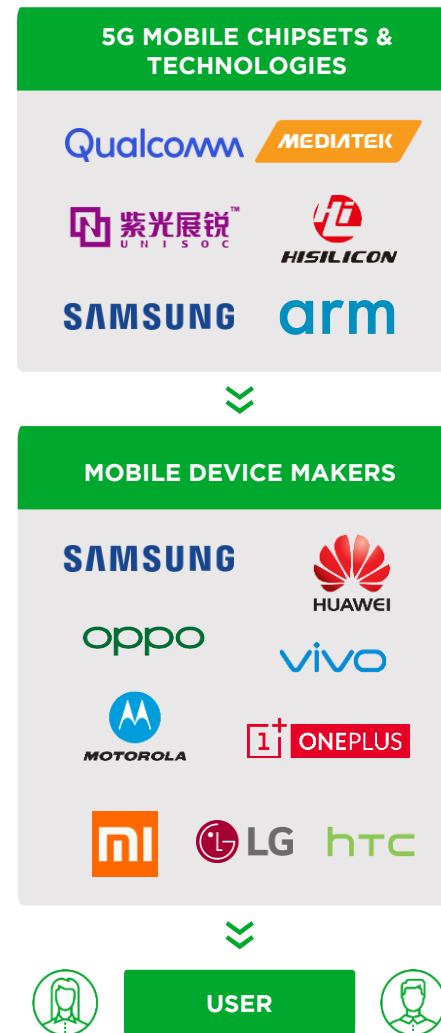
MOBILE DEVICES

5G chipsets and smartphones

5G MOBILE CHIPSETS & TECHNOLOGIES

5G mobile chipsets are the key component in 5G-compatible mobile devices. When it comes to 5G modems, Qualcomm holds a strong leadership position in the space. With a long history in mobile telecommunications, Qualcomm has been actively involved in developing the 3GPP 5G standard, and it came as no surprise when the company announced the first 5G modem Snapdragon X50 back in 2016. Up until this point, almost all existing 5G devices use Qualcomm's Snapdragon SoCs, except for Huawei, which uses its chip arm HiSilicon to build chips based on Arm technology, Samsung, which builds its in-house 5G-enabled modem Exynos based on Arm technology, and MediaTek, which also uses Arm technology in its chipsets.

The Taiwanese company MediaTek is playing a pioneering role in 5G chipsets. In November 2019, MediaTek announced its high-end 5G SoC Dimensity 1000, powered by Arm Cortex-A77 CPU and Arm Mali-G77 GPU. In fact, MediaTek was the first silicon vendor to announce a product based on the new Cortex-A77 CPU—only a few days after Arm publicly revealed the new microarchitecture.

MOBILE DEVICE MAKERS

5G is undoubtedly under the spotlight of the mobile device market in 2020 and will remain so in the following years. Leading mobile brands like Samsung, Huawei, Xiaomi, Vivo, and OPPO have already launched their first 5G models and are all set to introduce a full lineup of 5G devices in 2020. Apple is also rumored to launch a 5G iPhone in 2020. With leading brands participating, more and more consumers will be lured to the 5G ecosystem. The 5G rollout, however, is still in the early stages. We predict that it will still take three to four years for the technology to become mainstream to consumers.

5G MOBILE CHIPSETS & TECHNOLOGIES

Qualcomm · MEDIATEK · 紫光展锐 UNISOC · HISILICON · SAMSUNG · arm

MOBILE DEVICE MAKERS

SAMSUNG · HUAWEI · OPPO · vivo · MOTOROLA · ONEPLUS · mi · LG · HTC

USER

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FLAGSHIP 5G MODELS ANNOUNCED BY LEADING OEMS

Overview of the specs

SAMSUNG GALAXY S20+ 5G
6.7-inch with 1440 x 3200 resolution
Exynos 990/Qualcomm Snapdragon 865 with 12GB RAM
4500 mAh battery

OPPO RENO3 PRO
6.5-inch with 1080 x 2400 resolution
Qualcomm Snapdragon 765G with 8/12GB RAM
4025 mAh battery

SAMSUNG GALAXY NOTE10+ 5G
6.8-inch with 1440 x 3040 resolution
Exynos 9825/Qualcomm Snapdragon 855 with 12GB RAM
4300 mAh battery

XIAOMI MI 9 PRO 5G
6.39-inch with 1080 x 2340 resolution
Qualcomm Snapdragon 855+ with 8/12GB RAM
4000 mAh battery

HUAWEI MATE 30 PRO 5G
6.53-inch with 1176 x 2400 resolution
HiSilicon Kirin 990 5G with 8GB RAM
4500 mAh battery

VIVO NEX 3 5G
6.89-inch with 1080 x 2256 resolution
Qualcomm Snapdragon 855+ with 8/12GB RAM
4500 mAh battery

3 HOW 5G-READY ARE WE?

5G-ready mobile devices

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A **5G-ready smartphone** is a smartphone that can connect to 5G networks via an embedded 5G modem. When 5G networks are not available, the device will be able to switch to previous generations of networks including 4G LTE, 3G and below.

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<1%

of all active smartphones were 5G-ready as of the end of 2019, which is **7.5 million** worldwide.

1Bn

active 5G-ready smartphones predicted by the end of 2022, which will be **21.8%** of all active smartphones worldwide.

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3.5 BILLION ACTIVE SMARTPHONE USERS GLOBALLY

With 4.2 billion active mobile devices predicted by the end of 2020

SMARTPHONE USERS AND ACTIVE SMARTPHONES
Global | 2018-2020

● Smartphone users   ● Active smartphones

- 2018: 3.0Bn / 3.6Bn
- 2019: 3.3Bn / 3.9Bn
- 2020: 3.5Bn / 4.2Bn
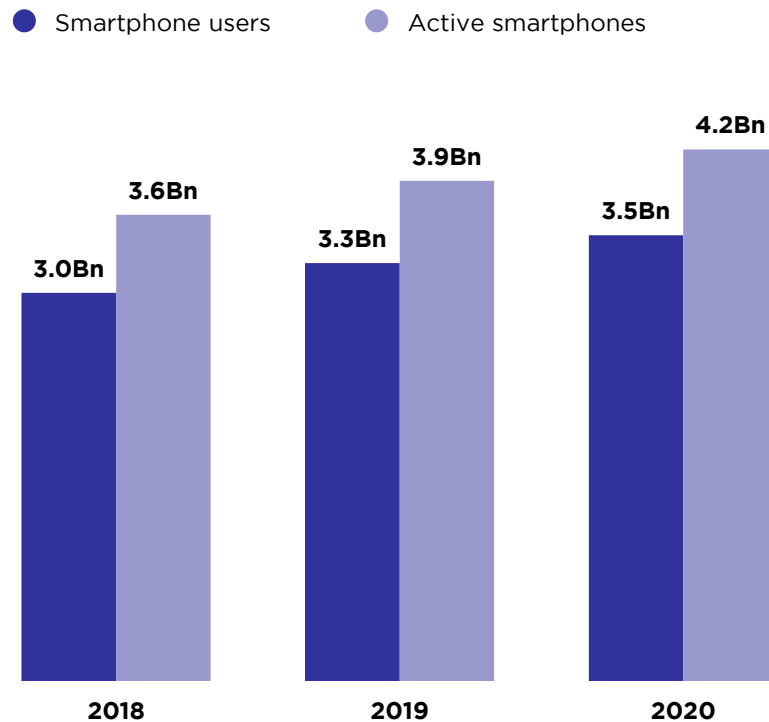
ACTIVE SMARTPHONE USERS
Per region | 2020

2020 TOTAL
3.5BN
+6.7%
YEAR ON YEAR

- 9% NORTH AMERICA
- 9% LATIN AMERICA
- 9% WESTERN EUROPE
- 6% EASTERN EUROPE
- 12% MIDDLE EAST & AFRICA
- 17% ASIA PACIFIC*
- 13% INDIA
- 25% CHINA

*Excludes India & China

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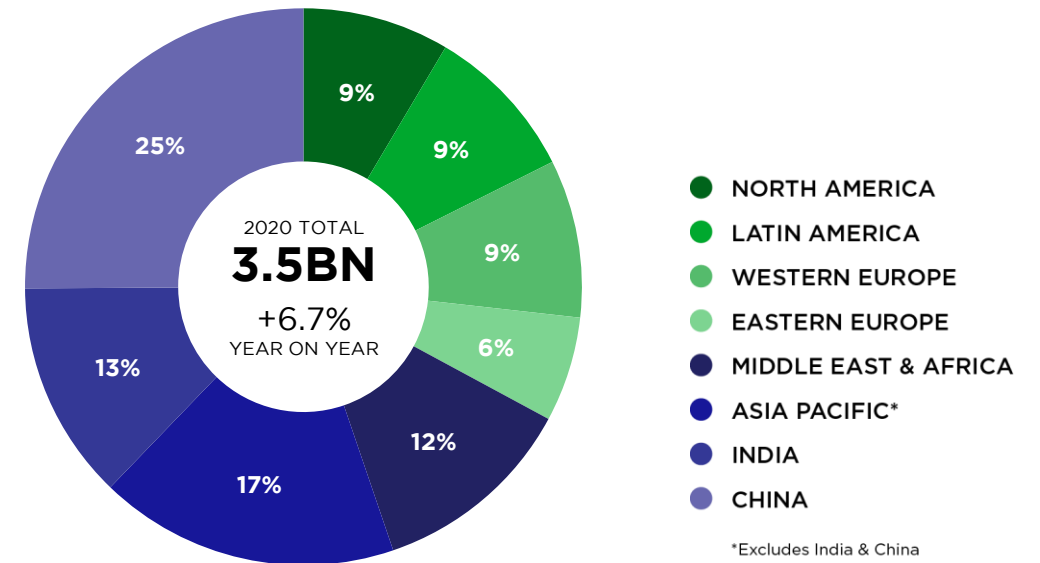
5G IS STILL IN ITS INFANCY, BUT WILL GROW FAST

Less than 1% of all active devices were 5G-ready by the end of 2019

DISTRIBUTION OF SMARTPHONES BY CONNECTIVITY

June 2016 – December 2019 | Global

● 5G ● 4G ● 3G ● 2G or below

2G: 17M
3G: 272M
4G: 3,614M
5G: 7.5M

(Y-axis: 4.5Bn, 4.0Bn, 3.5Bn, 3.0Bn, 2.5Bn, 2.0Bn, 1.5Bn, 1.0Bn, 0.5Bn, 0.0Bn)

(X-axis: Jun 2016, Dec 2016, Jun 2017, Dec 2017, Jun 2018, Dec 2018, Jun 2019, Dec 2019)
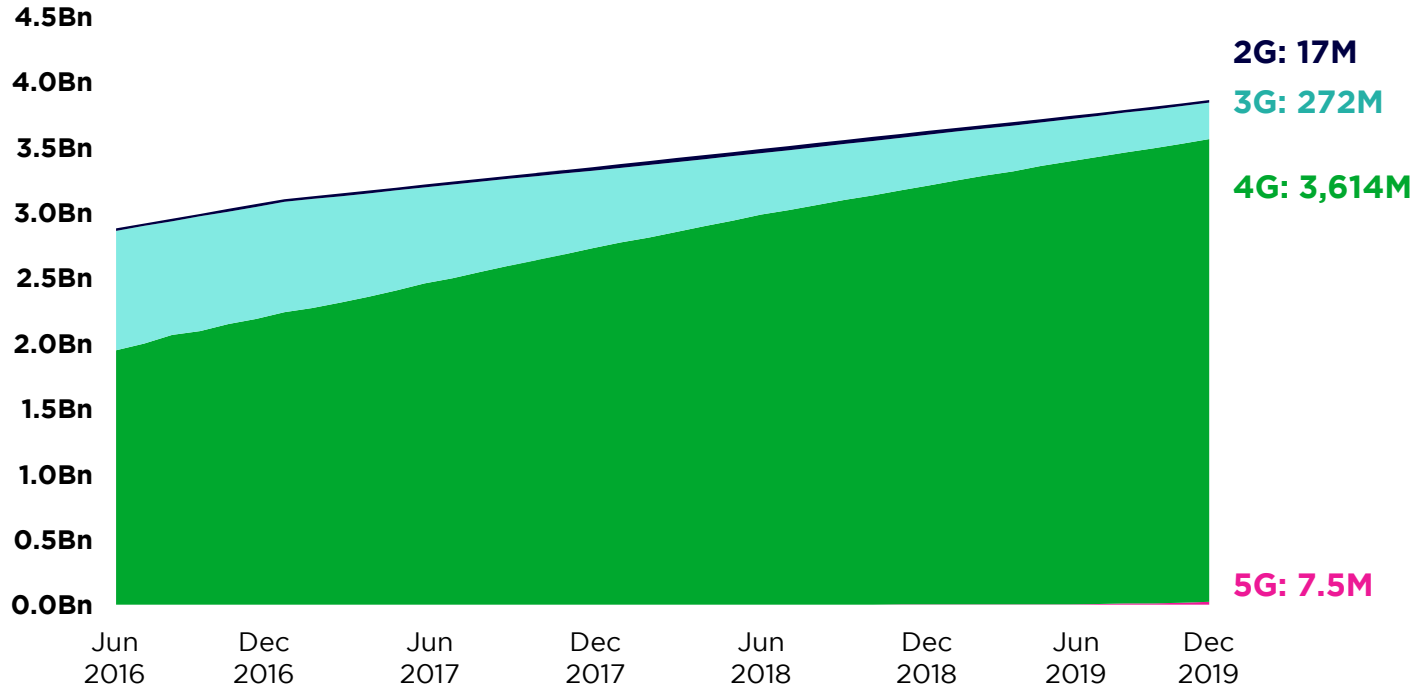
0.2%

of all active smartphones were 5G-ready by the end of 2019, which is **7.5 million** smartphones worldwide.

#1 MARKET
by 5G penetration

In December 2019, **11.3%** of all smartphones in South Korea were 5G-ready, making South Korea the **#1 market by 5G penetration** among all active smartphones.

#2   **#3**

0.8% in Dec 2019   **0.5%** in Dec 2019

Australia is one of the first countries in the world to launch 5G. 5G networks became available in Australia as early as May 2019, introduced by the country's largest telecom company Telstra.

THERE WILL BE OVER 1 BILLION ACTIVE 5G PHONES BY 2022

China will overtake South Korea as the largest 5G market by active smartphones

ACTIVE 5G SMARTPHONES

Global | 2019-2022

+411%

CAGR 2019-2022

21.8%
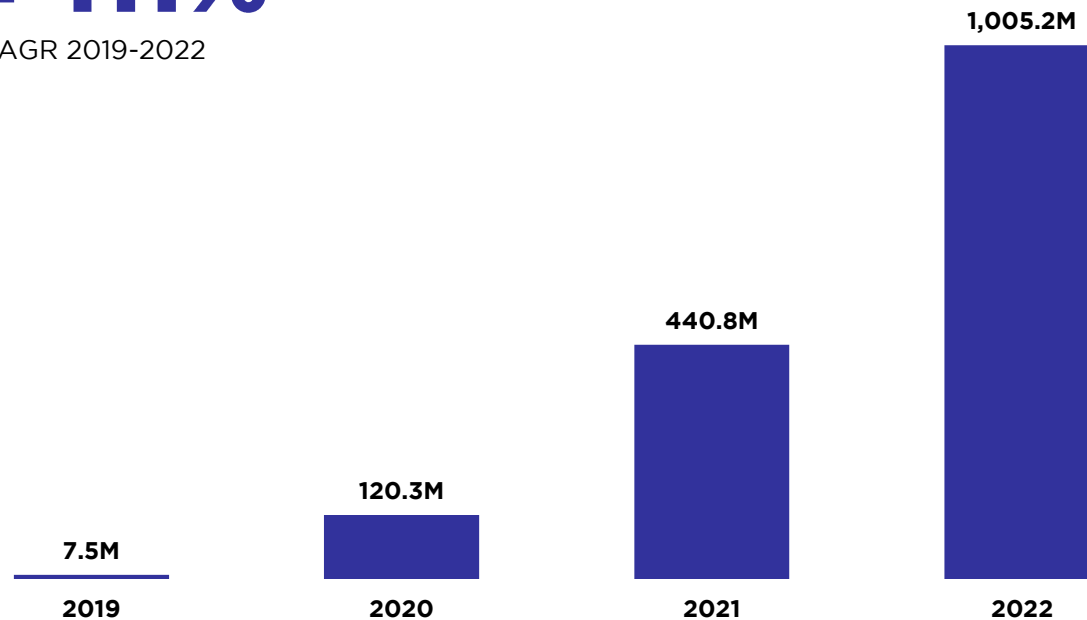
of all active smartphones will be 5G-compatible by 2022.

#1 MARKET
by 5G smartphones

China will be the largest market in 2022 by number of active 5G smartphones. We predict that there will be **391.5 million** active 5G smartphones in China by 2022, accounting for **34.7%** of active smartphones in the country.

7.5M	120.3M	440.8M	1,005.2M
2019	2020	2021	2022

"5G is a transformative technology that provides phenomenal opportunities for the mobile ecosystem. This will drive the need for higher performing mobile devices to enable new services and immersive experiences made possible by the 5G rollout. As a result, we expect to see more performant and efficient architectures, processors, and SoC solutions on mobile."

Paul Williamson, Arm VP & GM, Client Line of Business

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4 NEW GAMING EXPERIENCES

5G's impact on gaming and beyond

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THE GAMES MARKET CONTINUES TO REACH NEW HEIGHTS

Gaming is booming: consumers worldwide will spend over $160 billion on gaming in 2020

$138.7Bn **$148.8Bn** **$160.5Bn** **$173.3Bn** **$189.6Bn**

2018   2019   2020   2021   2022
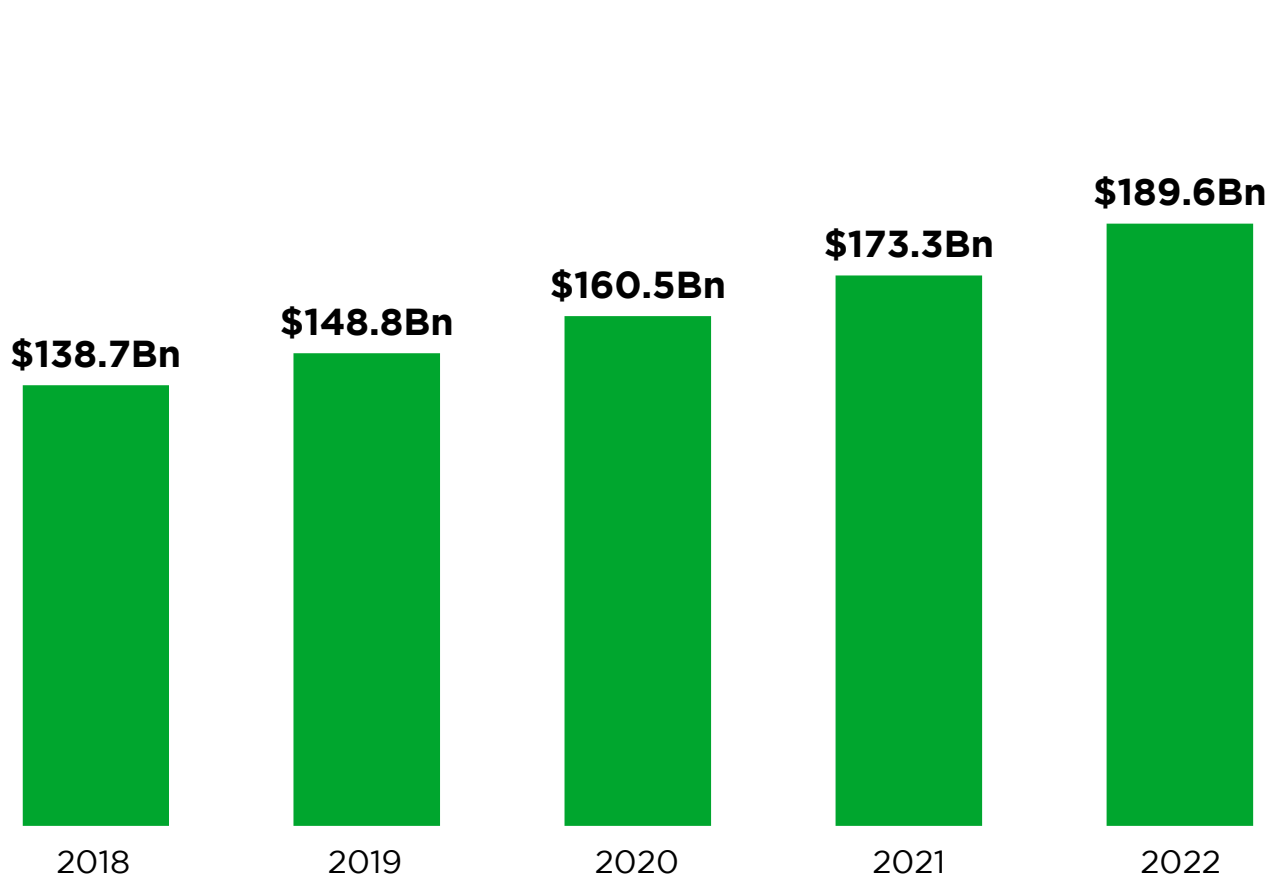
+8.1%

TOTAL MARKET CAGR
2018-2022

+10.8%

TOTAL MOBILE GAMES
MARKET CAGR 2018-2022

Source: ©Newzoo | Global Games Market Report

$68.2 BILLION GLOBAL MOBILE GAME REVENUES IN 2019

Mobile is the largest gaming segment and will remain so towards 2022

MOBILE
$68.2*Bn
+9.7% YoY

TABLET GAMES
$13.4Bn
+3.3% YoY

(SMART)PHONE GAMES
$54.7Bn
+11.4% YoY

PC
$35.3Bn
+2.8% YoY

BROWSER PC GAMES
$3.5Bn
-15.4% YoY

BOXED/ DOWNLOADED PC GAMES
$31.8Bn
+5.2% YoY

CONSOLE
$45.3Bn
+7.3% YoY

2019 TOTAL
$148.8Bn
+7.2% YoY

9% 2% 24% 21% 46% 37% 30% 30%
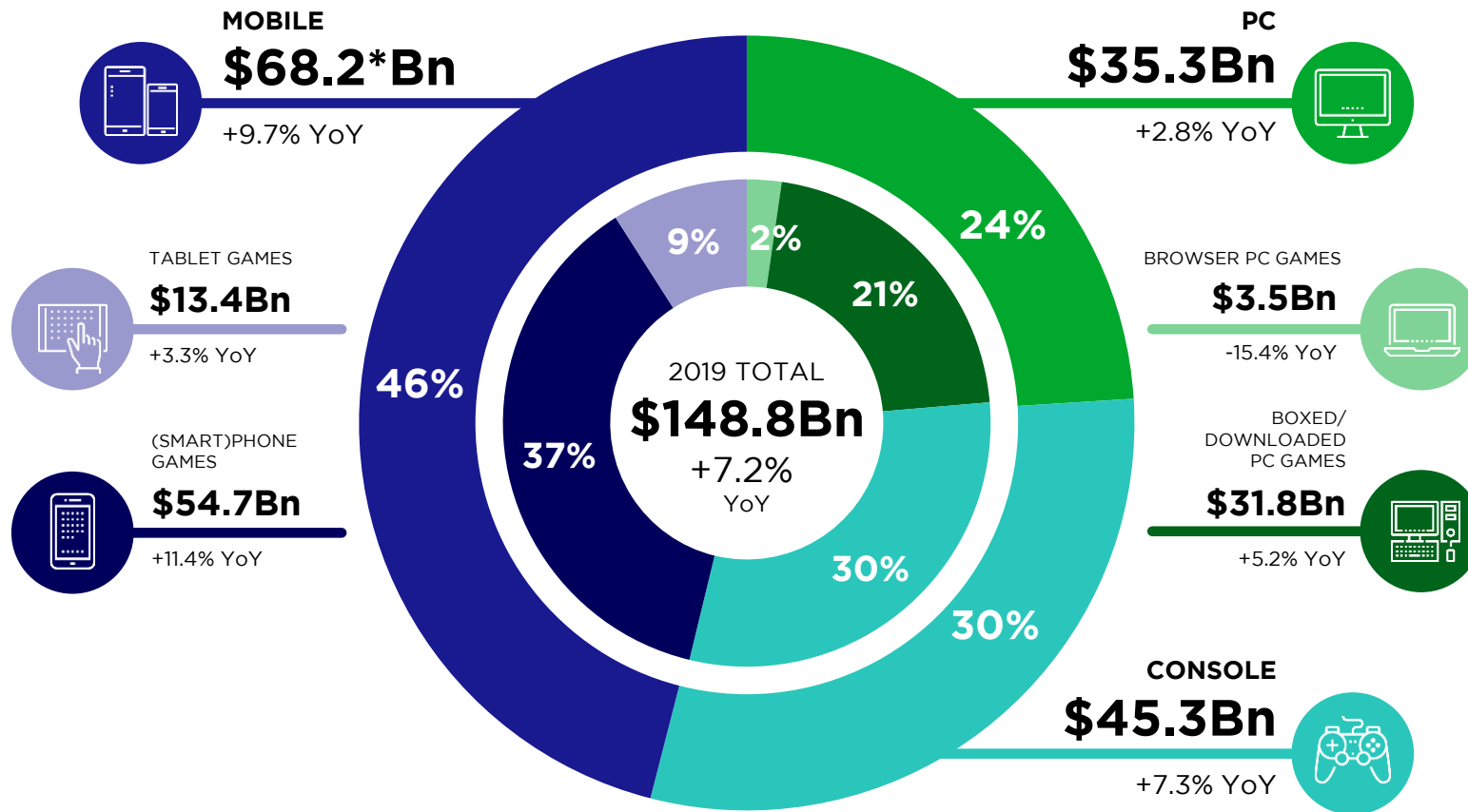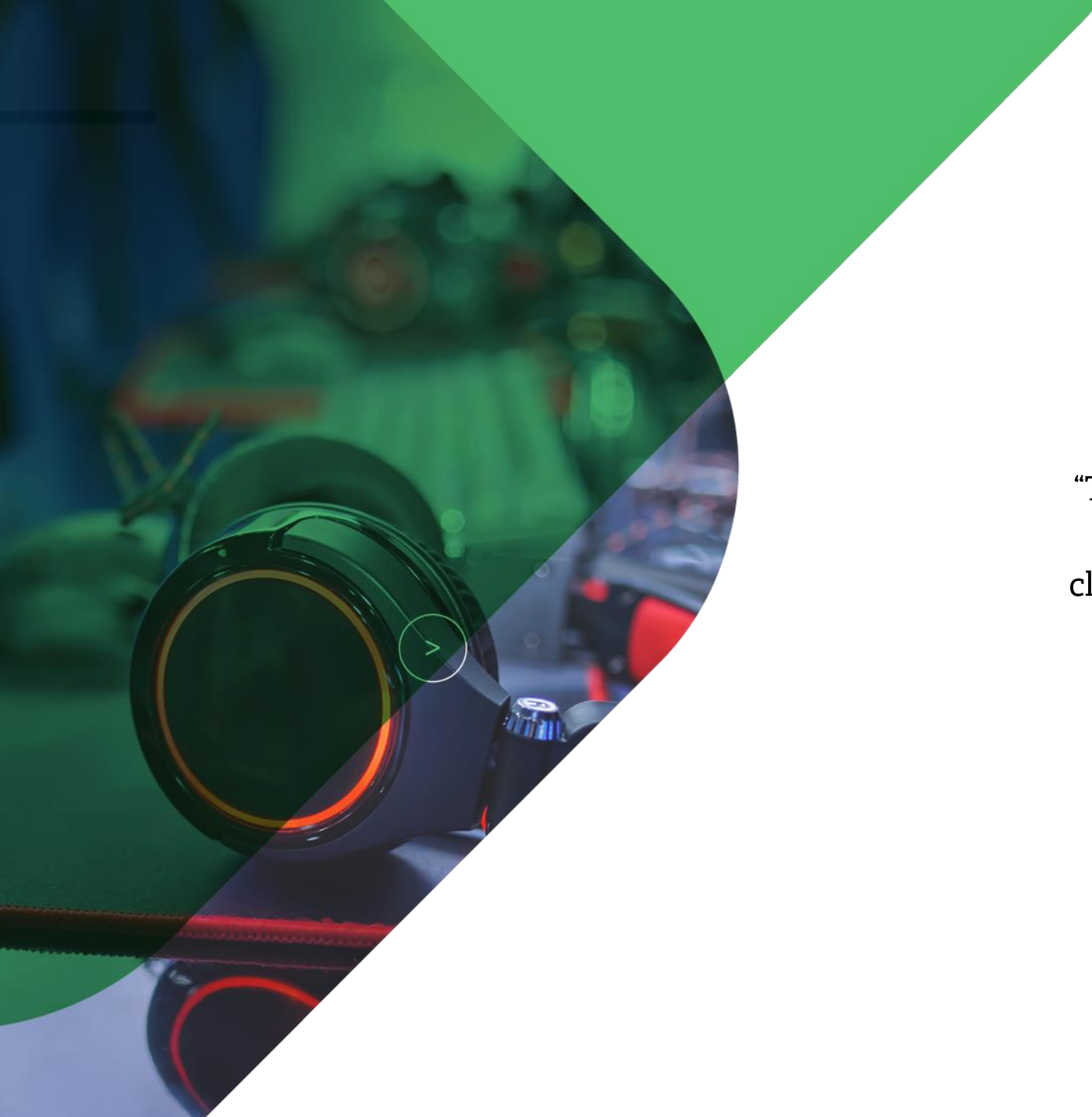
$68.2Bn

Mobile game revenues in 2019 accounted for 46% of the global market.

*Due to rounding, tablet games ($13.4Bn) and (smart)phone games ($54.7Bn) add up to $68.2Bn.

"The global games market is moving towards a future in which platform choice is less relevant, driven by cloud gaming, cross-platform game services, and even cross-platform multiplayer—all powered by 5G."

Peter Warman, Newzoo CEO & Co-Founder

newzoo

5G WILL ENABLE THE GROWTH OF CLOUD GAMING

Cloud gaming, in turn, could be the "killer app" of 5G

ALL PLAYERS WANT A PIECE OF THE CLOUD GAMING PIE

Even though 5G is still in its infancy, the technology is already set to affect the games business dramatically. One of 5G's major use cases is that it allows for a smooth **cloud gaming** experience. 5G's low latency and the convenience of smartphones will make mobile a key platform for cloud gaming. Today's mobile-first gamers are increasingly exposed to midcore, immersive, and competitive game experiences—titles that were previously available only on console and PC. Cloud gaming and 5G will make many more of these premium titles available on mobile. It is unclear if 4G connections will meet the minimum requirements for cloud gaming. However, it is likely that a better quality of experience will be required, making 4G not suitable in the long term. Therefore, 5G will become necessary for gamers to enjoy cloud gaming virtually latency-free. Just as video and music streaming were major selling points for consumers upgrading from 2G and 3G to 4G, so too could cloud gaming become **5G's killer app**.

However, 5G is still far away from reaching its full potential. For the near future, cloud gaming will be more limited by the readiness of the overall network than the hardware capabilities of the client or server. Moreover, 5G millimeter-wave radio signals have a short range and are more easily blocked by obstacles such as walls. These are challenges for engineers looking to provide an uninterrupted mobile service.

While companies from various businesses like game publishers, tech giants, and hardware makers are fighting for a piece of the gaming pie, there's a less obvious stakeholder: **communications service providers (CoSPs/Telcos)**. One primary value a telco can offer consumers is ultimately the **convenience factor**. Consumers already have an internet subscription, and adding a gaming service to that is a simple process for a consumer already used to the concept of **bundling**. In fact, many carrier offerings are already underway. For example, Swiss telecom company Sunrise launched its cloud gaming service in November 2019. Hatch regularly collaborates with telecom companies across the globe that launch 5G services, which then offer customers exclusive access to Hatch's premium cloud gaming service.

CLOUD GAMING SERVICES NOW ON MOBILE

Hatch is a cloud gaming service exclusively for mobile. Rovio, the creator of Angry Birds, and Japanese telecom NTT DOCOMO are both investors. Hatch's premium subscription ($7 to $10, varying per country) offers access to 100+ premium mobile games. None of the games include ads or in-app purchases.


Sunrise, a telecom company from Switzerland, launched its cloud gaming service Sunrise Game Cloud in November 2019, partnering with white-label provider Gamestream. Priced at CHF9.90 ($9.95) per month, Sunrise Game Cloud provides consumers with 50+ console games on their 5G smartphones. Similar to Hatch, games do not have ads or in-game purchases.

Project xCloud is a service offered by Microsoft which is currently in beta, allowing users to stream over 50 Xbox games directly to their Android devices. The service is only available on mobile now but will expand to other platforms in the future.

THE MOBILE MARKET WILL EVOLVE AS AN ECOSYSTEM

Cloud gaming's impact on key mobile stakeholders
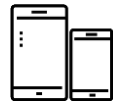
MOBILE DEVICES

Cloud gaming will bring many premium titles previously only available on PC / console to mobile. OEMs have an opportunity to design the next generation of 5G phones to capture the cloud gamer.

1. **Larger screen sizes** have been a major trend in the mobile market and are likely here to stay. **Foldable phones** might pique the interest of cloud gamers in particular.

2. Larger screen sizes and longer play sessions for premium games will simultaneously increase power usage. Ultimately, widespread adoption of cloud gaming will lead manufacturers to continue investing in **longer-lasting batteries** and **fast-charging solutions**, which will require efficient and performant IP on the SoC.

3. Maintaining connectivity to Wi-Fi and 5G networks is critical for the best cloud gaming experience, leading to **antenna** design and placement prioritization in mobile devices.

4. **5G** is key in cloud gaming, with stakeholders eager to establish 5G technology leadership, as it can increase gamers' engagement and drive 5G phone upgrades.

MOBILE PERIPHERALS

The core and competitive nature of premium games may result in a spike in demand and revenues for mobile gaming peripherals.

1. In the future, mobile controllers will likely be as **complex** as these controllers, albeit **smaller in size** or **collapsible for portability**.

2. It is also likely that we will see more peripherals that are **compatible across all platforms**, thanks to the platform-agnostic nature of cloud gaming.

Along these lines, **Microsoft** is now experimenting with Switch-like prototype Xbox controllers for phones and tablets. **Razer** launched Junglecat controller to support cloud gaming on mobile.

Microsoft's prototype controller
Source: ©Microsoft

Razer's Junglecat controller
Source: ©Razer

TELCOS

We have addressed opportunities for telcos in the cloud gaming space by offering service bundling (see previous slide #31), but there are also challenges for carriers to meet.

1. At the moment, telcos are spending big on **infrastructure/5G network upgrades**. Cloud gaming will potentially become one of the largest consumers of internet traffic in the coming years, and it remains challenging for telcos to be able to handle it and ensure low latency.

2. Another challenge is **data caps**. If data caps remain at their current level (e.g., 50GB/month for T-Mobile in the U.S.), only allowing gamers to stream Google Stadia on mobile for roughly five hours at 1080p, they will discourage consumers from using cloud gaming services on their mobile networks. Cloud gaming could be the catalyst that changes Internet data cap policies.
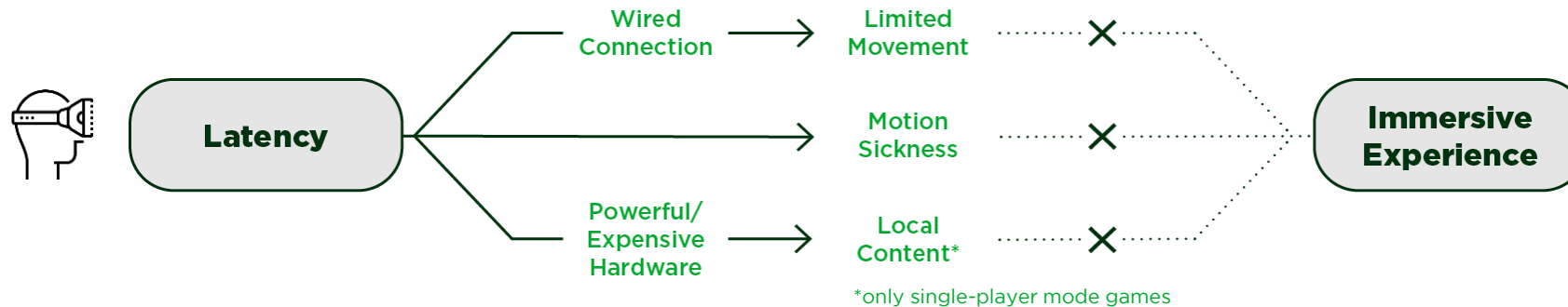
SEAMLESS XR GAMING IS ONE STEP CLOSER WITH 5G

The AR and VR opportunity

5G'S LOW LATENCY HAS THE POTENTIAL TO BE A MAJOR BREAKTHROUGH FOR THE TECHNOLOGIES

VR has always required seamless latency to ensure that the experience is as immersive as possible; after all, immersion is a key unique value proposition for VR. 5G technology could help solve VR's current obstacles caused by latency, such as motion sickness, bringing **untethered experiences** to the platform. 5G would enable **processing to be done remotely** through the edge computing infrastructure and the cloud. With its high bandwidth and low latency, 5G allows VR gamers to play with and against others across all platforms (via online multiplayer modes). Similar to cloud gaming, cloud VR will **largely reduce consumer's investment in hardware**, further lowering the entry barrier to VR gaming.

VR IMMERSION OBSTACLES CAUSED BY LATENCY

```
                    Wired              Limited
                    Connection   →     Movement    ✕ ·····
                                                            ·····
         ┌──────────┐                  Motion                    ·····  ┌────────────┐
    (VR) │ Latency  │──────────────→   Sickness    ✕ ·········· ······· │ Immersive  │
         └──────────┘                                           ·····   │ Experience │
                    Powerful/          Local              ·····         └────────────┘
                    Expensive    →     Content*    ✕ ·····
                    Hardware

                              *only single-player mode games
```

Like VR gaming, low latency is also the key to AR gaming. AR is extremely **data-intensive**, requiring **real-time processing**. Today's AR technology is hindered by limited data capacity and 4G latency alike. Together with AI, 5G will bring AR gaming to the next level, with more **immersive gaming experiences** and **multiplayer modes**. In the foreseeable future, mobile will remain the largest platform for AR gaming. Powered by 5G, more location-based AR games are expected.

5G's higher bandwidth and lower latency also enable streamed XR content. Streamed XR services will give consumers the same flexibility and experience they have come to expect from music and video streaming services. 5G can also improve the development of XR technologies, making it more accessible to consumers.

5G CAN DELIVER A PLATFORM-AGNOSTIC FUTURE FOR GAMING

We expect to see multiplayer games flourish across all platforms

5G'S LOW LATENCY IS THE KEY TO GAMING'S PLATFORM-AGNOSTIC FUTURE

The global games market is moving toward a future in which **platform choice is less relevant**, driven by cloud gaming, cross-platform game services, and even cross-platform multiplayer—all **powered by 5G**. The hardware and screens that consumers use are becoming a non-factor. If graphics are rendered on the cloud, consumers can access game content on whichever screen they like, whether that be a smartphone screen, a PC monitor, or a TV.

Besides **cloud gaming**, 5G will also bring us a true **cross-platform** gaming experience. Cross-play is under the spotlight of the games market, attracting companies from all businesses to enter the fray. Apple Arcade, for example, delivers multi-platform gaming experience by focusing on a common developer environment across iOS, MacOS, and Apple TV. While the mobile platform is integral here, the cross-play potential of Apple Arcade is appealing for a different set of consumers. Other services currently available that offer the ability to play a game on any device include Steam Link, Omen, Tencent WeGame, and PlayStation Remote Play.

Obvious stakeholders in the cross-play pie are traditional game companies. Today, premium games such as Call of Duty already support cross-play between console and PC, but including mobile presents integration challenges due to mobile hardware limitations. By moving data processing to the cloud and at the edge, hardware capabilities are no longer a deciding factor for gaming experiences. 5G can ensure a seamless latency across all gaming platforms. What's more, **multiplayer modes**, which are already common on PC and console, are expected to flourish across all platforms. Today's mobile gamers are increasingly looking for more midcore and hardcore experiences, and we've already seen multiplayer games (e.g., MOBAs, shooters, MMORPGs) coming to mobile, but with simplified game design, which limits the cross-platform possibility. 5G will break the boundaries of gaming—on VR and AR alike. With its high bandwidth and low latency, 5G will allow gamers to play with and against others across all platforms via online multiplayer modes while on the move.

All in all, 5G plays a key role in achieving gaming's platform-agnostic future. Together with cloud and edge computing, 5G ensures a seamless connection across all gaming platforms, with players from all over the world.

Steam Link allows gamers to enjoy the Steam gaming experience on their mobile devices or TVs over the local network.

PlayStation Remote Play allows players to switch to other gaming screens—such as phones and laptops—on the same broadband network, without being tied to the TV.

CONTENT IS STILL KING

Gaming services will be in the midst of a content gold rush in the platform-agnostic future

CONTENT LIES AT THE HEART OF ALL GAMING SERVICES

As gaming moves toward a platform-agnostic future, **subscription** will become the norm. However, **content is still king** and lies at the heart of any successful subscription service. After all, content will be a primary influence on the adoption and retention of all gaming services. This development will further increase the power of **game IP owners**, which already hold a strong position. As hardware is no longer a limitation for game enthusiasts, the unique selling points of the individual game services will instead take precedence. This is already happening in the video-streaming space, in which Netflix, Amazon, Hulu, Disney, and other players are in the midst of a content gold rush, with each one vying for the best content to attract consumers to their service. Content is king, and breaking down hardware barriers will only strengthen its crown. For a service to differentiate itself in a cross-platform future, owning IP and making exclusivity deals will be more important than ever. Naturally, game enthusiasts are unlikely to pay for a service that lacks the games they enjoy.

Along these lines, Google, without any strong roots in the games business, is working very hard to secure (exclusive) content on its cloud gaming service Google Stadia. The company has confirmed that Ubisoft's UPlay+ will be available to purchase for Stadia users. In addition to third-party content, Google founded a new development studio, Stadia Games and Entertainment, which will focus on developing unique experiences made possible by cloud gaming.

Mobile will be an important access point of platform-agnostic gaming services, especially for mobile-first players. With cloud gaming and cross-play, we expect to see more and more **immersive**, **competitive**, and **interactive** gaming content adapted to mobile. **AAA games** will finally come to mobile without simplified game designs. Powered by other developments in the mobile market, including mobile devices and peripherals (see slide #32), premium gaming experiences will eventually land on mobile.

MOGA Mobile Gaming Clip for Microsoft xCloud's Xbox Wireless Controllers

Google Stadia controller with phone mount "CLAW"

"From the U.S. and Europe to China, Australia, and South Korea, many consumers are now beginning to experience the initial promises of 5G for themselves. 4K video streaming is poised to become virtually ubiquitous and seamless—just like we stream music today."

Cristiano R. Amon, Qualcomm President

newzoo

CONSUMERS LOOK FOR IMMERSIVE & INTERACTIVE EXPERIENCES

5G's impact on the entertainment business beyond gaming

INTERACTIVE LIVE STREAMING EXPERIENCE

With the meteoric rise of Twitch and interactive streaming, audiences have shown they love interacting with viewers and content creators. For example, Twitch Plays Pokémon hit the Guinness World Record for having "the most participants on a single-player online videogame" with nearly 1.2 million people. Limited by low bandwidth and latencies, interactive live streaming on mobile is still in its infancy in the 4G era. 5G is likely to bring new forms of (direct) interactions with content, viewers, and streamers.

HIGH-DEFINITION VIDEOS ON MOBILE

Today's consumers are used to consuming video content on the go. In mobile-first countries like China, many streaming services even report more users on mobile than PC. With 4G, video quality often only reaches 480p while consumers still face other frustrations (load times, buffering, playback, etc.). Coupled with the trend of large mobile screens, 4K video content on mobile attracts consumers. Along with edge computing, 5G will vastly reduce stalling and buffering, and enable high-resolution mobile video content.

High Speed

5G

Low Latency

3D HOLOGRAMS

Volumetric display, also known as 3D holograms, will be vastly improved by 5G. The technology requires more data than streaming a 4K video, with low latency requirements. Images captured by 3D cameras have to be uploaded to the cloud, where data processing is done, and collected data is then rendered. With 5G, the process is accelerated. 3D holograms can meet the increasing consumer demand for immersive and interactive experiences in gaming, esports, interactive live streaming, and more.

IMMERSIVE ENTERTAINMENT POWERED BY XR

XR's applications stretch beyond gaming. With 5G, we expect to see more gamification of other entertainment formats powered by XR, such as hybrid sports events and cinematic experiences.
With XR, immersive viewing experience of live sports (including esports) events and concerts will advance to a new level. 5G-enabled stadiums will be able to stream content to the mobile devices of a live audience from different views—for example, from a sportsperson, a coach, an esports gamer, or even a singer.

GAMING WILL BE PART OF THE ALL-ENCOMPASSING EXPERIENCE

The merging of all content: streaming, playing, and sharing

GAMING IS THE MOST DISRUPTIVE ENTERTAINMENT

Gaming often acts as a first adopter to new technologies across the entertainment business. Soon, the industry will witness new ways through which games will become an all-encompassing experience, brought forth by the union of streaming, playing, and sharing.

Throughout the 5G rollout, we expect to see all forms of entertainment merge under one platform. In fact, the trend is already emerging in the market. Google Stadia, while currently launched, does not yet have the touted cloud-enabled features but plans to deliver them in the future. The ability to share save states, for example, allows users (including viewers) to jump into a game at the same point as another user—after the original user has shared their save, of course. Through the integration with YouTube, Google promises a seamless transition between watching and playing. In the longer term, it is highly likely that UHD video streaming and interactive live streaming (including various live views and XR) will also be integrated with the platform as a one-stop service, ensuring a seamless transition across streaming, playing, and sharing.

5G and cloud services will ensure a seamless experience for users, while content will lure consumers to different platforms. Tech giants with leadership in all the spaces are likely to stand out in the competition—in the East and West alike.

COMPANY	5G NETWORK	CLOUD INFRASTRUCTURE	GAMING SERVICE	STREAMING PLATFORM
Microsoft	PARTNERSHIP SK telecom AT&T	Microsoft Azure	XBOX Windows	mixer
Google		Google Cloud	STADIA	YouTube
amazon		amazon web services		twitch
Tencent 腾讯		Tencent Cloud	Tencent WeGame QQ游戏	企鹅电竞 Tencent Egame

THE RUSH FOR 5G HAS ONLY JUST BEGUN

The adoption curve of 5G is expected to be steeper than 4G, though the technology is still in its infancy

5G is happening at a faster pace than expected thanks to consumers' love for the technology!

While the world is excited about 5G, the technology has a long road ahead. The high frequency of millimeter waves will naturally cause a shorter range of radio signals and an abrupt drop-off in signal strength. To fully deploy 5G networks, a large number of 5G base stations and small cells are needed.

What's more, 5G-powered technologies such as more advanced AI and XR all require massive data storage and processing capacity. At the same time, 5G's high bandwidth will drive the market's demand for low latency to the next level. This means that other technologies—such as cloud and edge computing—must develop alongside to accelerate 5G to reach its peak.

Despite all the obstacles and challenges, the market is seeing 5G happen faster than expected. It had been generally estimated that the first commercial 5G network would not be available to consumers until 2020, but it took place one year earlier than anticipated. Consumers' desire

for the technology drives every party involved—from governments to OEMs—to accelerate the investment and development.

To consumers, 5G must also provide a compelling use case. Gaming often acts as a first adopter to new technologies across the entertainment business, and we believe gaming will also be the major touchpoint between consumers and 5G on the mobile platform. 5G will likely deliver gaming a platform-agnostic future and mobile will be an important access point for 'platform-agnostic' gaming services, such as cloud gaming. In fact, cloud gaming could be the "killer app" of 5G.

All in all, the 5G rollout is still at an early stage. However, when the technology reaches its peak, it is bound to revolutionize the world in many aspects. 2020 will be a groundbreaking and exploratory year for 5G, but another three to four more years are expected before mainstream consumer adoption.

<1ms

Latency that 5G is targeting to reach.

TIANYI GU
Market Analyst

THE EVOLUTION OF GAMING THROUGH 5G

The new era of mobile networks and its impact on gaming

newzoo   arm