3GPP-A MOBILE CONNECTED WORLD

September 2023

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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 August 2023, 265 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. Progress of 5G adoption
6. Interoperability of mobile networks

As well as a special topic covering Network Slicing and how it could solve some challenges that 5G faces.

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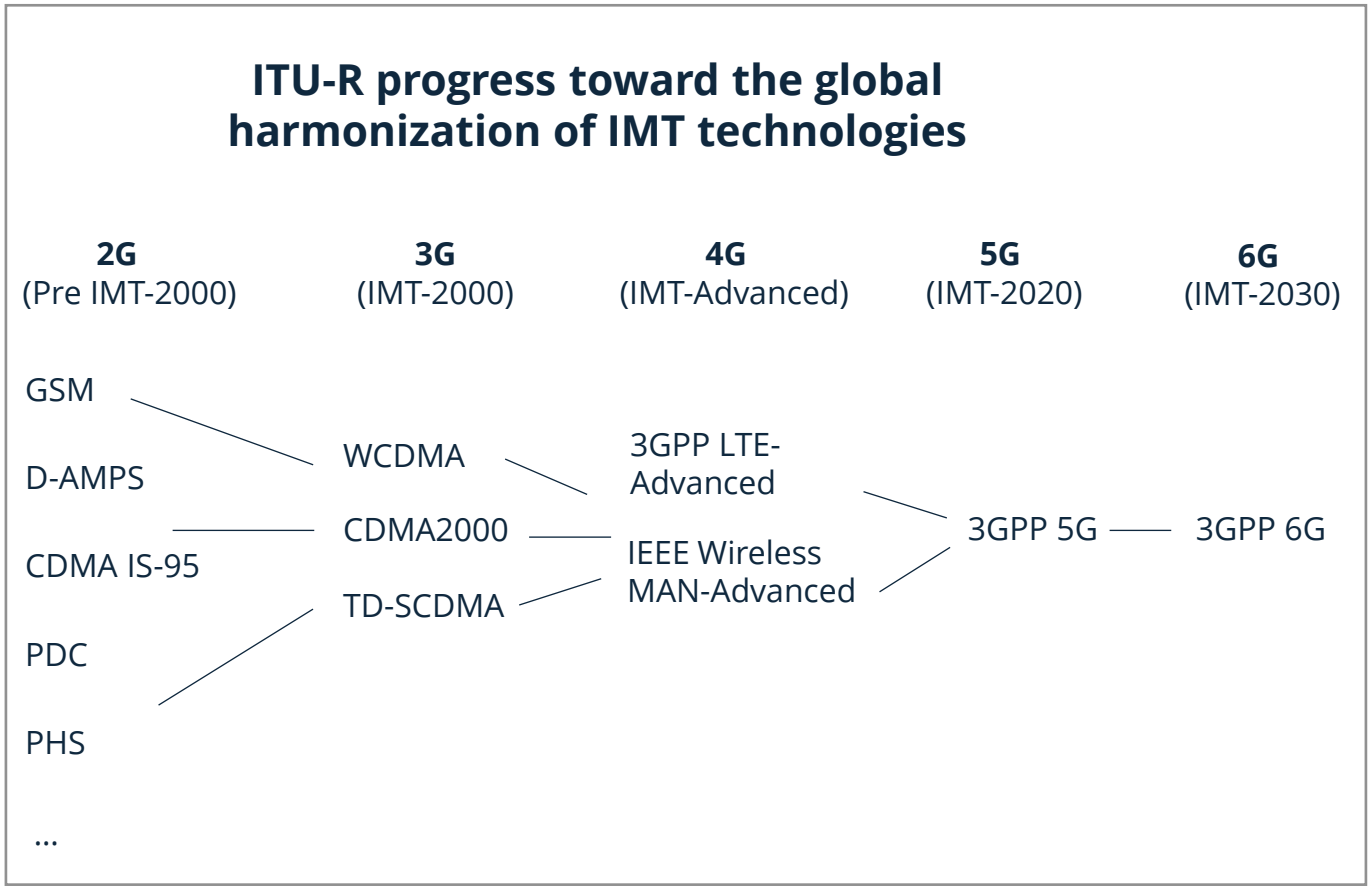
How 3GPP “G” standards lay the foundation for a successful global mobile internet ecosystem

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.

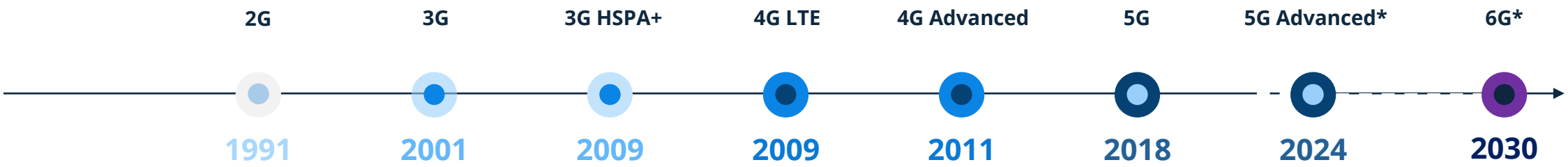
In order to achieve this goal, ITU-R established the concept of IMT, which includes a harmonized timeframe for future development, taking into account technical, operational, and spectrum-related aspects.

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

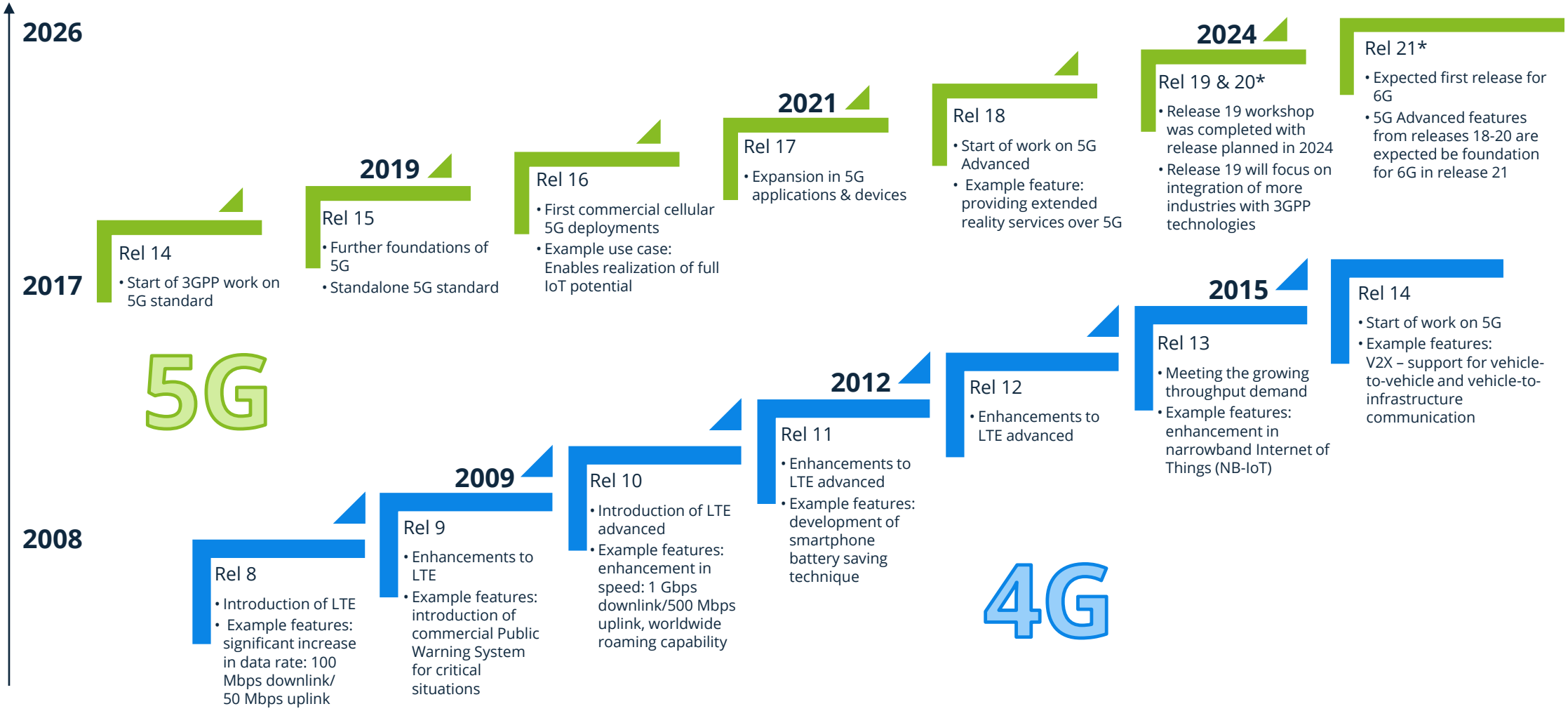


	2G	3G	3G HSPA+	4G LTE	4G Advanced	5G	5G Advanced*	6G*
	1991	2001	2009	2009	2011	2018	2024	2030
Mp3 file download time (5 MB)	13 mins.	1 min.	9.6 sec.	4 sec.	0.5 sec.	12 ms	2.4 ms	Lab tests have shown air latency under 100 microseconds is feasible with 6G innovations.
Typical Latency	<1000 ms	<400 ms	<200 ms	<100 ms	<50 ms	<5 ms	**<1 ms	
Typical download speed	0.05 Mbit/s	0.7 Mbit/s	4 Mbit/s	10 Mbit/s	90 Mbit/s	200 Mbit/s	**1 Gbit/s	Current theoretical limits for 6G as lab tested by Osaka university is 11 gigabits per second.
Typical upload speed	0.03 Mbit/s	0.3 Mbit/s	1 Mbit/s	5 Mbit/s	15 Mbit/s	40 Mbit/s	**500 Mbit/s	

Notes: * No official 3GPP timeline yet. **Expected requirements to be classified in category, not exact
Source(s): Rantcell, Techtarget, 3gpp, cablefree, commsbrief, Ofinno

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
Source(s): ETSI, CableFree, Qualcomm, Ofinno, 3GPP.org

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

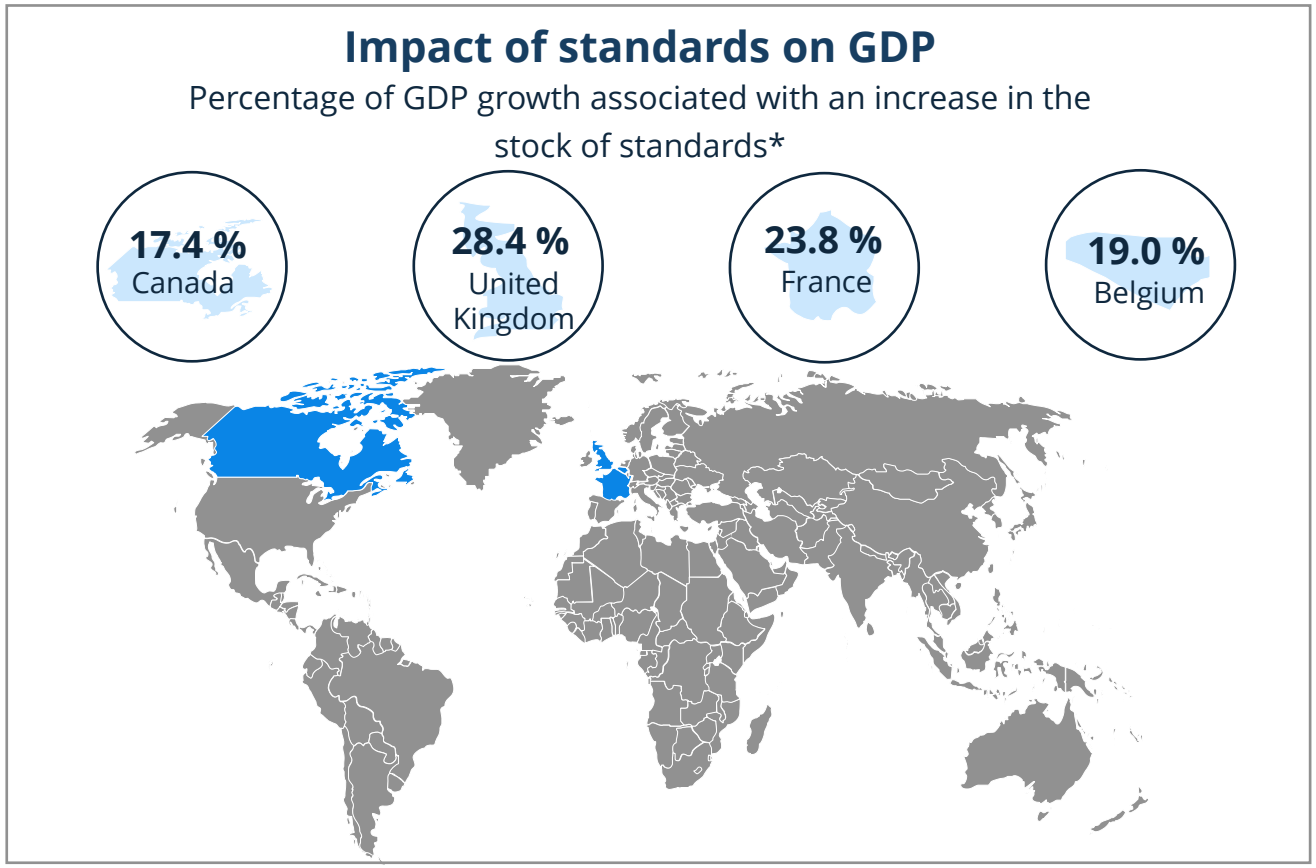
3GPP is a collaboration among well-established regional standard organizations (organizational partners). The seven organizational partners (OPs) determine the general policy and strategy of 3GPP.

The twenty-six 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.

Source(s): 3gpp - partners

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 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 are the basis for economic and societal activities across the world

Benefits of standardization and the main actors

DOMAIN	BENEFITS	ACTORS
Public goods	▪ Safeguard and promote values ▪ Common good protection (e.g., environment)	 Governments
Markets	▪ *Consumers:* product comparison, protection ▪ *Producers:* economies of scale, reduce costs, certainty, quality	 Industries Consumers
Infrastructure	▪ Interoperability ▪ Interconnection ▪ Interworking ▪ Knowledge	 Public administrations Industries

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

02 End user benefits

- Penetration
- Time to market
- Affordability

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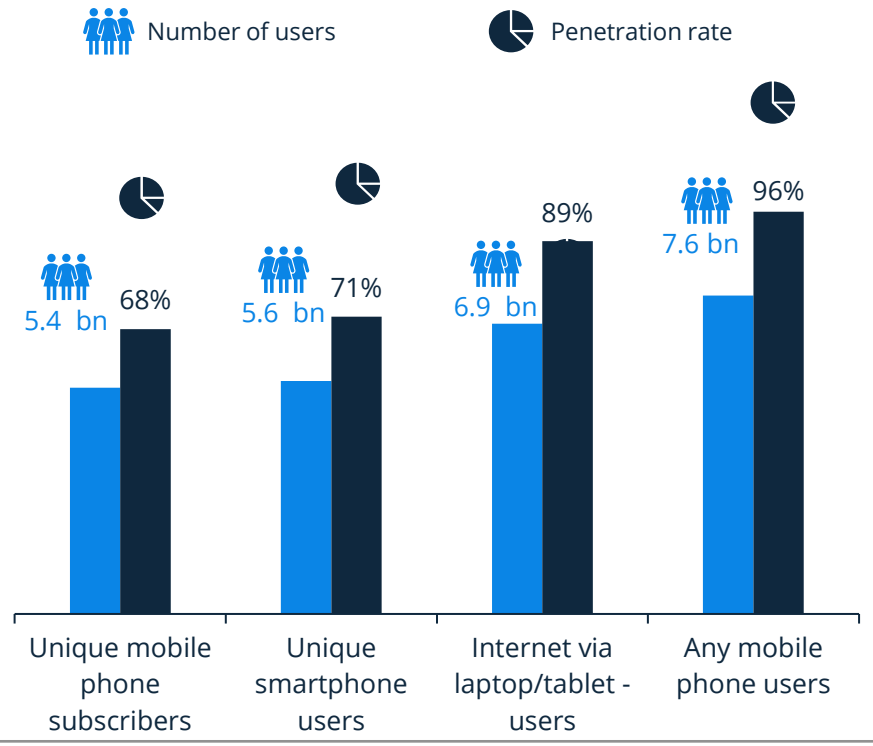
The spread of 3GPP communication technologies has resulted in unprecedented global penetration today …

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

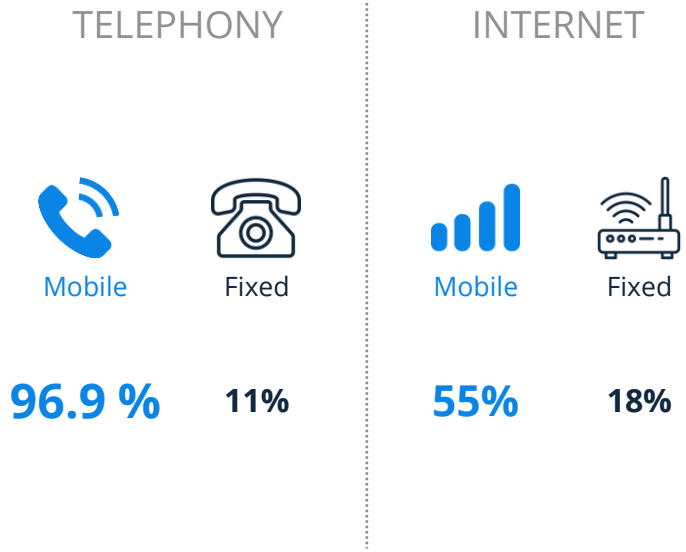
Mobile society

Penetration rate and number of users (2022)



Fixed vs. mobile connection

Penetration rate in % (July 2023)



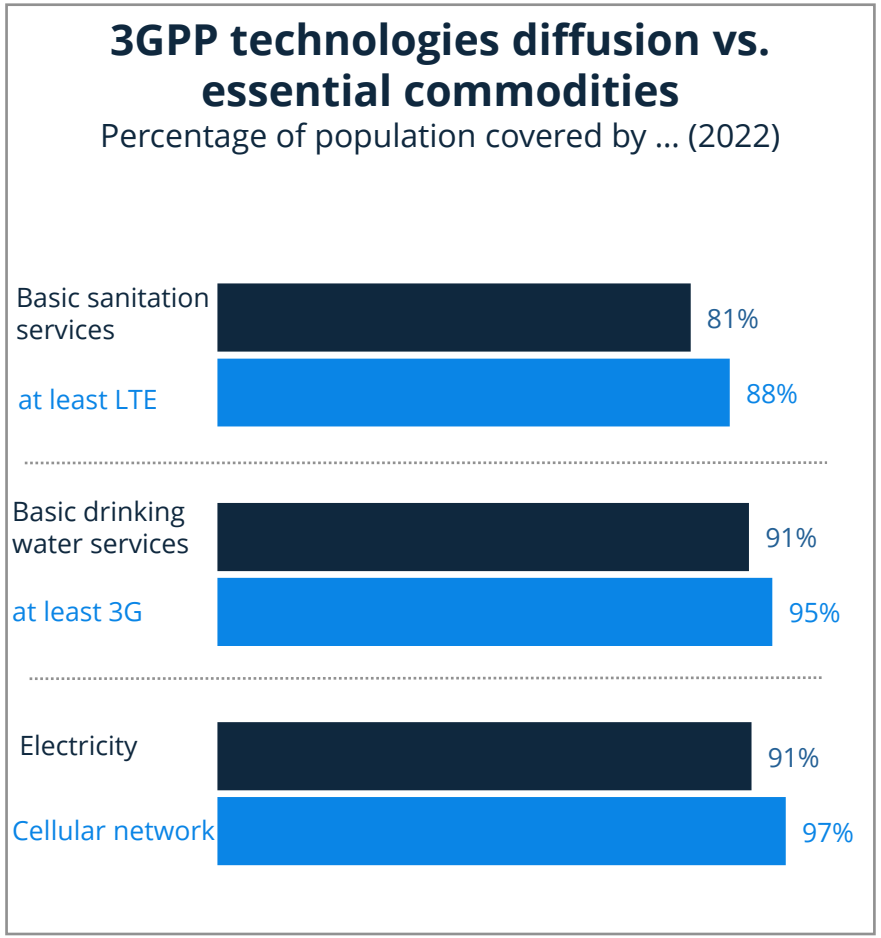
3GPP cellular technologies are an integral part of our society. Unique mobile subscribers reached 68% of population in 2022.

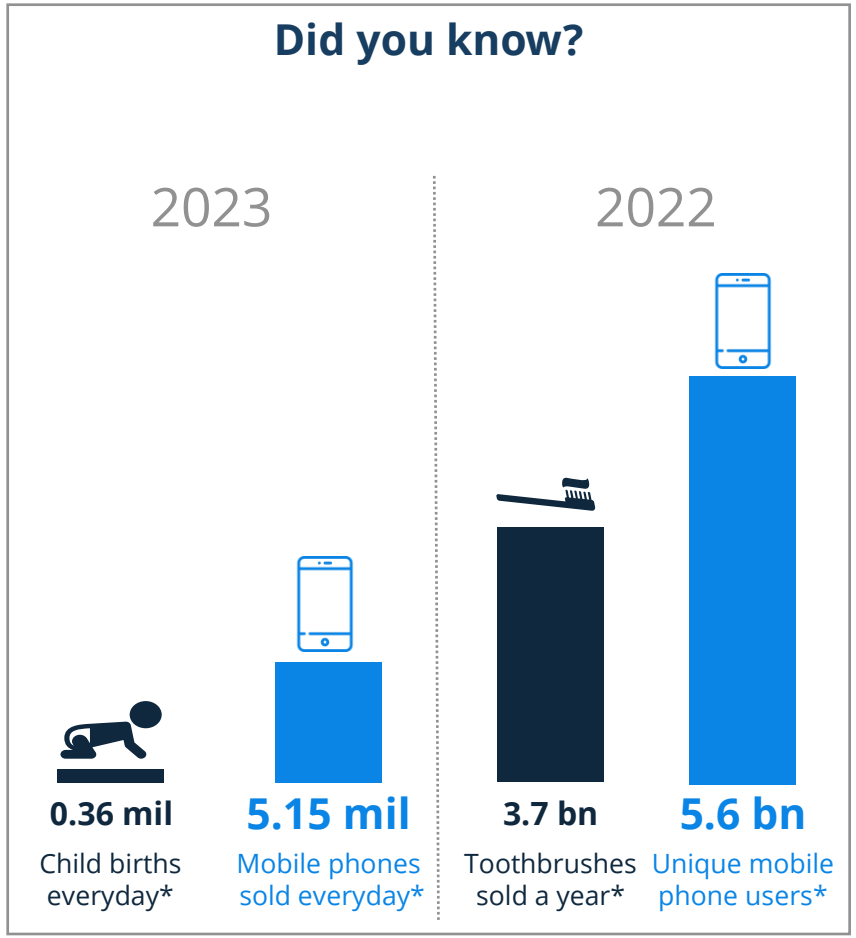
3GPP mobile networks enable access to mobile communication technology in regions where other communication technologies, such as fixed telephony and fixed broadband, failed to establish themselves (e.g., in Asia and Africa).

Note(s): World population is assumed to be 7.95 billion by end of 2022 and 8.05 billion by end of July 2023.
Source(s): GSMA, ITU, Datareportal, Worldbank

… 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.

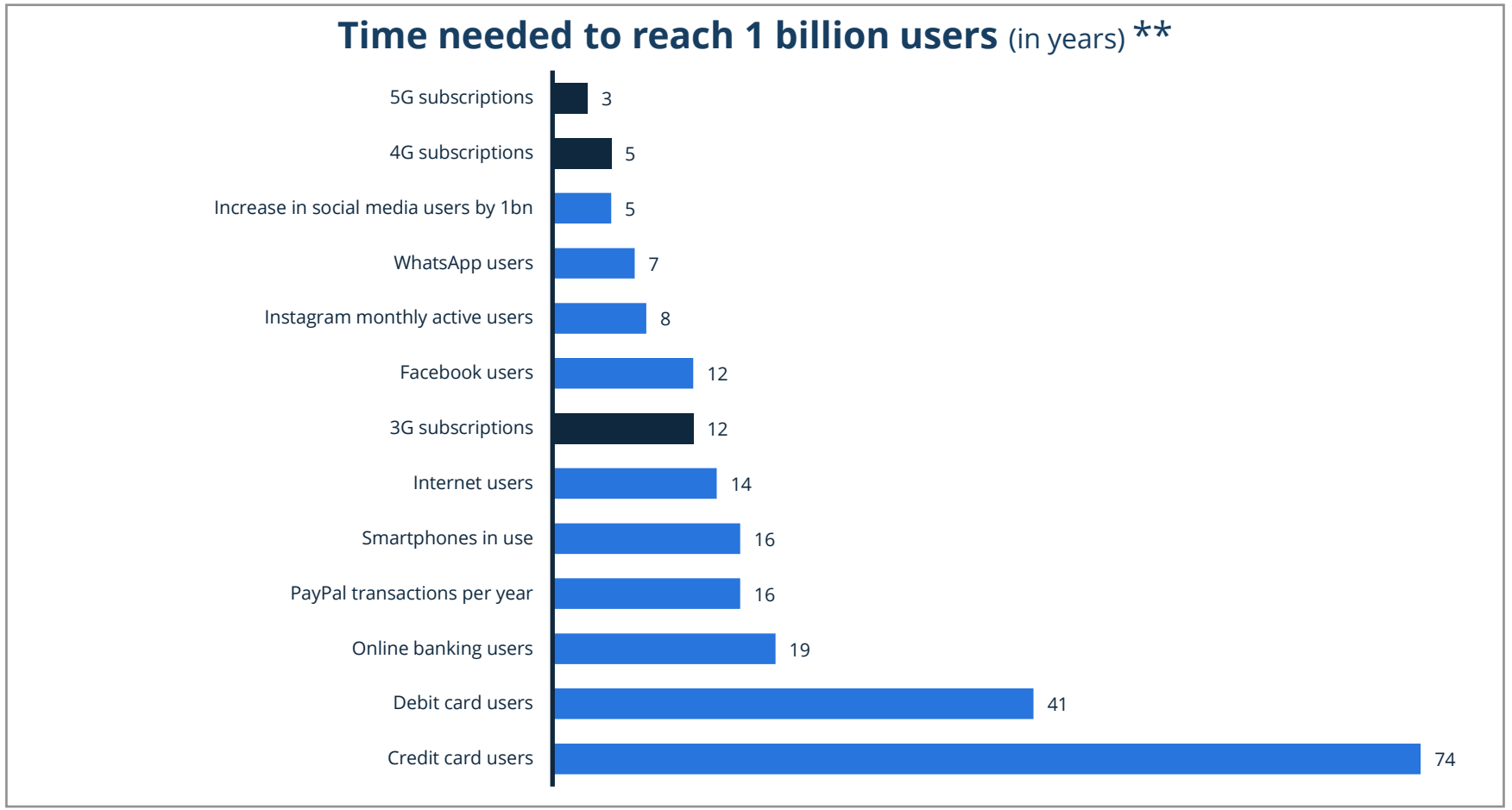
Fun facts:

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): Worldbank, ITU,

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.

Number of 5G subscriptions reached 1.1 billion in the first quarter of 2023. Estimations suggest that this figure could reach 4.6 billion by the end of 2028.

Note(s): *3GPP includes 3G,4G & 5G ** The years have been counted from the entrance of the mentioned technology to the market onwards.
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 (1/4)

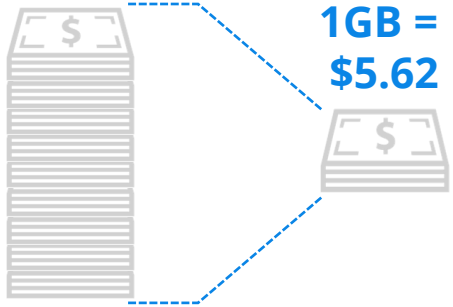
Change in the price of 1GB of mobile data in USA (2012–2021)

Purchasing power of $108 (2012)*

Share of disposable income 0.32 % (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 = $5.62

Purchasing power of $5.62 (2022)

Share of disposable income 0.012 % (2022)

0	movie tickets
0	Big Macs
12	kWh of electricity
30	days of computer use
4	liters of diesel
104	travelled km by car

Change in overall consumer price index (2012 - 2022)

OECD **29%** **27%**

Data volume is important – and gets increasingly more affordable.

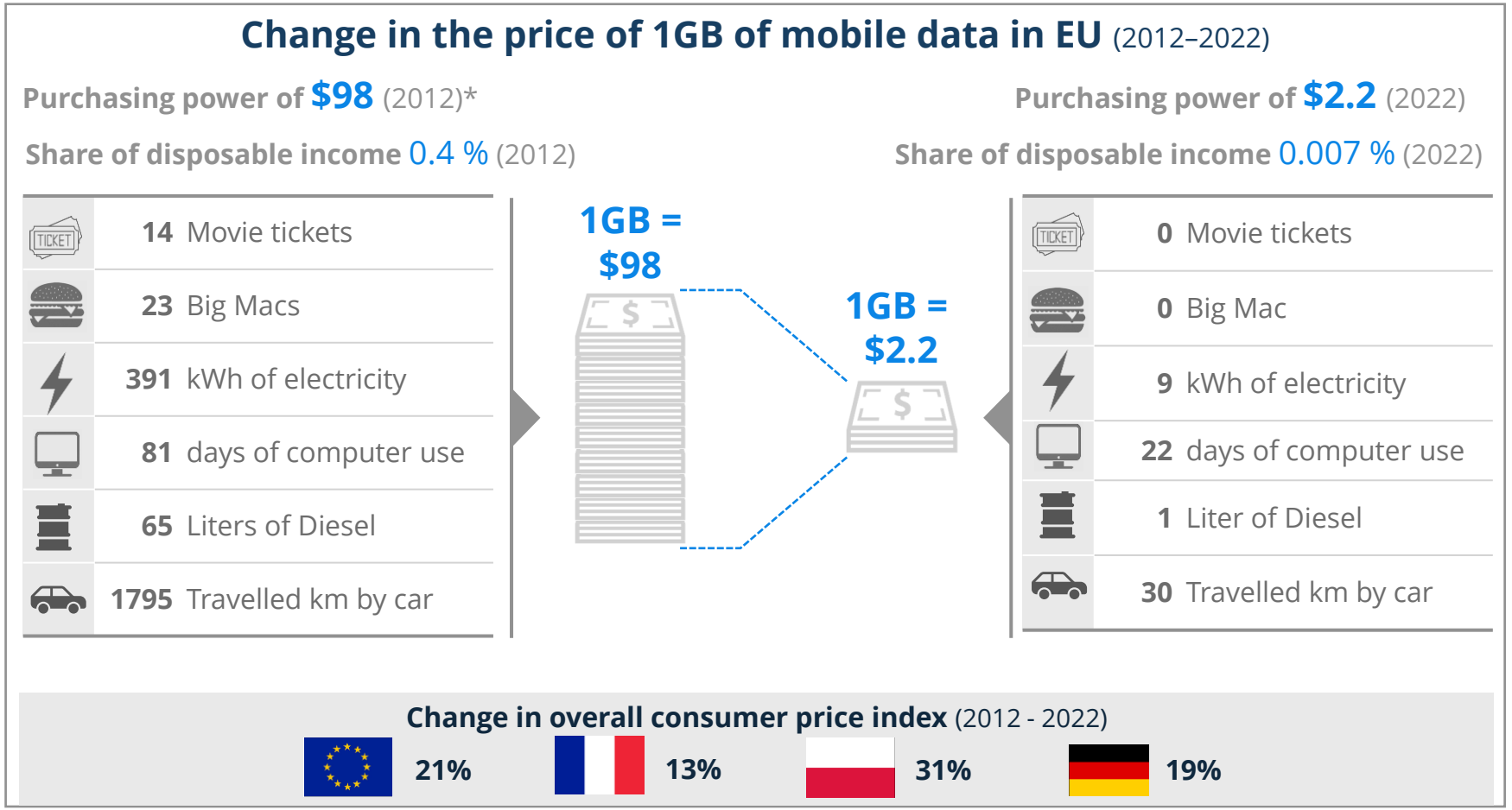
In contrast to overall commodity prices, mobile data became significantly more affordable between 2012 and 2022.

In the USA, the price for 1GB data has decreased by 95% 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. Kilometers travelled is based on Toyota Corolla 1.4D4D 4.1 liters per 100 km. Computer use refers to desktop computer energy take-up.
Source(s): Cable UK, Energysage., Economist, EIA, Expatistan, MPAA, Statista analysis, OECD CPI, OECD - Disposable income

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

Change in affordability of mobile data services - Europe (2/4)



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.

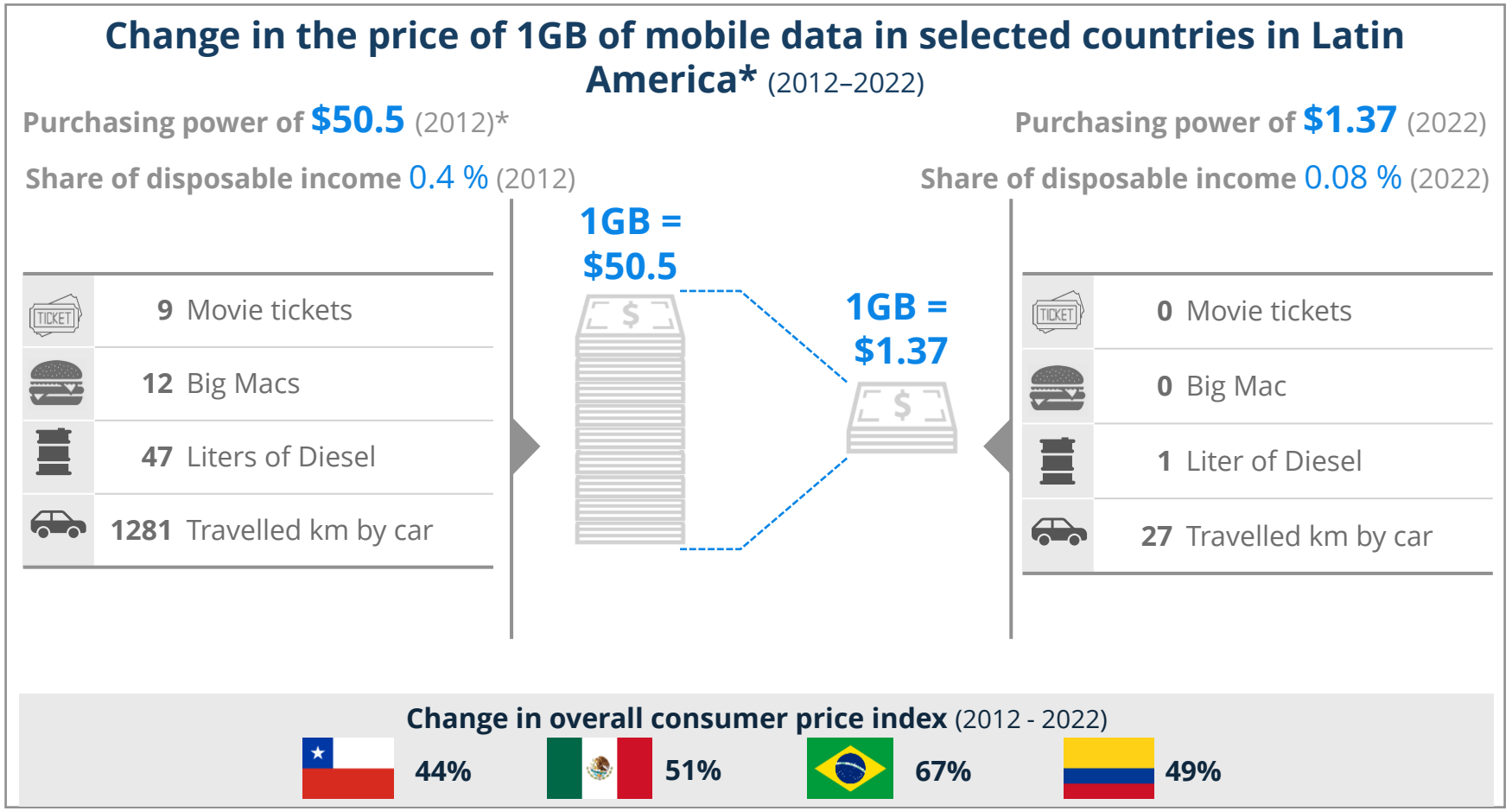
In 2022, 1 GB of mobile data only cost equivalent to 1 liter of diesel, i.e., 30 km of travel by car. Comparing this decline to consumer price indices in Europe, mobile data has become significantly more affordable.

Despite all round inflation, mobile data continues to become more affordable.

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) 4.1 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 CPI, OECD - Disposable income

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 (3/4)



In 2012, it was possible to buy 9 movie tickets for the price of a gigabyte in the selected Latin American countries. In 2022, 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.

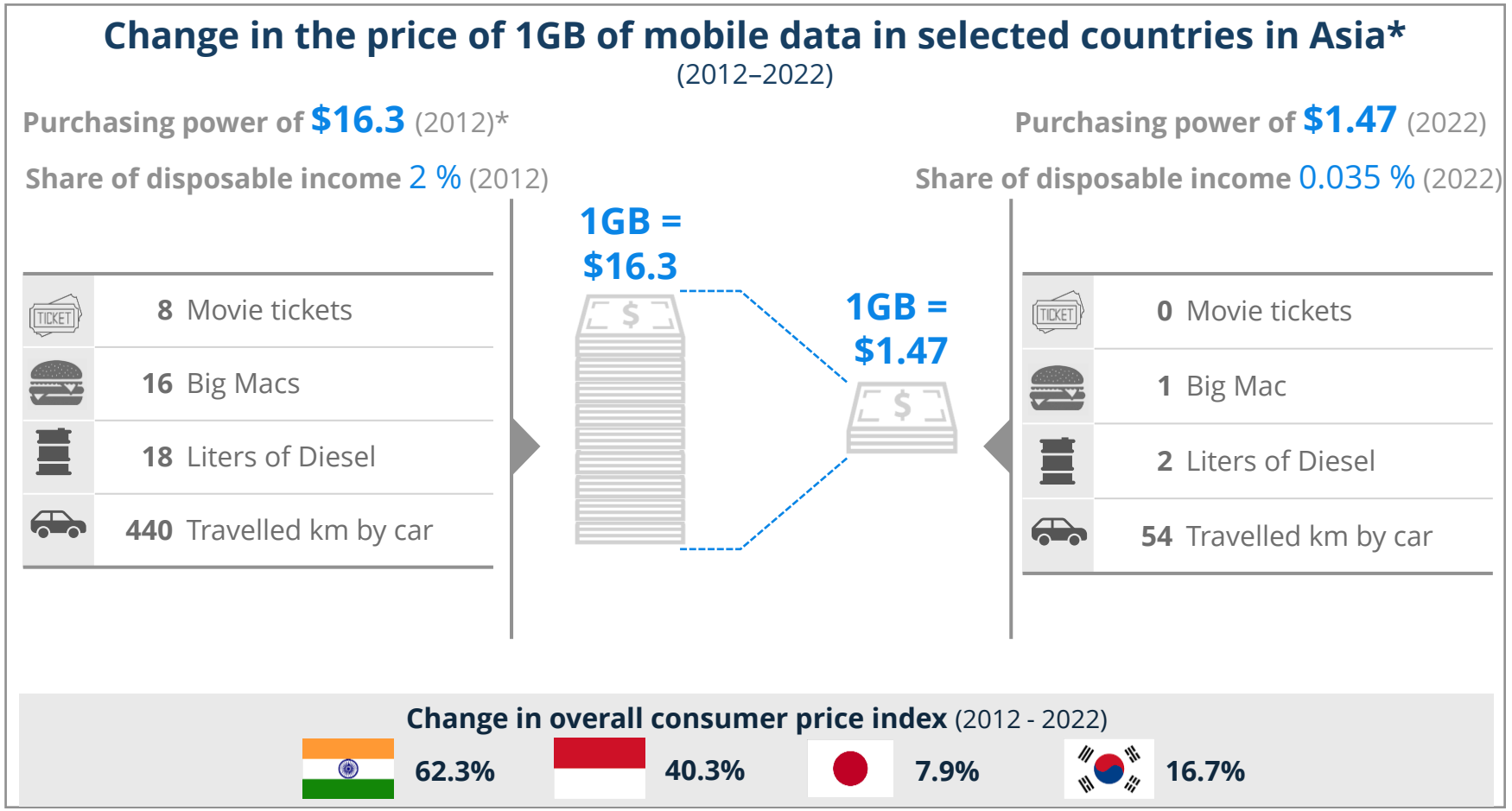
This development enables an increase in purchasing power, from which everyone benefits.

Note(s): *Selected countries are Brazil, Mexico, Colombia. Kilometers travelled is based on Toyota Corolla 1.4D4D (one of the most popular cars in the world) 4.1 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 CPI, OECD - Disposable income

Despite increasing purchasing power, Asia as well sees mobile data prices become more affordable

Change in affordability of mobile data services – Selected countries in Asia (4/4)



In 2012, it was possible to buy 8 movie tickets for the price of a gigabyte in the selected in Asia. In 2022, it was not even enough for one whole movie ticket.

Despite significant increases of price index in counties like India, there are stark reductions in pricing of mobile data.

Note(s): *Selected countries are India, Indonesia, Japan and Korea. Kilometers travelled is based on Toyota Corolla 1.4D4D (one of the most popular cars in the world) 4.1 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 CPI, OECD - Disposable income

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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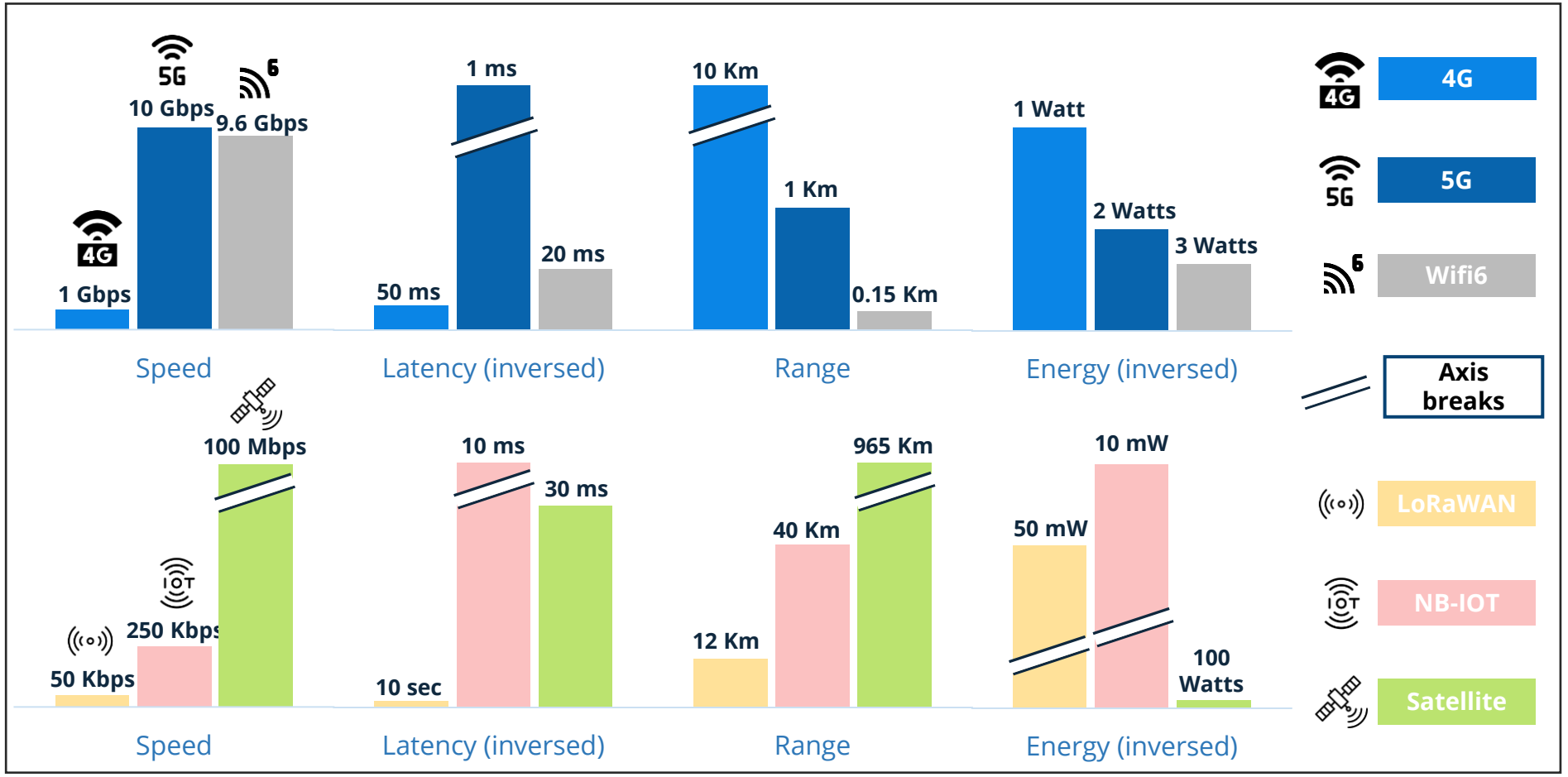
5G is due to receive more improvements in range and energy efficiency while breaking benchmarks in speed and latency

5G vs. other wireless technologies



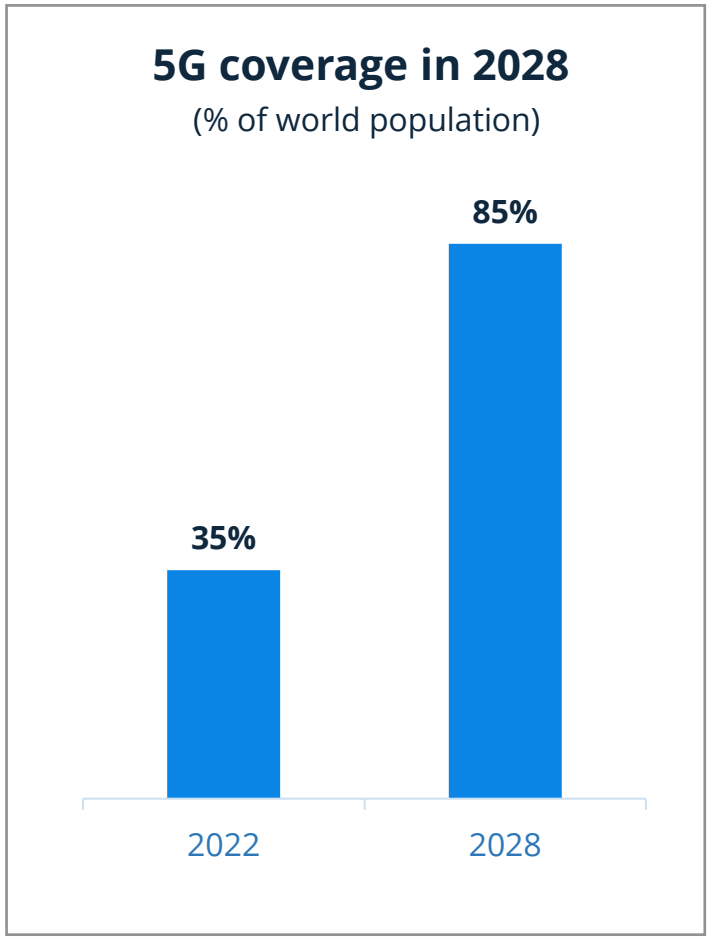
5G does not yet provide optimal results for range and energy consumed because of current technological and infrastructure limitations, but it will eventually become the technology of choice for critical communications that require extreme reliability and service quality, including those within industrial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

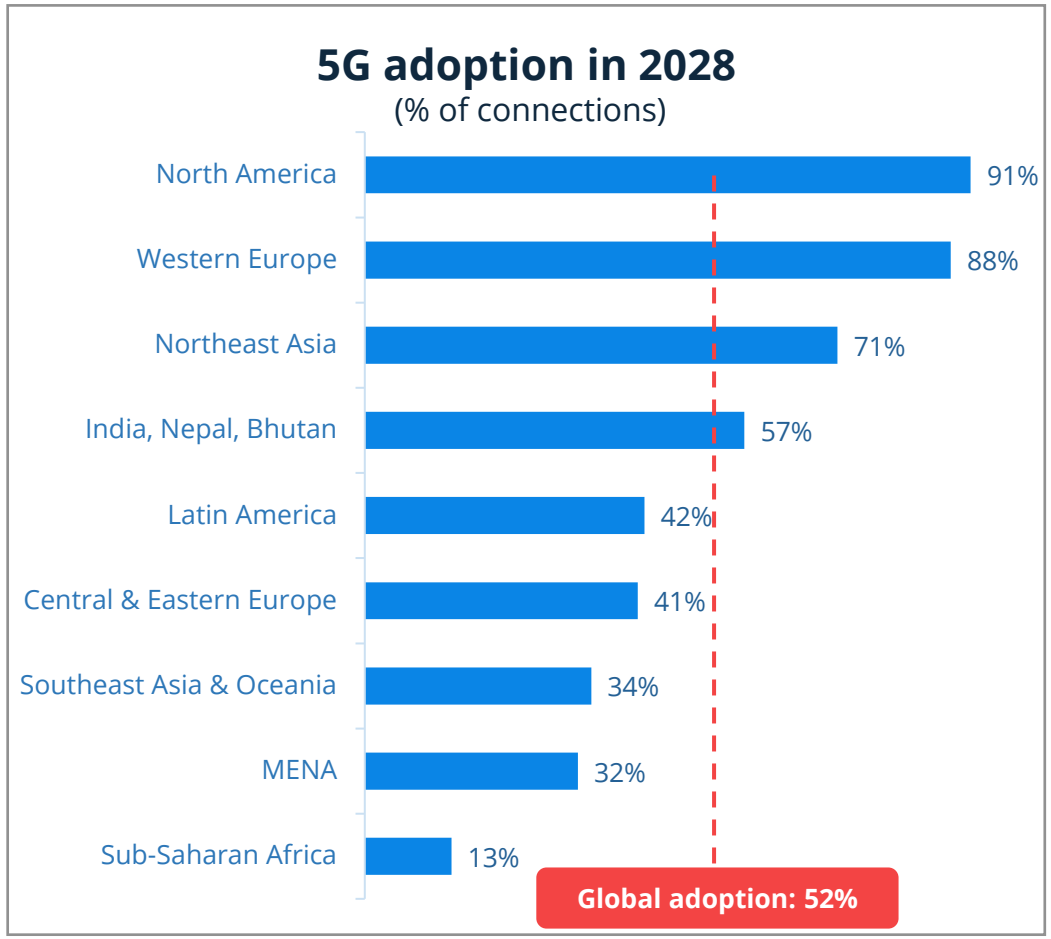
4G was much further away from reaching the performance of Wifi6, 5G however has not only closed this gap but shows better results than Wifi6 for speed and latency.

Notes: Figures considered are an average of typical user figures. Latency and Energy consumption are represented with inversed figures to highlight technologies with lower figures.
Source(s): ETSI, intel, starlink, SCDN, LoRa alliance

5G is expected to gain rapid adoption as per current trends: Western Europe and North America are the forerunners

5G coverage & connections





In the first quarter of 2023, 5G subscriptions reached 1 billion.

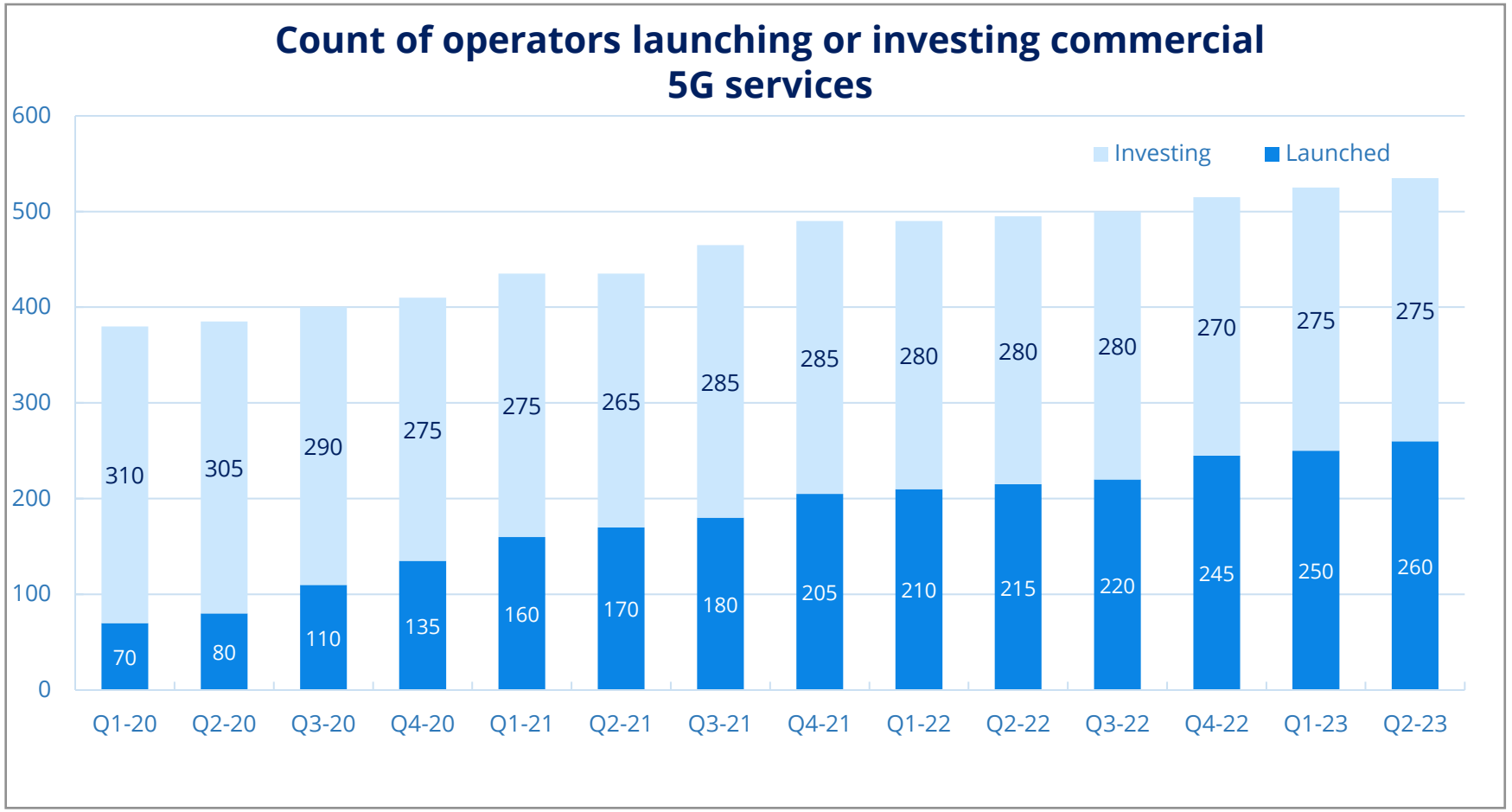
Looking into the future, North America is the leader in adopting and establishing 5G mobile networks with more than 91% (400 million) of connections using 5G standards, closely followed by Western Europe (88%) and Northeast Asia (71%).

The global average for adoption of 5G mobile networks will be around 52%, that is 4.4 billion individuals, by 2028.

Source(s):, Ericsson Mobility visualizer June. 2023

3GPP - 5G commercial launches continue to gain momentum

Operators with 5G services



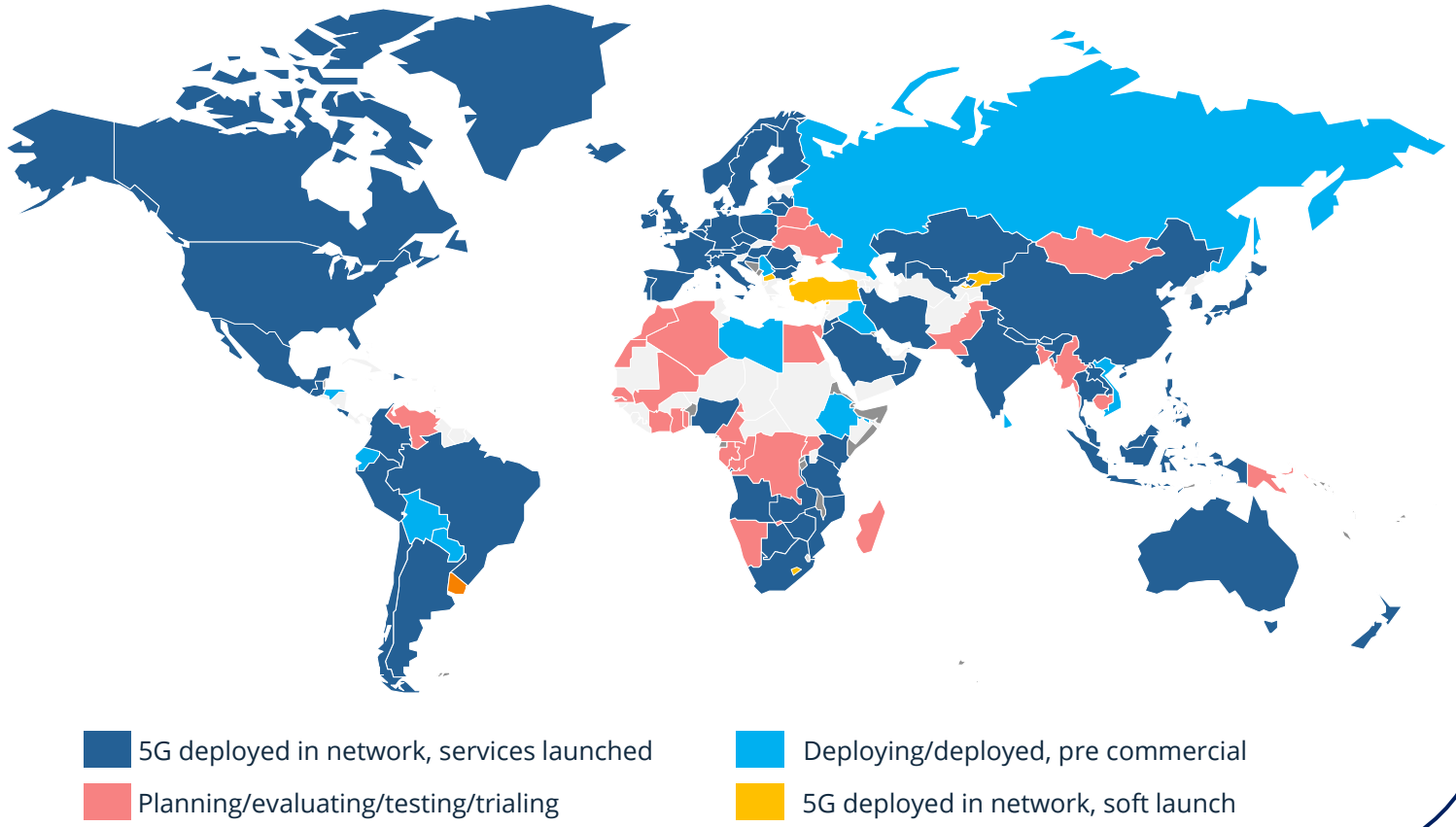
- By the end of June 2023, 535 operators in 162 countries and territories have been investing in 5G networks .
- These investments have been in the form of tests, trials, pilots, planned and actual deployments.
- Of these, 259 operators in 102 countries and territories had launched one or more 3GPP-compliant 5G services commercially.

Source(s): GSA, July 2023

3GPP-5G standalone expansion:
102 countries have already launched commercial public 5G

5G standalone expansion map around the globe

Map of global operators investing in public 5G networks (as of the end of June 2023)



115 operators are identified as investing in standalone 5G for public networks (including those evaluating or testing, piloting, planning or deploying as well as those that have launched standalone 5G networks).

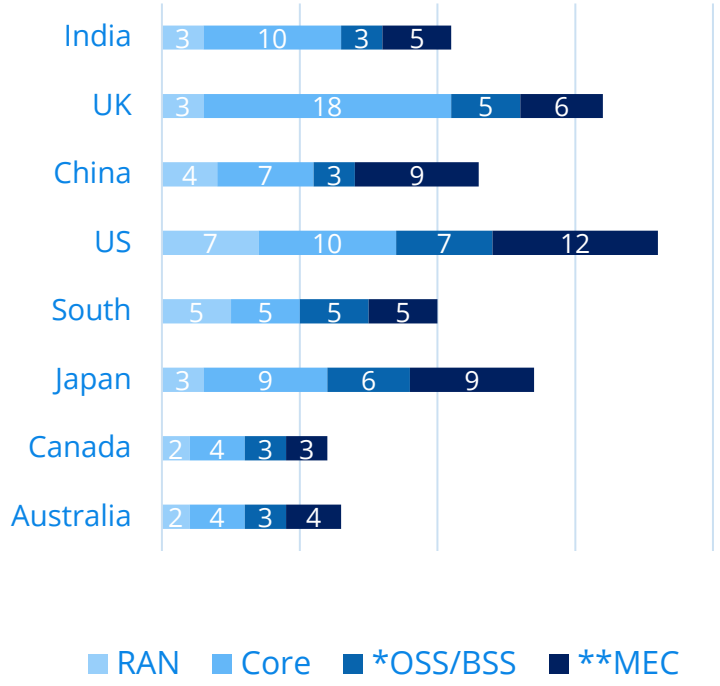
GSA has catalogued 41 operators as having deployed, launched or soft-launched standalone 5G in public networks

Source(s): GSA, 2023

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	**MEC
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	

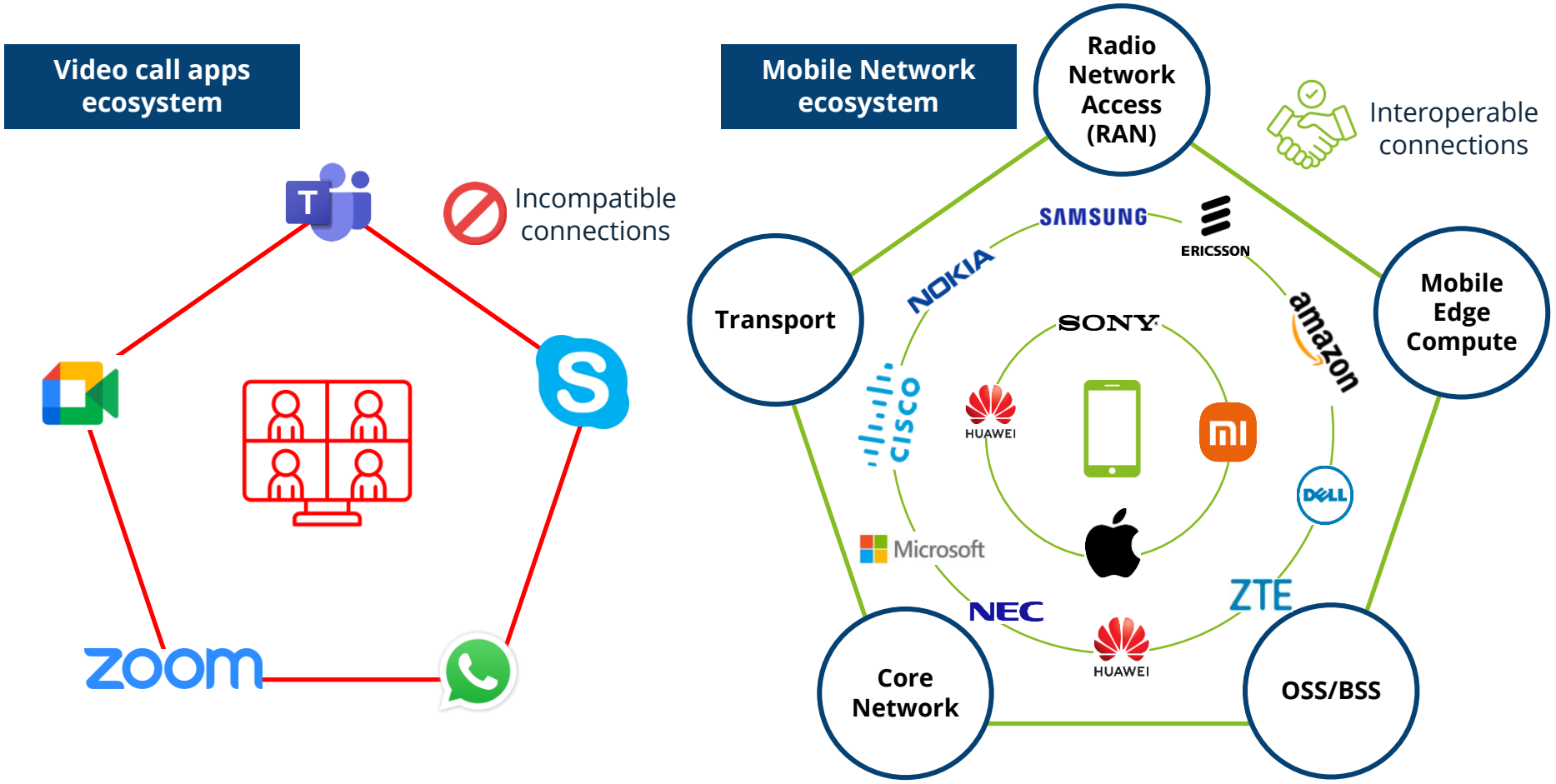
The transition from one mobile generation to the next has, historically, been a time when mobile operators evaluate their current suppliers and explore new ones. With 5G, unlike previous generations, there is unified agreement on what 5G technology should be. 5G ecosystem provides operators with many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

In eight countries where network rollouts are in advanced stages (Australia, Canada, China, India, 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 2023

Unlike countless other technologies, mobile networks are largely interoperable owing to 3GPP standards

3GPP as a mean to interoperability



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 Network slicing

- What is network slicing and how does it solve challenges of 5G?
- What are use cases for network slicing?

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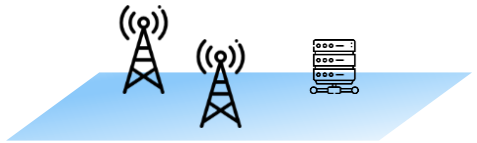
Network slicing can help create new services more tailored to the applications that the network is being used for

What is network slicing and how does it solve challenges of 5G?

5G's high speed, reliability and low latency opens opportunities for many new business models.

This would mean that traffic within networks would continue to increase. Furthermore, network requirements often change based on the applications they are being used for.



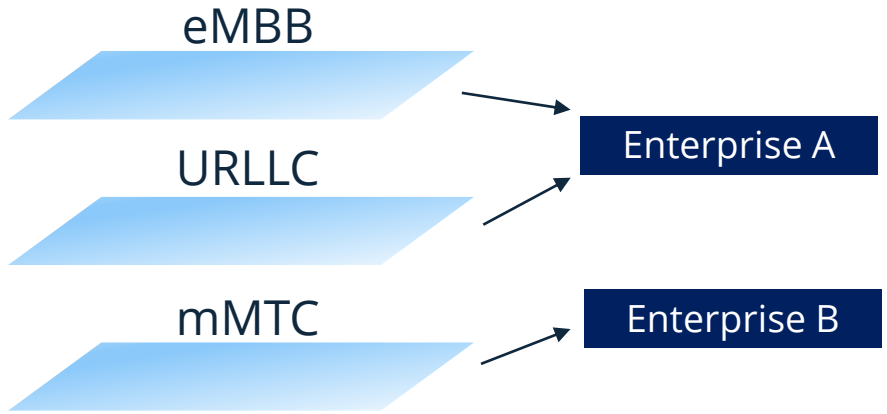
For these reason multiple networks would be required to satisfy traffic and optimal operational demands.

To avoid having to invest heavily in multiple networks, network slicing is used. Network slicing can divide a single physical network into several virtualized slices.

These slices can have different Service Level Agreements (SLAs) regarding throughput, reliability and latency. This allows for the network to cater to one specific application segment on each layer.

Common application segments are enhanced mobile broadband **(eMBB)**, ultra reliable low latency communications **(URLLC)** and massive machine type communications **(mMTC).**

Such slices could be assigned to specific enterprises as packages so that enterprises would not have to invest in standalone private networks.



Source(s): Ericsson

Network slicing is expected to target all major industry segments by providing tailored software defined networks

What are use cases for network slicing?

Use Cases

Enhanced Mobile Broadband (eMBB) is a key aspect of 5G technology, offering ultra-fast data speeds to enable seamless connectivity.

Ultra-Reliable Low Latency Communications (URLLC) takes advantage of the low latency of less than 5ms that 5G offers to create networks for applications that require immediate response times.

Massive Machine Type Communications (mMTC) is tailored for connecting vast numbers of IoT devices efficiently, scalability and energy efficiency are paramount here.

eMBB

- Augmented reality/virtual reality app
- Real-time multiplayer gaming
- Stadium event broadband

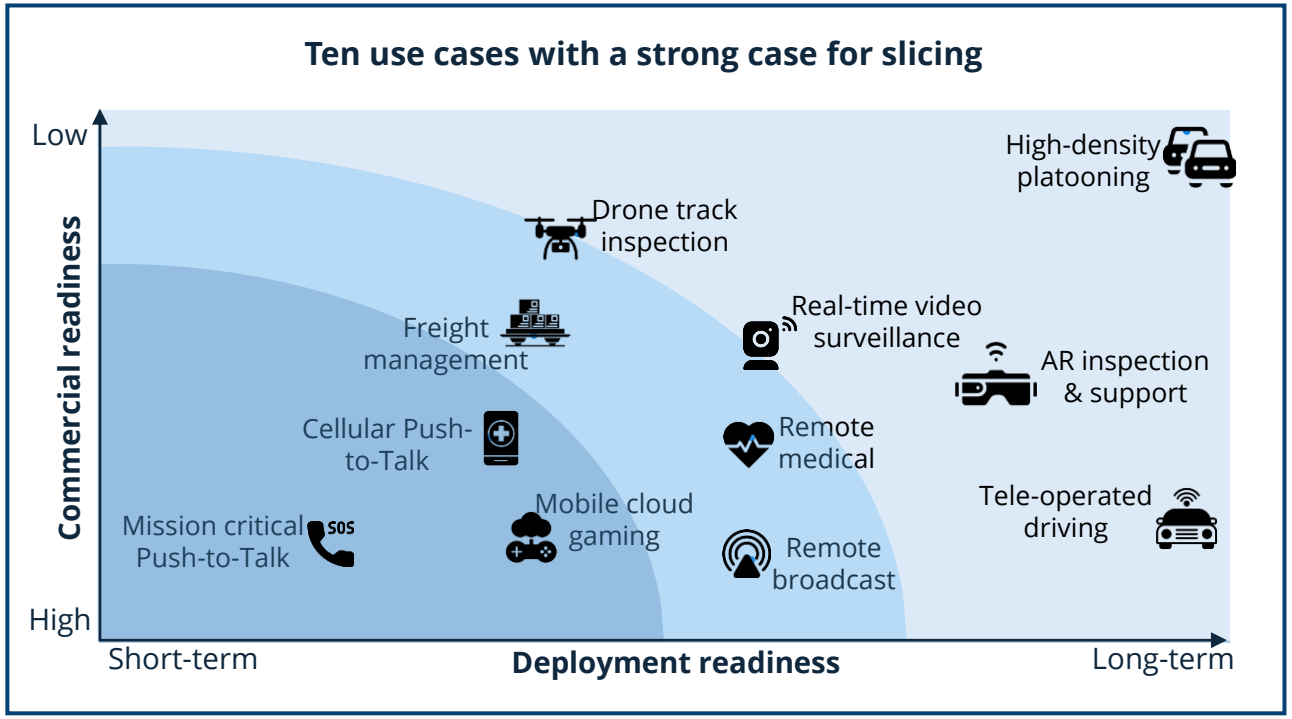
URLLC

- Industrial automation and control
- Autonomous vehicles
- Remote surgery

mMTC

- Agricultural monitoring
- Smart city sensors and meters
- Fleet management and telematics

Use case potential



Source(s): Ericsson1, Ericsson2

Sources

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