3GPP-A MOBILE CONNECTED WORLD

December 2022

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The role of 3GPP technologies in our mobile world

Executive summary

5G - the new generation in mobile communication, was released in 2019, and as of end of October 2022, 228 commercial 5G networks have been launched around the world. 5G networks are the latest 3GPP standard – with speed between 10 and 100 times faster than 4G.* Largely thanks to this massive increase in speed, 5G is expected to revolutionize mobile communication and enable the digitalization of many aspects of everyday life. Perhaps the most important aspect for future innovation of 5G technology is the ability to transfer massive amounts of data in real-time. 5G could serve as the basis for a "Fourth Industrial Revolution" and provide the connectivity required for smart cities of the future. In addition to these macro-level benefits, this technology will bring ease and efficiency to the lives of countless individuals around the world.

But are we boasting about this technology, or are there tangible effects of 3GPP that can be measured?

This Statista report quantifies the impact of 3GPP mobile standards (commonly known as 3G, 4G & 5G **) on today's connected society, starting from the time that these technologies entered the market and providing insight into their future development; described in six dimensions:

1. Constantly evolving technology timeline
2. Growing penetration (adoption by end users) of the technology
3. Increasing affordability
4. Short time to market reflecting the popularity of the services
5. Benefits/opportunities enabled by the 3GPP standard for other digital services
6. Digital transformation enabled by 5G

What is 3GPP?

3GPP technologies cover cellular telecommunication technologies, which include radio access, core network and service capabilities, and provide a complete system description for mobile telecommunications. 3GPP or the Third Generation Partnership Project, consists of **seven*** standards development organizations** which develop **protocols for mobile telecommunication.** The association was founded in 1998 and started with introducing the 3G technology. **3GPP** is a **global** and **open** standard ensuring **interoperable** equipment and devices.

Note(s): * actual download speeds will depend on a number of factors including location and network traffic **2G is not a part of 3GPP standard, however it is included in this report's figures & stats ***ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, and TTC. For more information see also: https://www.3gpp.org/about-3gpp/partners
Sources: GSA

01 A unique standard

- Technical background
- Historical timeline
- 3GPP partners ecosystem
- Benefits of standard

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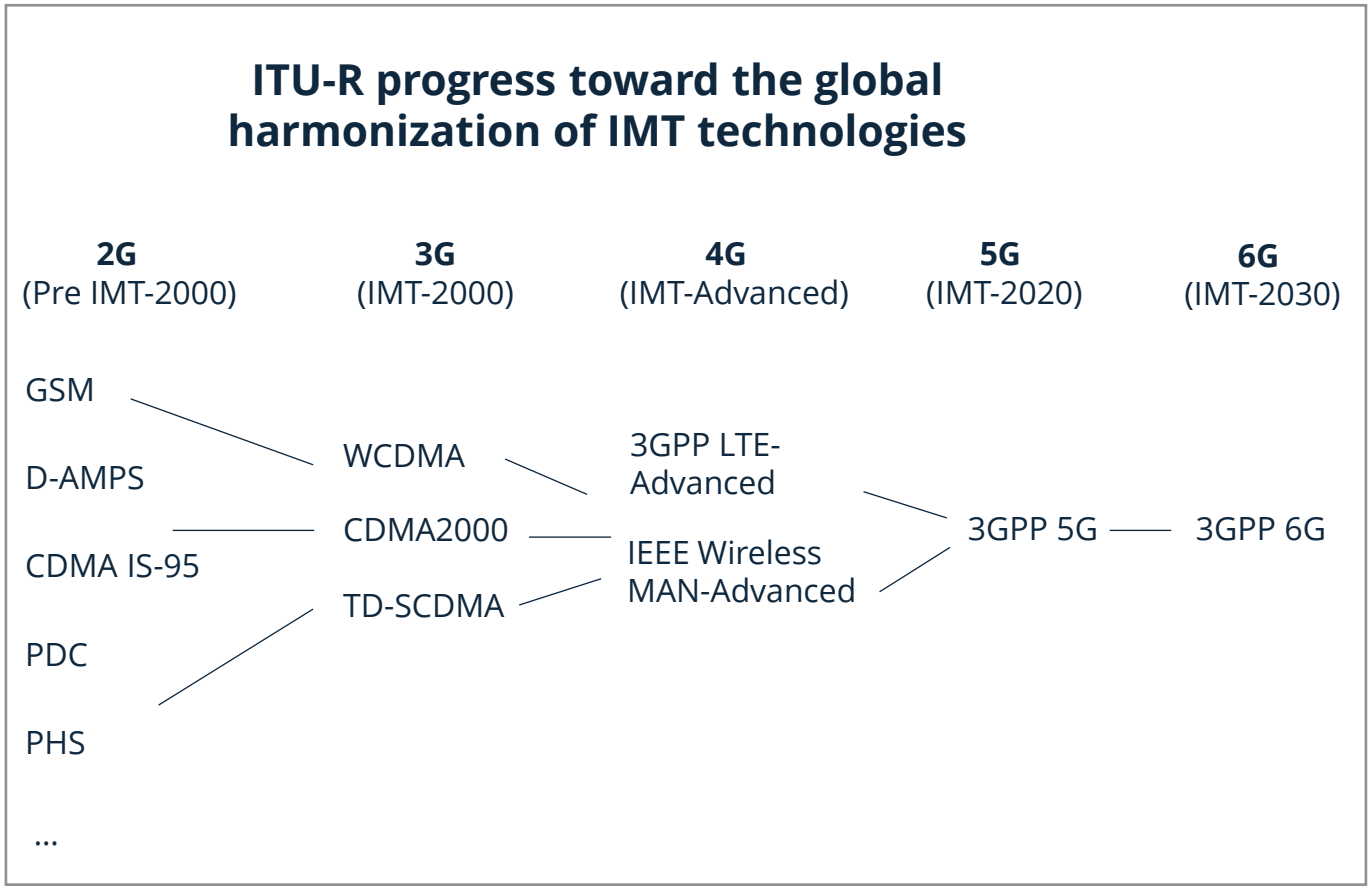
How 3GPP “G” standards lay the foundation for a successful global mobile internet ecosystem

Technical background: 3GPP Standard Development



Technical Development from 2G to 6G:

For the past 30 years, the ITU Radiocommunication sector (ITU-R) has been coordinating efforts with governments and industries to develop unified global broadband multimedia international mobile telecommunications systems, also known as IMT.

Global operation and economies of scale are key requirements for the success of mobile telecommunication systems.

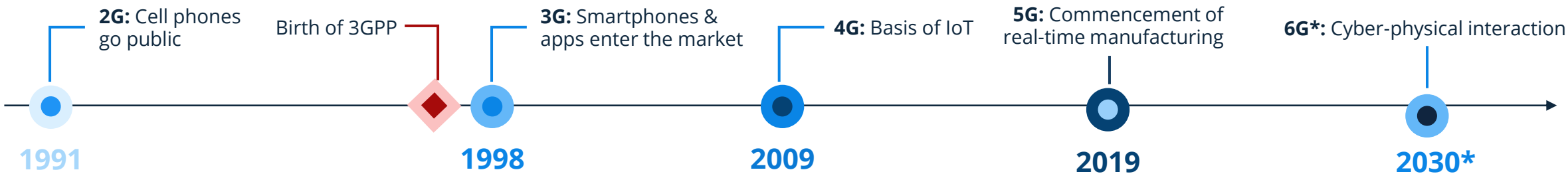
In order to achieve this goal, ITU-R established the concept of IMT, which includes a harmonized timeframe for future development, taking into account technical, operational, and spectrum-related aspects.

Since then, ITU-R has been striving for harmonized global standards, all through the processes of IMT-2000, IMT-Advanced and the soon-to-be IMT-2030.

Source(s): Delloro, ITU

3GPP mobile standards are a key driver for technical inventions and social evolution

Constantly evolving mobile data timeline



- **Key difference:** Phone calls to cellphones (regardless of the location) made possible
- **Reach:** Enables voice calls & texting via mobile phones for the public
- **Security:** Digital signals instead of analogue, phone conversations became encrypted & more secure

- **3GPP:** The first standard introduced by the 3GPP association
- **Rise of the smartphone:** Use of the smartphone for the wider public, data-based apps
- **More devices:** Mobile modems for laptops made possible

- **More media:** Real-time streaming of videos & faster gaming
- **NB-IoT:** Enabling narrowband IoT→ transferring small amounts of data over long periods of time, providing energy saving for IoT device
- **All-IP standard:** uses a standard communications protocol → data can be sent without being corrupted

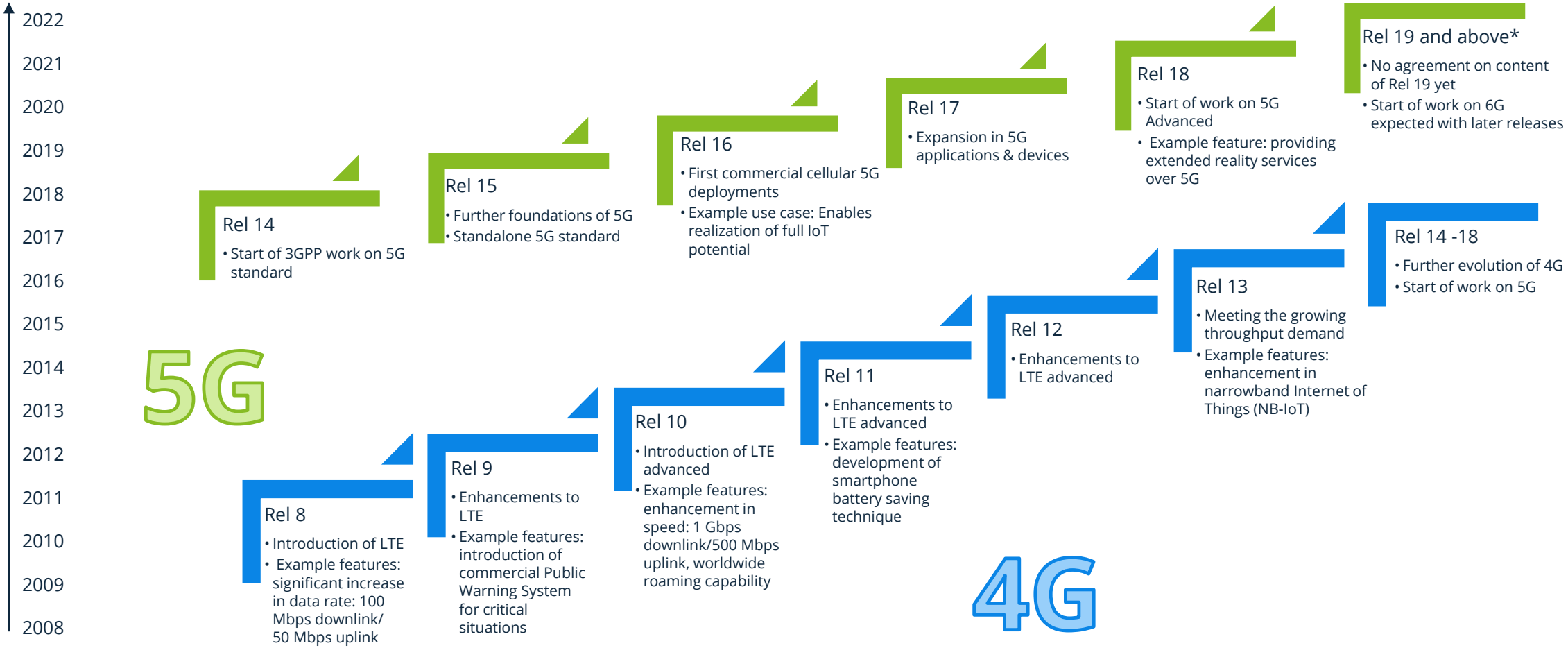
- **Higher performance:** Network speed up to 10Gbps, lower latency, much higher response rate
- **IoT:** Realization of the full potential of IoT. Enabler of real-time manufacturing & logistics as well as autonomous cars, smart cities & smart homes
- **Energy savings:** More efficient data transmission

- **Key difference**: Better than 5G performance, new services available
- **Pairing with AI:** Works in conjunction with AI, massive improvements in imaging, presence technology & location awareness
- **Cyber-physical continuum**: Seamless & immersive interaction between human & machine

Notes: * No official 3GPP timeline yet, neither for 6G nor for Rel-20/21/22
Source(s): Ericsson1, Ericsson 2, Uswitch, Rantcell, Round solutions, Techtarget

Continuous evolution of mobile network generations-Releases provide constant enhancements within each generation cycle

4G-5G Releases & their evolution



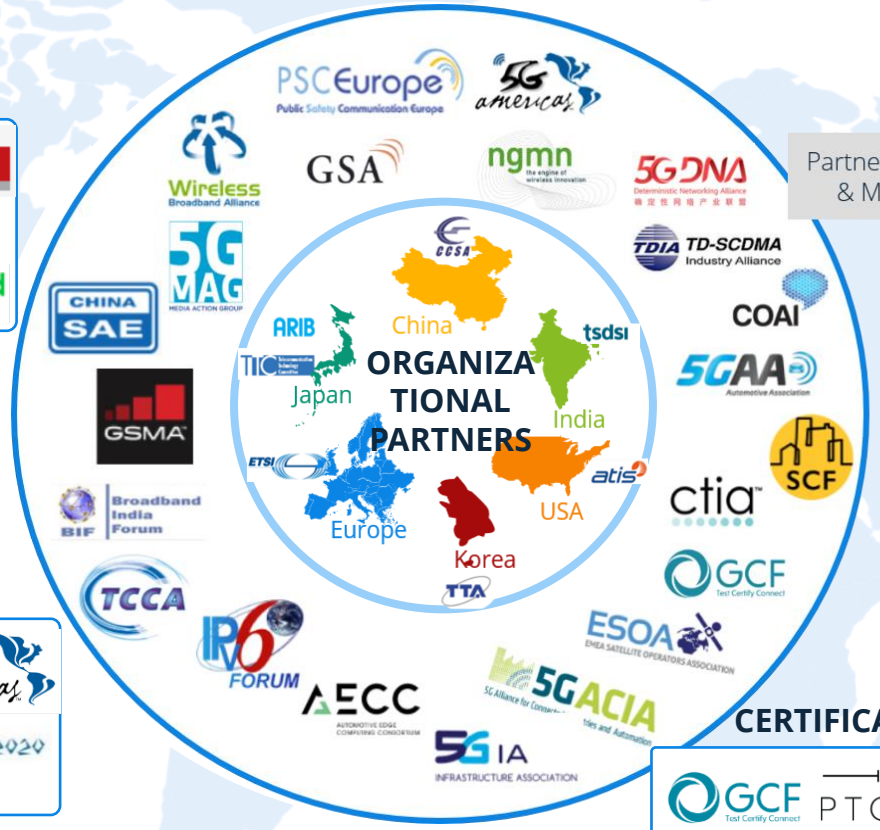
Notes: * No official 3GPP timeline is yet published, neither for 6G nor for Rel-19/20/21/22
Source(s): ETSI, CableFree, Qualcomm

3GPP partners with standard setting organizations, market representation partners, and external liaisons from across the world

3GPP ecosystem: Primary Members, Associate Members and External Liaisons

STANDARD BODIES

IEEE · IETF · oneM2M · ITU · oma SpecWorks · tmforum · broadband forum



Partners (OPs & MRPs)

5G PROJECTS

5GIMF · 5G Forum · 5G americas · ngmn · IMT-2020 · 5G IA · 5GAA

CERTIFICATION BODIES

GCF · PTCRB

3GPP is a collaboration among well-established regional standard organizations (organizational partners). These seven organizational partners (OPs) determine the general policy and strategy of 3GPP.

The twenty Market Representation Partners (MRPs) of 3GPP, together with organizational partners, perform tasks such as maintenance of the 'Partnership Project Agreement', approval of applications for 3GPP partnership, and making decisions related to the dissolution of 3GPP.

Notes: *the liaison with technical organization is an activity where technical co-ordination is taking place. This is not an exhaustive list.
Source(s): 3GPP liaisons, 3GPP management & orchestration

Standards accelerate economic growth by making resources more productive

Impact of an increase in stock of standards on GDP by country

Disseminating information
Having set standards is beneficial, as it codifies information about technologies, products, and processes, so that all manufacturers and service providers have access to the same information.

Contributing to efficiency in companies that use standards
Standards can reduce operational costs by establishing procedures that reduce expenses for repeated activities.

Supporting market efficiency
Standards help to prevent market failures, facilitate network externalities, reduce production costs, and increase company productivity.

Facilitating innovation
Standards are thought to support innovation by establishing the playing field for technologies on which new products and services can be built.

Standards are an important part of a multifaceted system of technology development and knowledge diffusion.

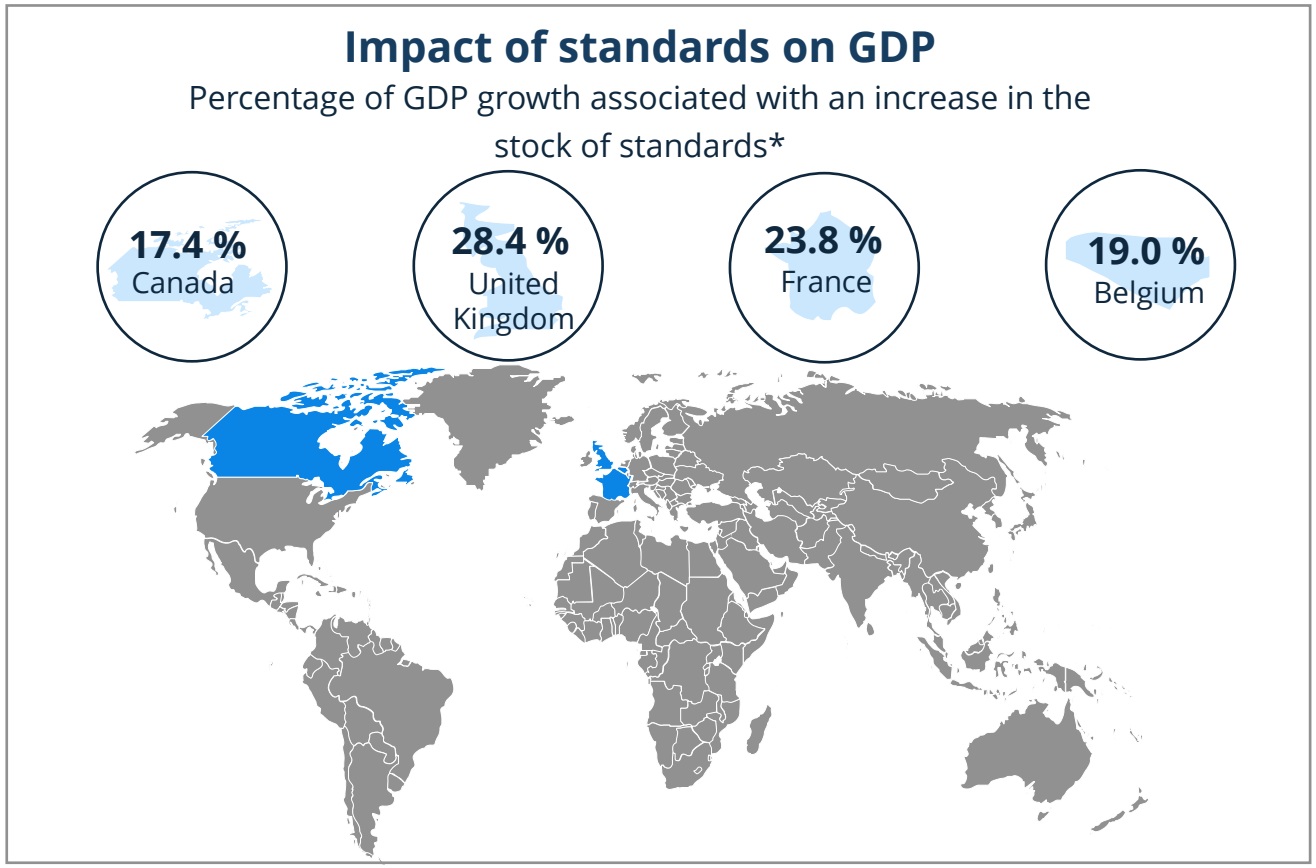
The overall "stock of standards" in any given country will include a range of different standard types, all of which can be expected to have different types of impacts.

They contribute to economic growth by serving as a component of Total Factor Productivity (TFP).

Source(s): ISO report

Standards accelerate economic growth by making resources more productive

Impact of an increase in stock of standards on GDP by country



Standards are thought to contribute to economic growth by serving as a component of Total Factor Productivity (TFP).

They augment the overall "knowledge stock" in an economy, and therefore improve the productivity of capital and/or labor.

Standards also affect other aspects of economic productivity such as international trade and innovation.

Note(s): * Time period: Canada 1950 – 2007; United Kingdom 1921 – 2013; France (1950 – 2007), Belgium (1994 – 2018)
Source(s): ISO report

Standards are the basis for economic and societal activities across the world

Benefits of standardization and the main actors

Specific Benefits	Domain	Actors
▪ Safeguard and promote values ▪ Common good protection (e.g. environment)	Public goods	▪ Governments
▪ Consumers: product comparison, protection ▪ Producers: economies of scale, reduce costs, certainty, quality	Markets	▪ Industry ▪ Consumers
▪ Interoperability ▪ Interconnection ▪ Interworking ▪ Knowledge	Infrastructure	▪ Public administrations ▪ Companies

Source(s): The Geopolitics of Standardisation » directions blog

02 End user benefits

- Penetration
- Time to market
- Affordability

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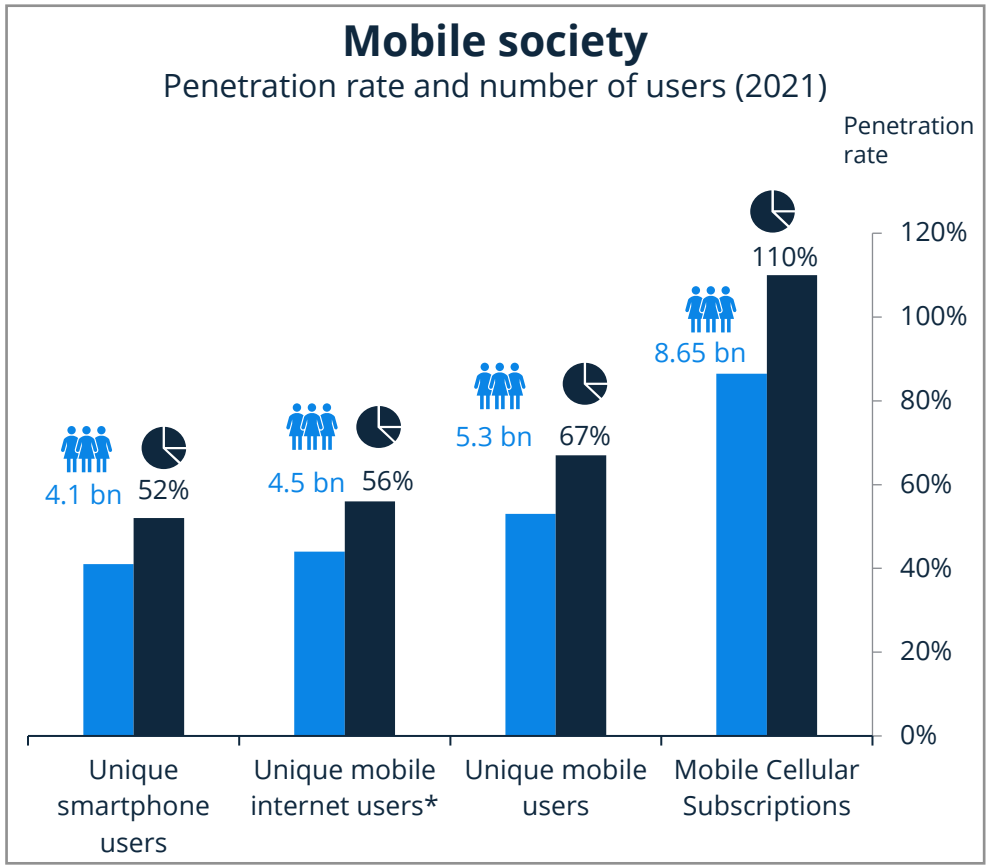
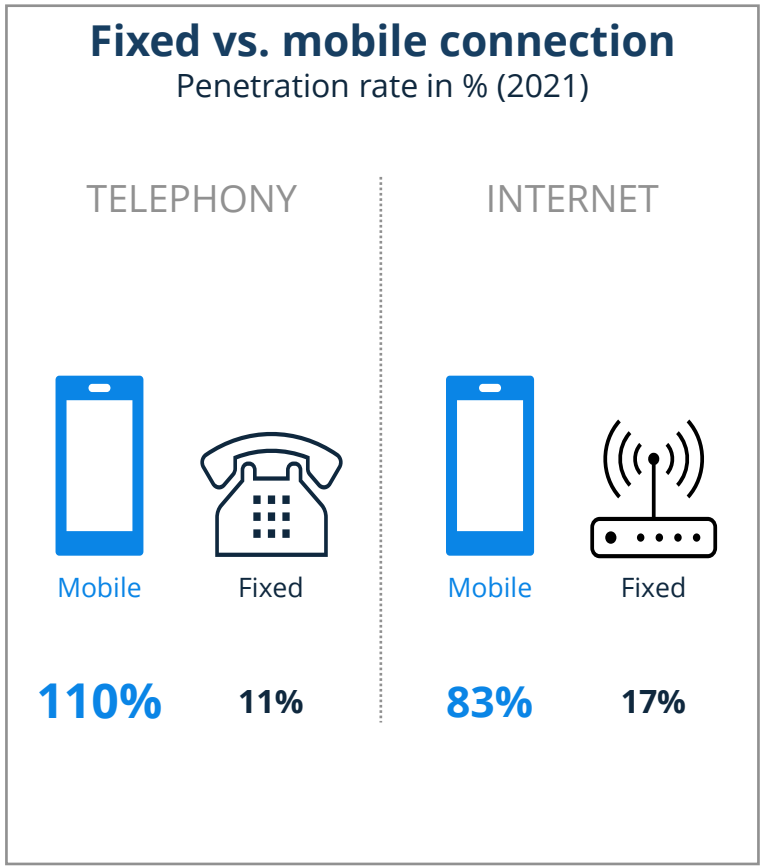
The spread of 3GPP communication technologies has resulted in unprecedented global penetration today …

Mobile technology as a part of our society (1/2)





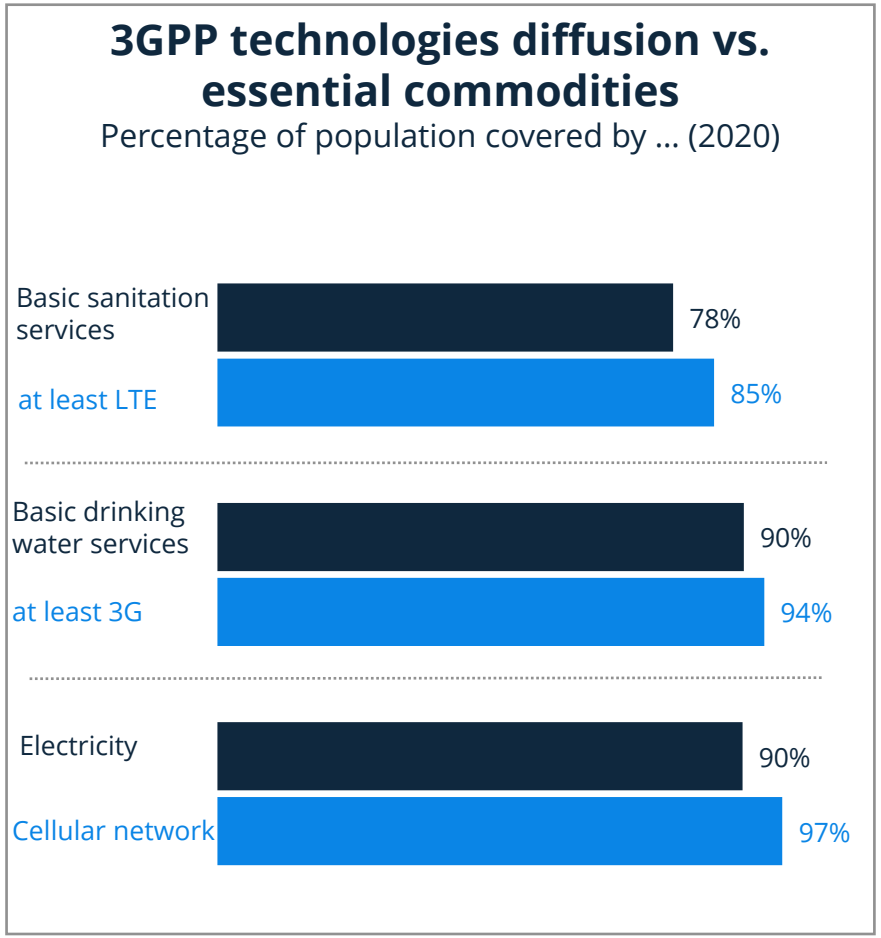
3GPP cellular technologies are an integral part of our society. Unique mobile subscribers reached 67% of population in 2021.

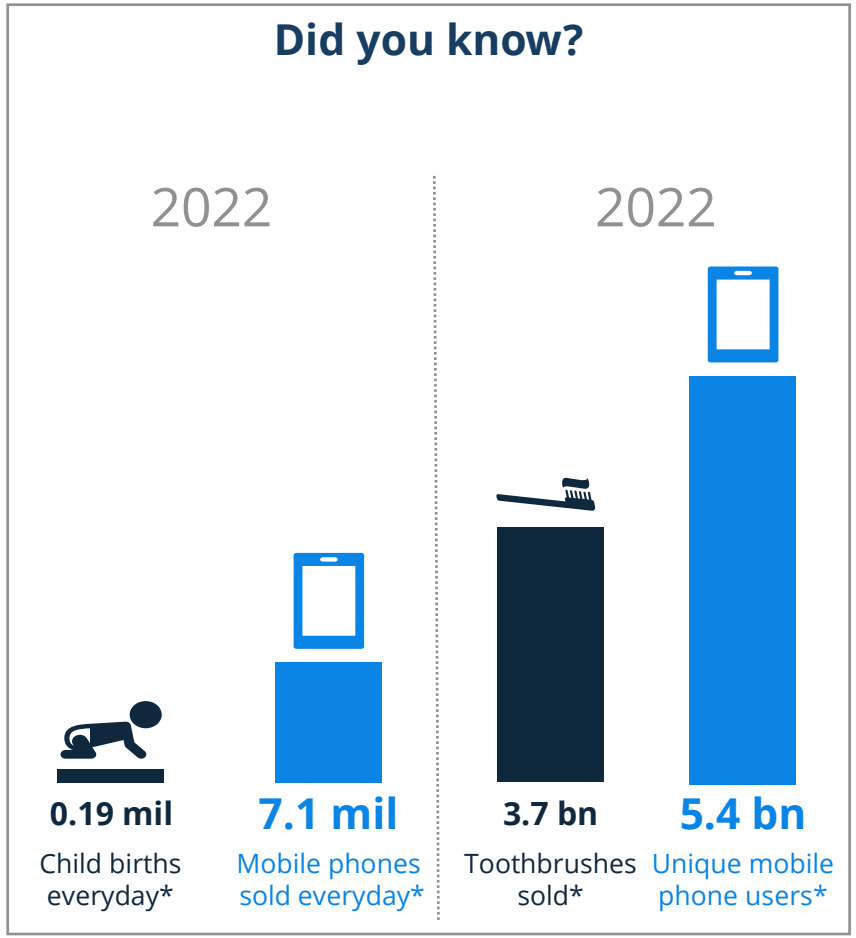
3GPP mobile networks enable access to mobile communication technology in regions where other communication technologies, such as fixed telephony and fixed broadband, failed to establish themselves (e.g., in Asia and Africa).

Note(s): * cellular or Wi-Fi. Data points are based on estimations for the year 2021by ITU or Statista calculation of unique number of users -> Penetration rate defines as the number of subscribers over the World Population in 2021, unless it is mentioned as unique number of subscribers. World population is assumed to be 7.89 billion by end of 2021
Source(s): GSMA, ITU, Datareportal

… and has even overtaken some long-established basic commodities in our society

Mobile technology as a part of our society (2/2)





3GPP network providers are offering unprecedented levels of coverage for telecommunications technology, even in comparison to other basic needs.

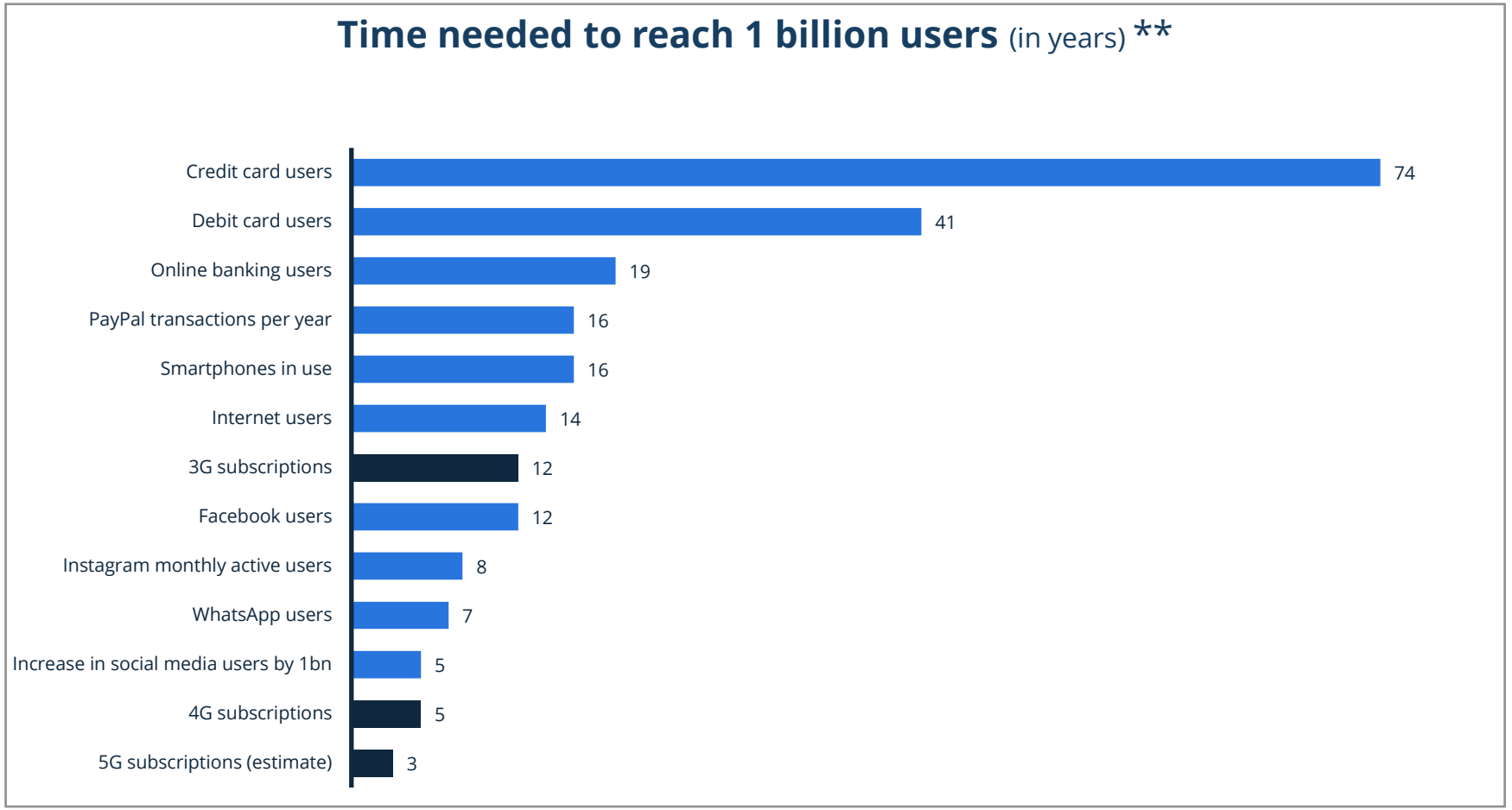
Fun facts:

1. More mobile phones are sold each day than children are born.
2. Perhaps more surprising, there were more unique mobile phone users than toothbrushes sold globally in 2022.

Note(s): * estimation by Statista
Source(s): Grandviewresearch,, ITU, Statista Analysis, WHO, Worldbank, Worldometer, Fortune business, UN population prospects, Data reportal, GSMA

5G is expected to reach 1 billion subscriptions faster than any other technological phenomenon

Time to market of 3GPP standards* compared to other technologies



Since the introduction of 2G mobile networks in 1991 and the sub-sequent introduction of 3GPP, mobile data technology has been adopted faster than many other technologies in the world.

Estimates suggest that 5G will have the fastest time to market cycle and will be used by one billion individuals worldwide in 3 years. This rapid adoption forecast is mainly due to its relatively affordable price, ease of building capacity, and its prominent benefits to society.

Note(s): *3GPP includes 3G,4G & 5G ** The years have been counted from the entrance of the mentioned technology to the market onwards. Calculated by Statista as of April 2020
Source(s): EMarketer, Ericsson mobility report, Facebook, GSA, Instagram, ITU, Jefferies & companies, our world in data, PayPal, Statista analysis, Strategy Analytics

Global scale and efficiency: Mobile data is increasingly affordable and accessible

Change in affordability of mobile data services - USA (1/3)

Change in the price of 1GB of mobile data in USA (2012–2021)

Purchasing power of $108 (2012)*

13	movie tickets
25	Big Macs
1097	kWh of electricity
228	days of computer use
103	liters of diesel
2808	travelled km by car

1GB = $108

1GB = $3.3

Purchasing power of $3.3 (2021)

0	movie tickets
0	Big Macs
23	kWh of electricity
5	days of computer use
3	liters of diesel
104	travelled km by car

Change in overall consumer price index (Q3 2012–Q3 2021)

OECD **19.4%** **18.7%**

Data volume is important – and gets increasingly more affordable.

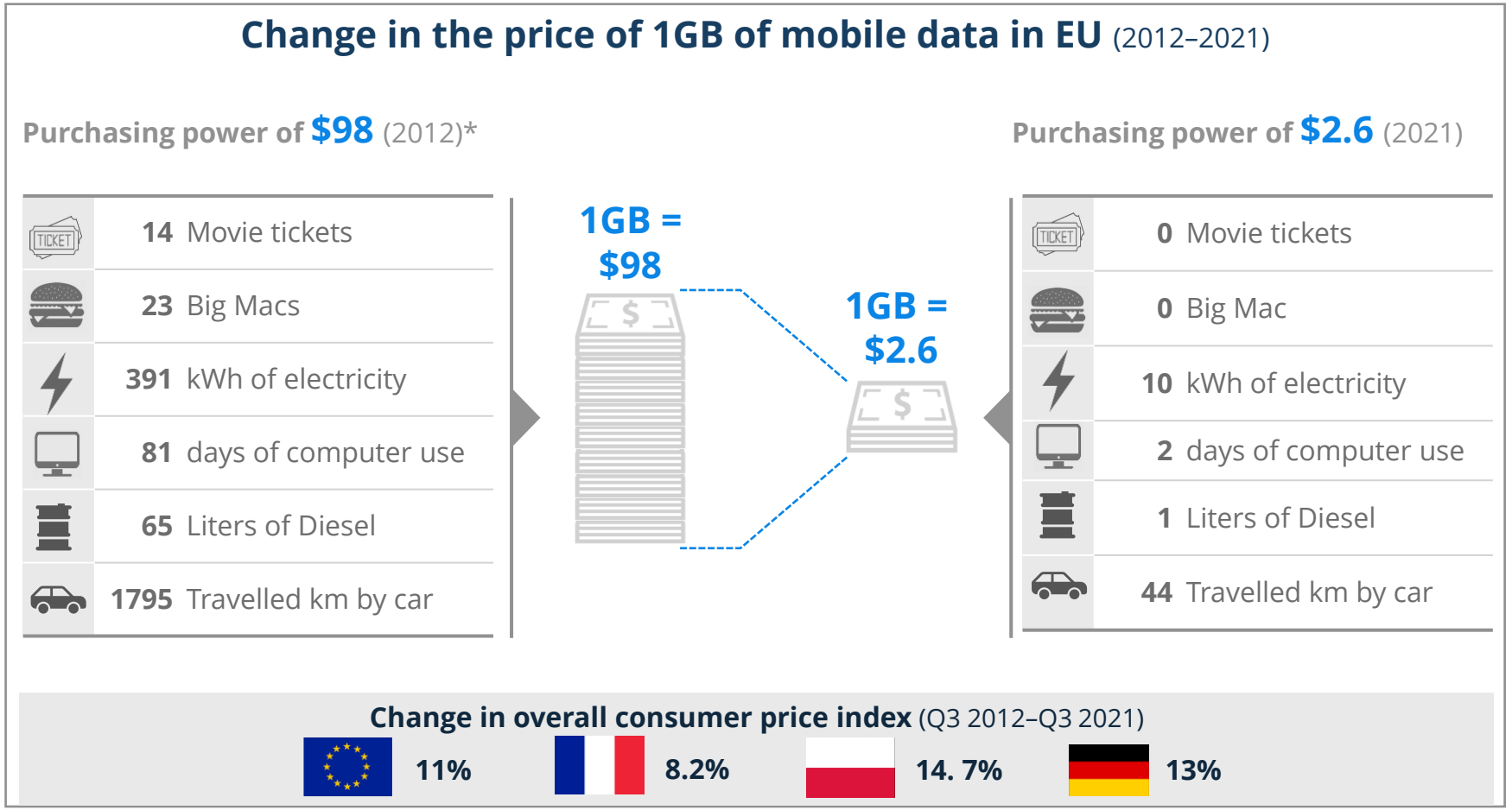
In contrast to overall commodity prices, mobile data became significantly more affordable between 2012 and 2021.

In the USA, the price for 1GB data has decreased by 97% in 9 years. In other words, in 2012, 1GB of mobile data cost consumers the same as using a computer for 228 days, whereas today it would only cost the same as 5 days.

Note(s): .* The quantities were rounded down after calculation. The value refers to the mobile-broadband basket, prepaid handset-based with a data volume allowance of 500 MB. Kilometers travelled is based on Toyota Corolla 1.4D4D 3,67 liters per 100 km. Computer use refers to desktop computer energy take-up.
Source(s): Cable UK, Choose energy, Economist, EIA, Expatistan, ITU, MPAA, Spritmonitor ,Statista analysis, Time, USA today, Whole sale solar

Greater affordability is not limited to the USA: Notable price decline also in Europe

Change in affordability of mobile data services - Europe (2/3)



In Europe, the price of 1 GB of mobile data in 2012 was equivalent to the cost of 65 liters of diesel, which amounted to around 1795 km of car travel.

In 2021, 1 GB of mobile data only cost equivalent to 1 liter of diesel, i.e., 44 km of travel by car. Comparing this decline to consumer price indices in Europe, mobile data has become significantly more affordable.

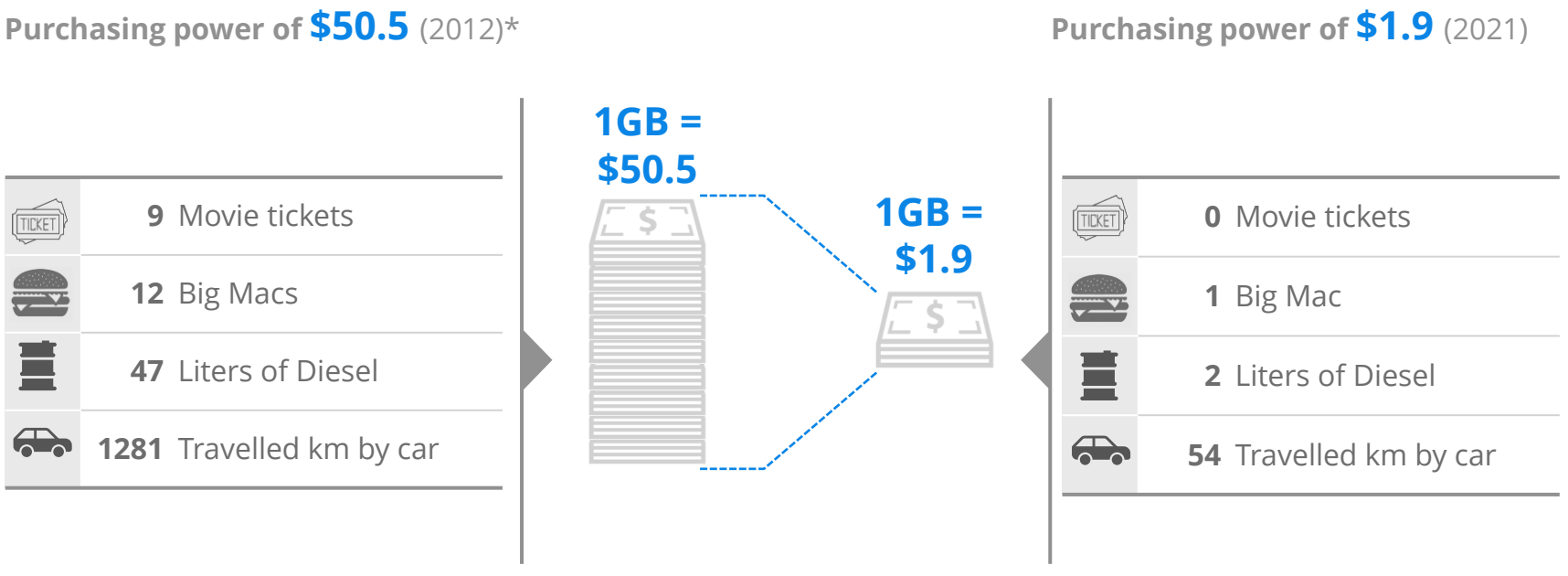
This development enables an increase in purchasing power, from which everyone benefits.

Note(s): *Mobile GB prices are based on data models with the usage of package prices. Europe is based on European Union (27 countries) /Kilometers travelled is based on Toyota Corolla 1.4D4D (one of the most popular cars in the world) 3,67 liters per 100 km. The quantities were rounded after calculation. Computer use refers to desktop computer energy take-up.
Source(s): Cable UK, Economist, EEA, Eurostat, ITU, Spritmonitor, Statista analysis, Global petrol prices, Time, UNIC, OECD

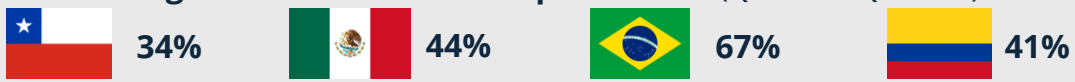
A significant, but slightly smaller, decline in prices can be observed in selected Latin American countries

Change in affordability of mobile data services – Selected countries in Latin America (3/3)

Change in the price of 1GB of mobile data in selected countries in Latin America* (2012–2021)



Change in overall consumer price index (Q3 2012–Q3 2021)



In 2012, it was possible to buy 9 movie tickets for the price of a gigabyte in the selected Latin American countries. In 2021, it was not even enough for one whole movie ticket.

Although the consumer price index has increased by around 50% among the selected countries, mobile data has become significantly more affordable.

This development enables an increase in purchasing power, from which everyone benefits.

Note(s): *Selected countries are Brazil, Mexico, Colombia, Chile. **Mobile GB prices are based on data models with the usage of package prices. Kilometers travelled is based on Toyota Corolla 1.4D4D (one of the most popular cars in the world) 3,67 liters per 100 km. The quantities were rounded after calculation.
Source(s): Cable UK, Economist, TheGlobalEconomy, ITU, Spritmonitor, canacine, NetCredit, Statista analysis, Global petrol prices, OECD

03 5G and future

- 5G vs. other wireless technologies
- Coverage, penetration & commercialization
- 5G operator's geographical expansion
- 5G commercial ecosystem
- 5G vendor options
- 3GPP as a mean to interoperability

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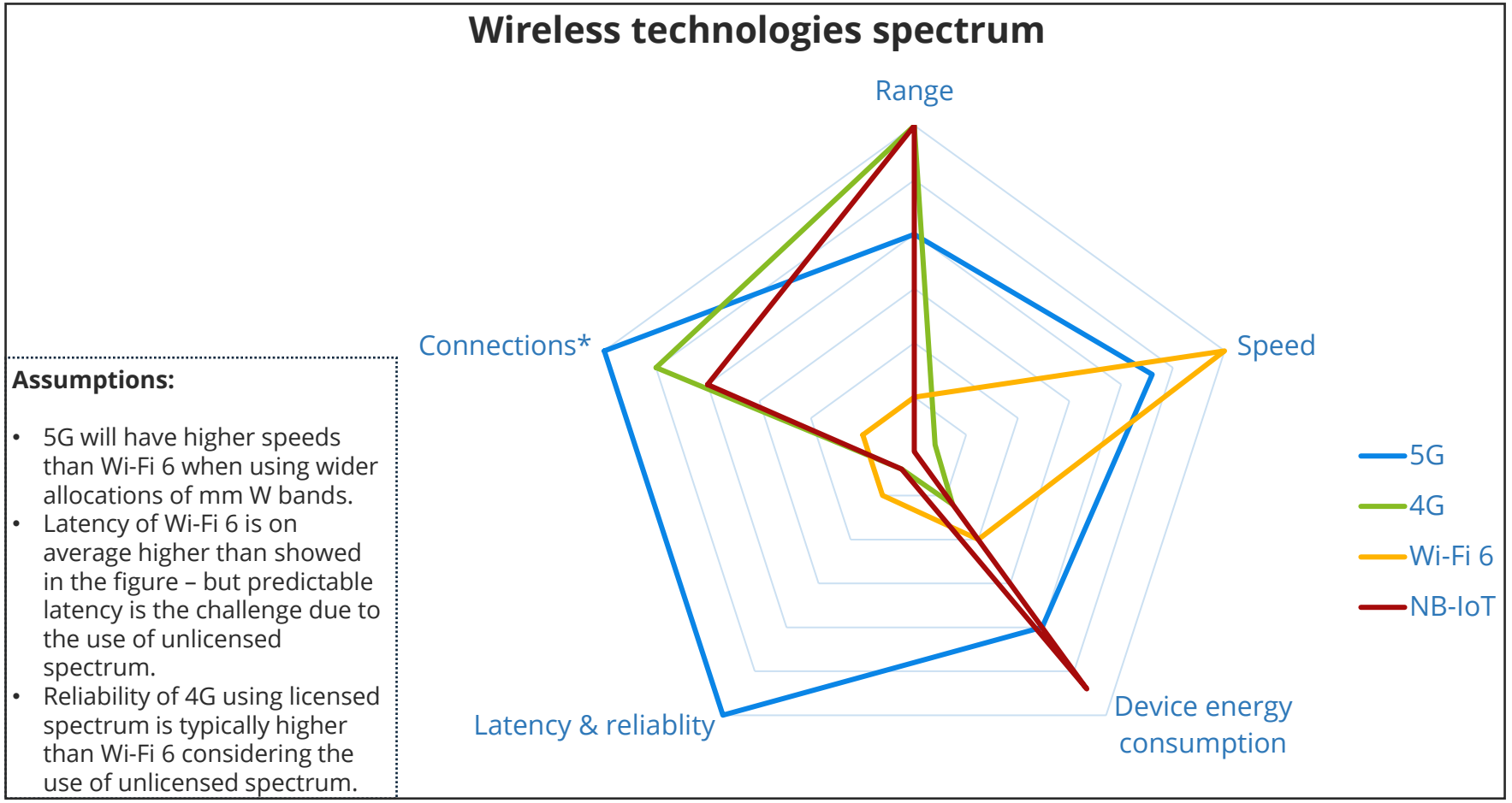
5G is more attractive due to improvements in speed, latency, reliability, and energy efficiency while supporting more devices

5G vs. other wireless technologies



Assumptions:

- 5G will have higher speeds than Wi-Fi 6 when using wider allocations of mm W bands.
- Latency of Wi-Fi 6 is on average higher than showed in the figure – but predictable latency is the challenge due to the use of unlicensed spectrum.
- Reliability of 4G using licensed spectrum is typically higher than Wi-Fi 6 considering the use of unlicensed spectrum.

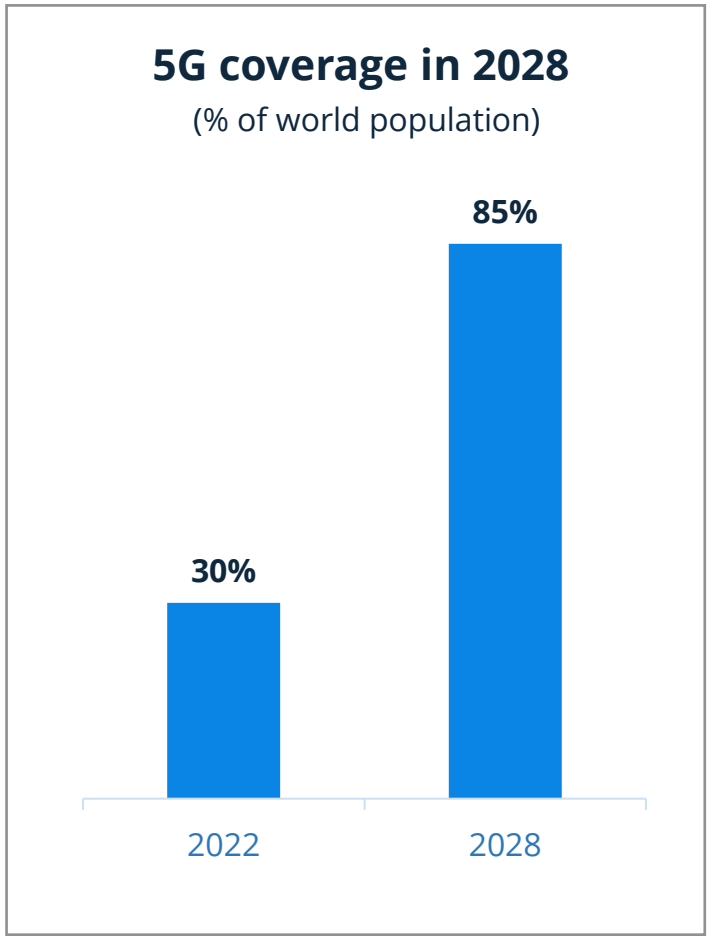
5G does not yet provide optimal results for all these dimensions because of current technological and infrastructure limitations, but it will eventually become the technology of choice for critical communications that require extreme reliability and service quality, including those within industrial settings.

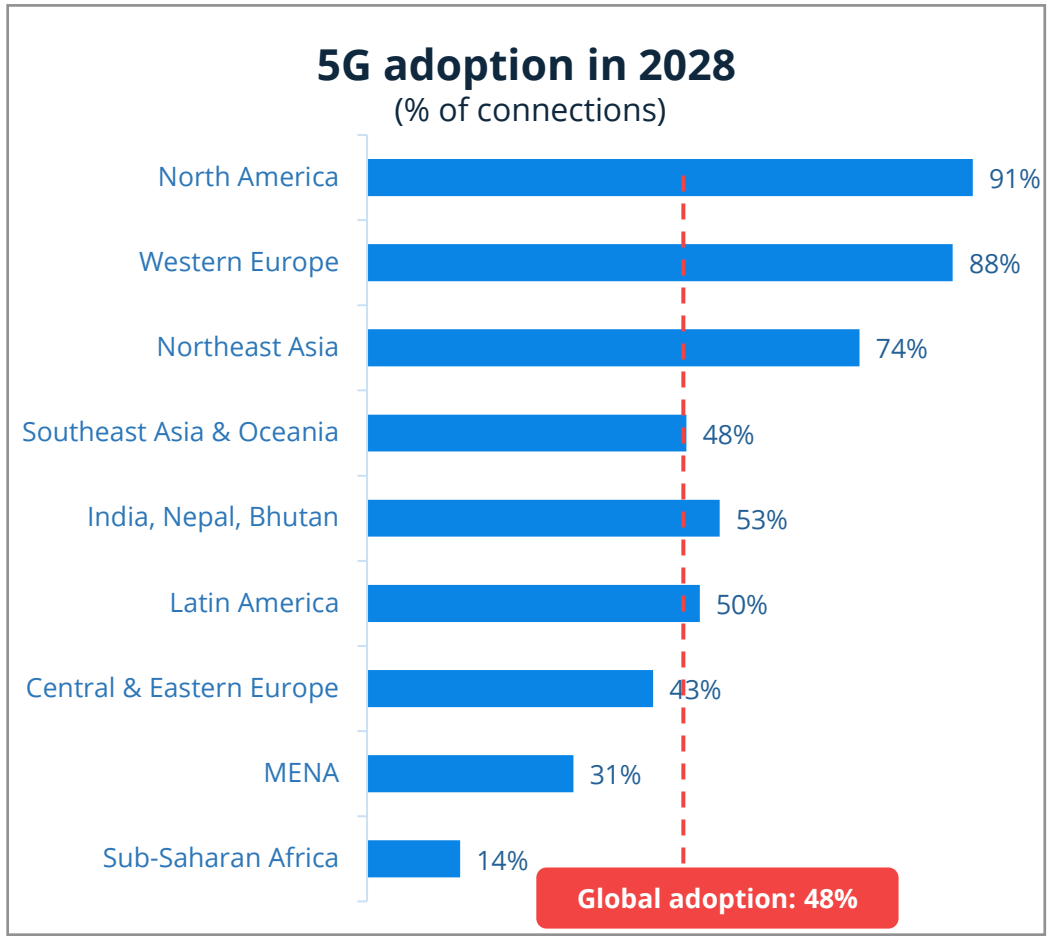
However, not all performance dimensions can be maximized at the same time. There are trade-offs between speed, range, energy efficiency, and latency.

Notes: * Describes number of supported devices per square meters.
Source(s): McKinsey

The 5G standard enables a quick roll out: Western Europe and North America are the forerunners

5G coverage & connections





By the end of 2022, 5G subscriptions are expected to reach 1 billion.

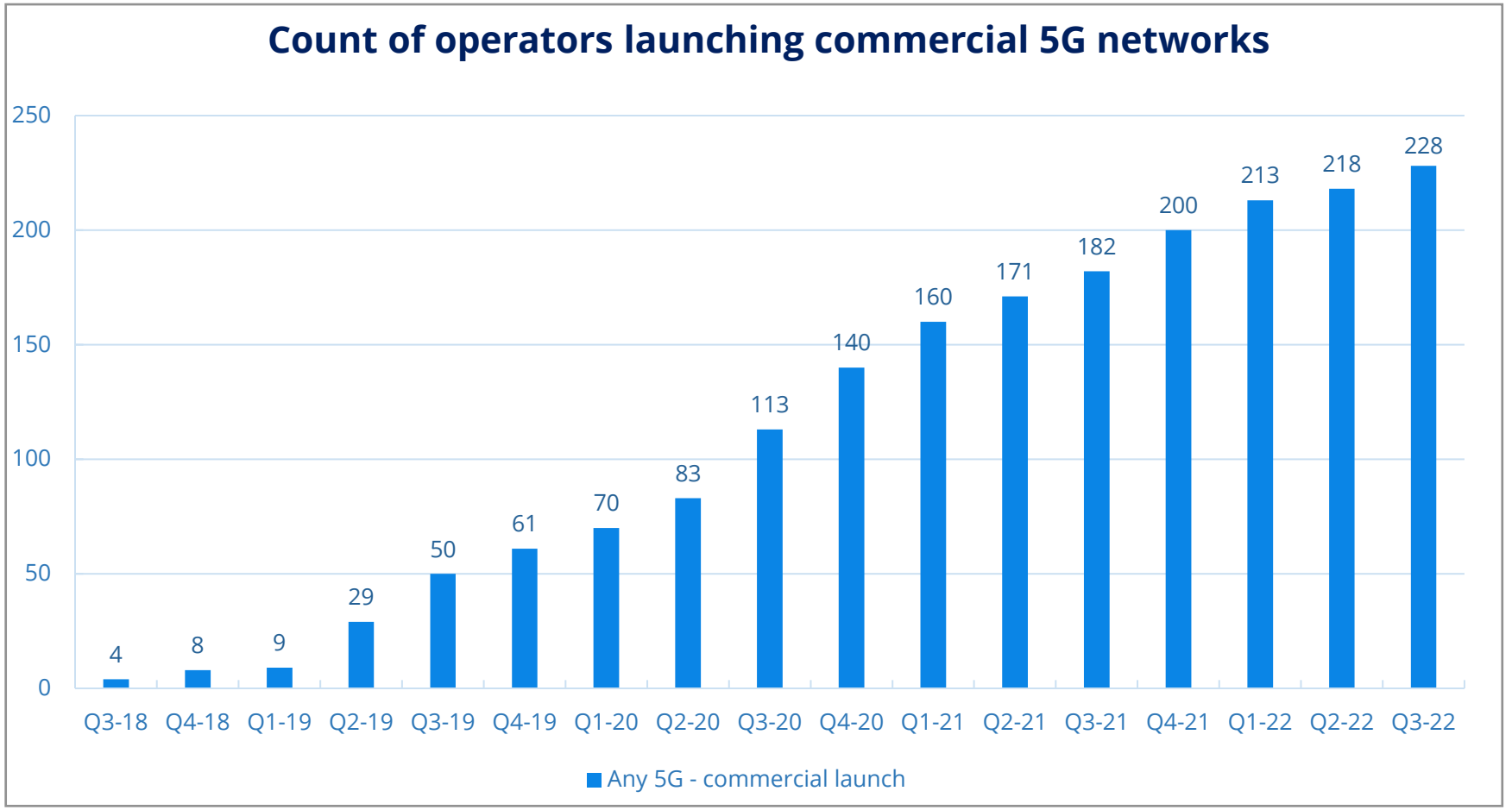
Looking into the future, North America is the leader in adopting and establishing 5G mobile networks with more than 91% (400 million) of connections using 5G standards, closely followed by Western Europe (88%) and Northeast Asia (74%).

The global average for adoption of 5G mobile networks will be around 55%, that is 4.4 billion individuals, by 2028.

Source(s): Ericsson mobility report November 2022, Ericsson Mobility visualizer September.2022

3GPP - 5G commercial launches gain momentum

Operators with 5G services

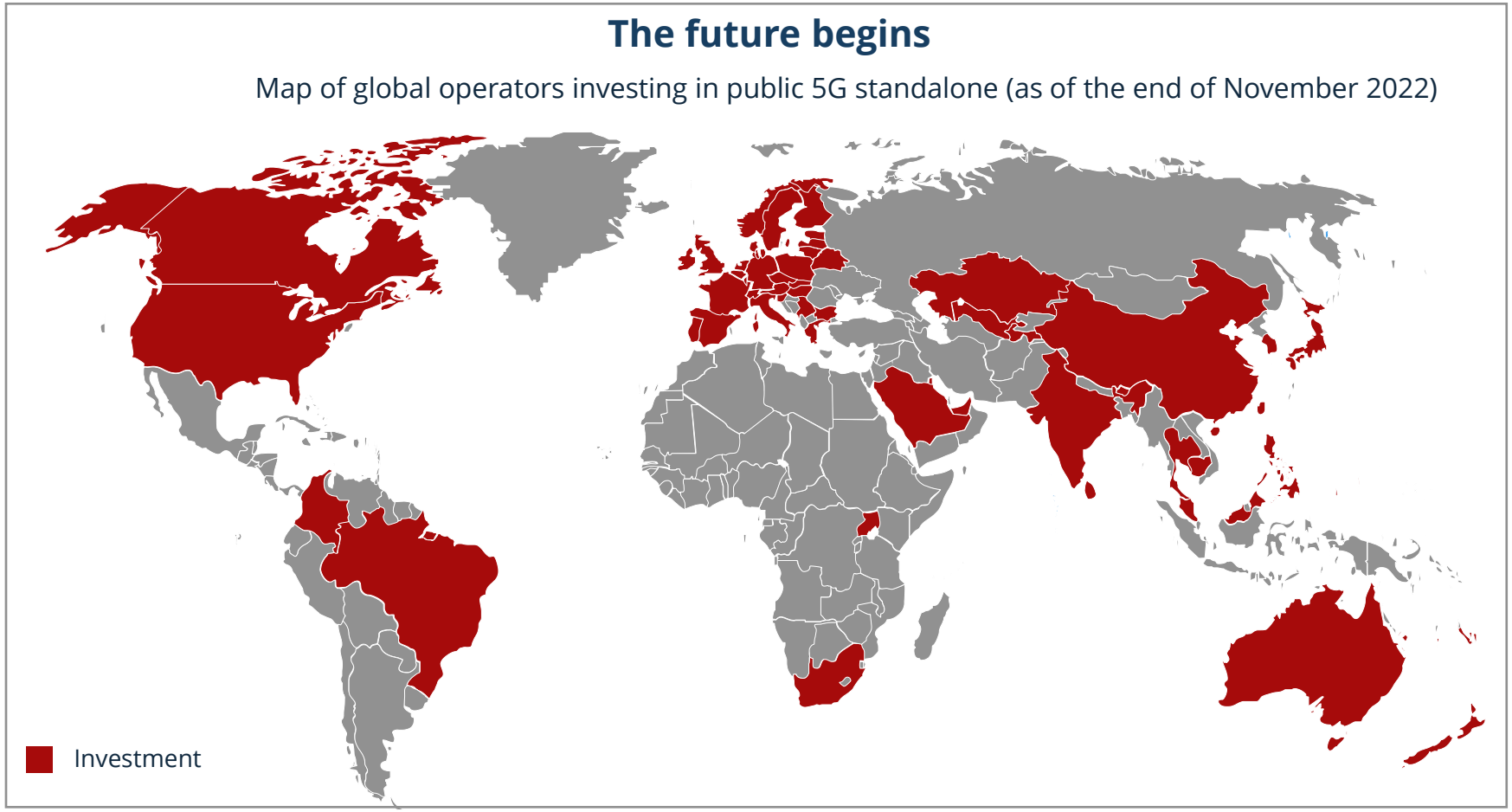


- By the end of September 2022, 505 operators in 155 countries and territories had invested in 5G mobile or 5G fixed wireless access or home broadband networks.
- These investments have been in the form of tests, trials, pilots, planned and actual deployments.
- Of these, **228** operators in 92 countries and territories had launched one or more 3GPP-compliant 5G services commercially.

Source(s): GSA 2022, GSA 5G reports archive

3GPP-5G standalone network expansion: 52 countries have already started the journey

5G standalone expansion map around the globe



Whereas non-standalone 5G uses a new 5G radio access network overlaid on the existing 4G LTE network core, standalone 5G uses the 5G radio access network on a new 5G core network.

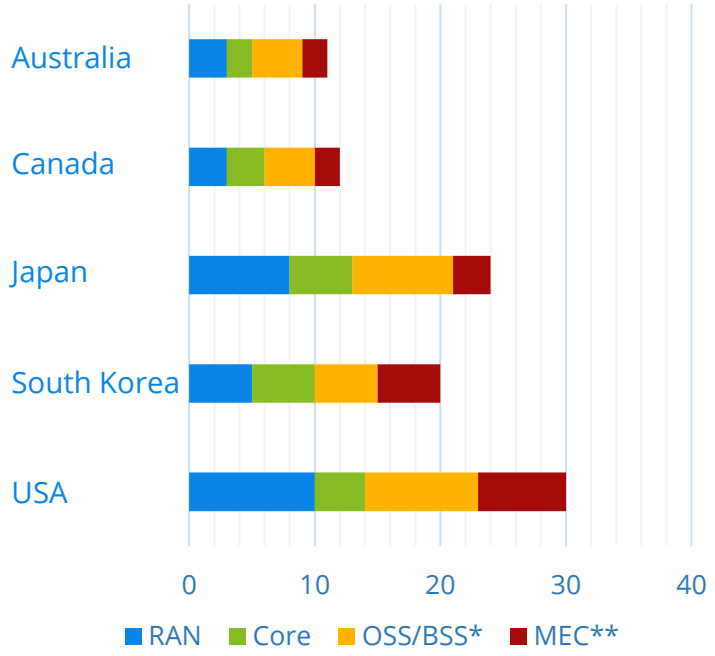
This allows for specific new features and use cases for 5G, including support for massive numbers of devices. GSA has identified **111** operators in **52** countries that have been investing in 5G standalone while 36 operators in 21 countries have already launched public 5G standalone networks.

Source(s): GSA 5G standalone summary, 2022

3GPP defines a common standard, providing operators with numerous choices of 5G vendors

5G mobile network vendor ecosystem

Active vendor partnerships in commercial 5G networks*
(by domain in selected countries)



Examples of current 5G network solution suppliers

RAN	Transport	Core	OSS/BSS**	Edge
Airspan	Adtran	Casa	Amdocs	Amazon
Altiostar	Airspan/ Mimosa	Cisco	Cerillion	Dell
Casa Systems	Aviat Networks	Ericsson	Cisco	Google
Commscope	Ceragon	HPE	Comarch	Huawei
Corning	Ciena	Huawei	CSG	Intel
Ericsson	Cisco	Mavenir	Ericsson	Microsoft
Fujitsu	Commscope	Microsoft (Metaswitch; Affirmed)	HPE	QTC
Huawei	DragonWave-X	NEC	Huawei	Radisys
Nokia	Ericsson	Nokia	NEC/ Netcracker	Red Hat (IBM)
Mavenir	Huawei	Oracle	Nokia	
NEC	Juniper	Samsung	Openet	
Parallel Wireless	Nokia	ZTE	Optiva	
Samsung	Siklu		Sigma Systems	
ZTE	ZTE		ZTE	

The transition from one mobile generation to the next has, historically, been a time when mobile operators evaluate their current suppliers and explore new ones. With 5G, unlike previous generations, there is unified agreement on what 5G technology should be. 5G ecosystem provides operators with many vendor choices.

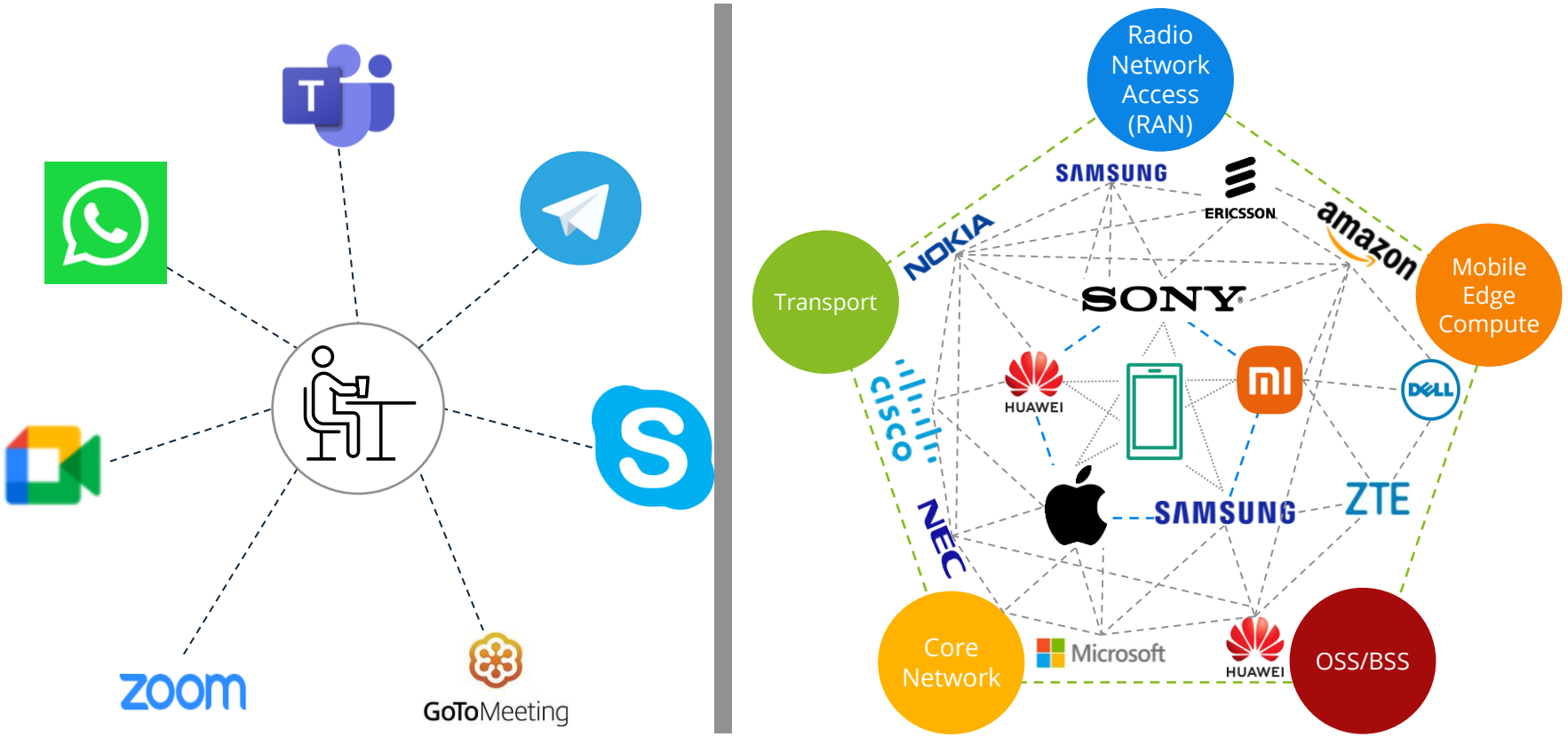
In seven countries where network rollouts are in advanced stages (Australia, Canada, China, Japan, South Korea, the UK, and the US), numerous active vendor partnerships can be seen to enhance competition and provide a good variety of choice for the operators.

Notes: * Omdia tracks the vendors active across different network domains that are currently supporting live commercial 5G networks. Vendor data was gathered using Omdia's sources, including the Telecoms Vendor Contract Database, which captures publicly available service provider contract information. Several vendors provide products and solutions across several mobile network domains. Vendors that operate in multiple domains are counted for each domain where we have identified an active partnership. *OSS/BSS stands for network management. **MEC stands for mobile edge compute.
Source(s): Omdia 2022, Omdia 2021

3GPP defines a common standard, providing a seamless connection between the users and providers

3GPP as a mean to interoperability

Video-call apps ecosystem VS **Mobile Network ecosystem***



Unlike countless other technologies which surround us, mobile networks are interoperable. Using different video call apps, one can see that they are in most cases incompatible - it is impossible to send or receive calls from, for instance, Skype to Zoom directly.

Considering mobile calls, we take it for granted that all kinds of cell phones are seamlessly compatible, regardless of their type. In addition, 3GPP standard has made it possible for numerous providers and suppliers, throughout the supply chain, to be able to sync.

Notes: *mobile networks consist of five domains which must interconnect for a data/call transfer to happen throughout the network.
Source(s): comvia, RCRwireless, omdia

04 **5G: Powering Global Trade**

- Communication drives trade
- 5G and merchandise trade
- 5G and service trade

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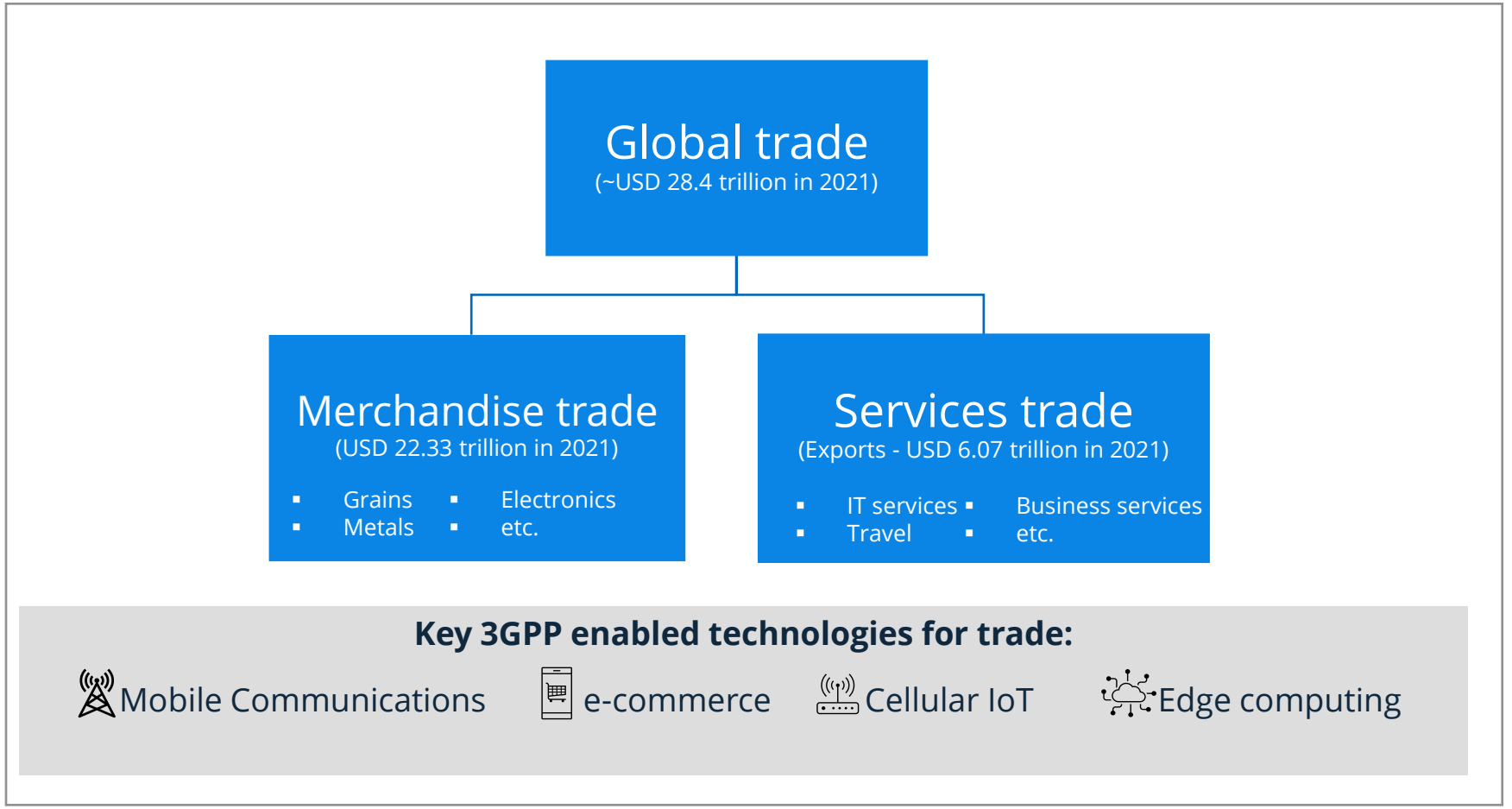
The backbone of the global trade ecosystem are 3GPP technologies

Importance of communications technology for trade



Communication technology plays a vital role in enabling trade in goods and services. It connects buyers and sellers and enables the logistics and transportation industries to function smoothly e.g.:

- 5G can enhance the productivity and efficiency of actors: ports, freight forwarders and cargo shippers, and e-commerce platforms.
- Better communications technologies enable trade in new kinds of services. For example, trade in AR/VR content can help increase value of trade in audio visual services.

Source(s): Statista, UNCTAD

Productivity & efficiency in merchandise trade ecosystem will be enhanced by 5G

Key technologies impacting the merchandise trade value chain

31% of online sales in Belgium in 2022 were cross border sales, the highest across 36 countries.	**Connecting buyers and sellers:** e-commerce platforms can enhance their value proposition for customers using augmented/virtual reality applications and using AI for suggesting future purchases.
USD 227 billion 5G applications' expected contribution to the global manufacturing industry by 2030.	**Manufacturing:** 5G enabled massive IoT applications, machine vision monitoring and data analytics are some of the most transformative applications in the manufacturing sector.
12% estimated increase in gross profit over 5 years for warehouse operators from cellular IoT solutions.	**Warehousing:** 5G enabled time critical communication paired with industrial robotics can help automate warehouse operations. Other applications include XR empowered analytics interfaces, and the use of drones for last mile delivery.
8.2% reduction in CO2 emissions per port terminal operation due to 5G applications.	**Shipping/Aviation:** 5G enables ports to deploy IoT and cellular solutions necessary for optimizing capacity utilization, enabling industrial automation, reducing operational costs, and lowering CO2 emissions.

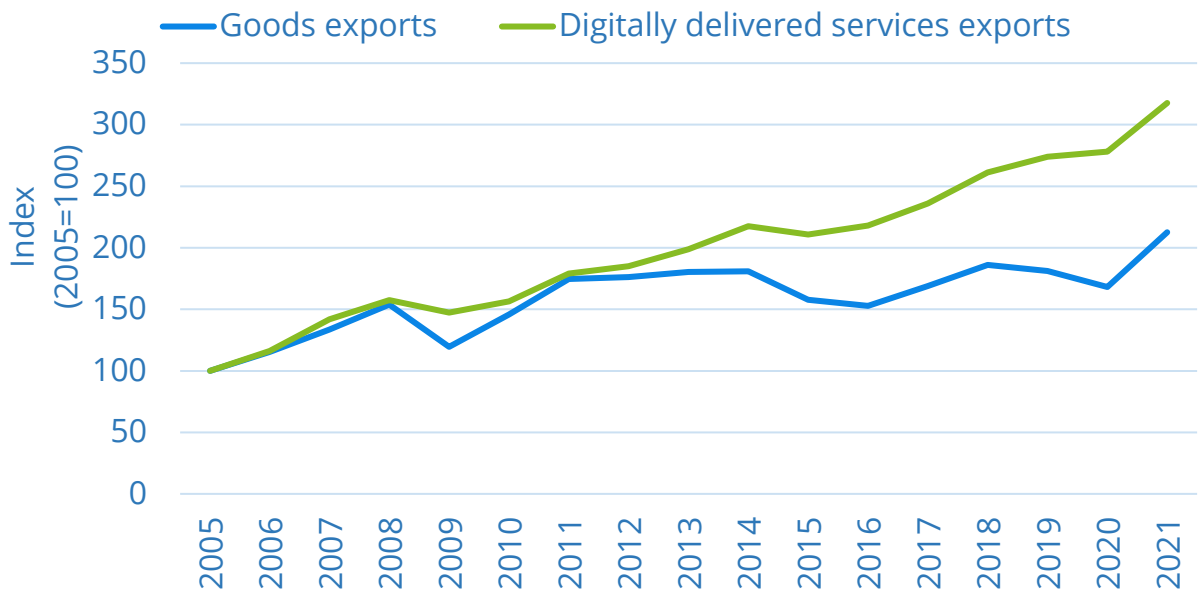
Source(s): Statista, WTO, GSMA, Ericsson, ABI research

5G enables trade in new types of services, and add to the value of existing traded services

Key technologies impacting trade in services

Growth in global digitally delivered services exports

(Index 2005 = 100)



5G networks can enable high volume, low latency **media applications like AR/VR and 4K/8K content.** This will enhance the variety of content that is available to be exported to foreign audiences, **increasing trade in audio visual services and trade in intellectual property**.

5G networks will enable the development of more **sophisticated IT services and allow for greater trade in cloud enabled IT services, 5G edge computing**, and trade in cross border communication services, including data storage and transmission from data centers.

Lower latency and higher reliability in communications infrastructure can **enhance productivity and quality in other traded services**, like business services and travel by reducing information asymmetry between buyers and sellers.

Source(s): Statista, WTO

Sources

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