Qualcomm

5G and the digital divide

2022

@qualcomm

Part 1
Introduction

The digital divide refers to inequalities in access to, and use of, high-speed internet and other digital technologies

The 3 main factors behind the digital divide are

- The lack of internet connectivity where people live, work or learn
- The lack of affordability
- The lack of skills to navigate the connected world

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Digitization is a challenge…

Individuals without broadband internet connectivity are cut off from society, information and opportunities. As the digital transformation accelerates, the consequences of the digital divide on the un- or under-connected are magnified. The digital divide is becoming the "new face of inequality."(I)

…and an opportunity

Broadband connectivity allows access to new digital tools that can help tackle many of today's challenges; from improving access to health care and education, to creating new jobs, to contributing to better energy efficiency and climate change mitigation.

A renewed policy priority

Closing the digital divide has been a policy priority for some time, but a distant one. With the pandemic, it has become clear that the persistence of the digital divide is very harmful to the economy and society. Closing the digital divide is at the forefront of the policy agenda everywhere in the world.

5G technology as a solution

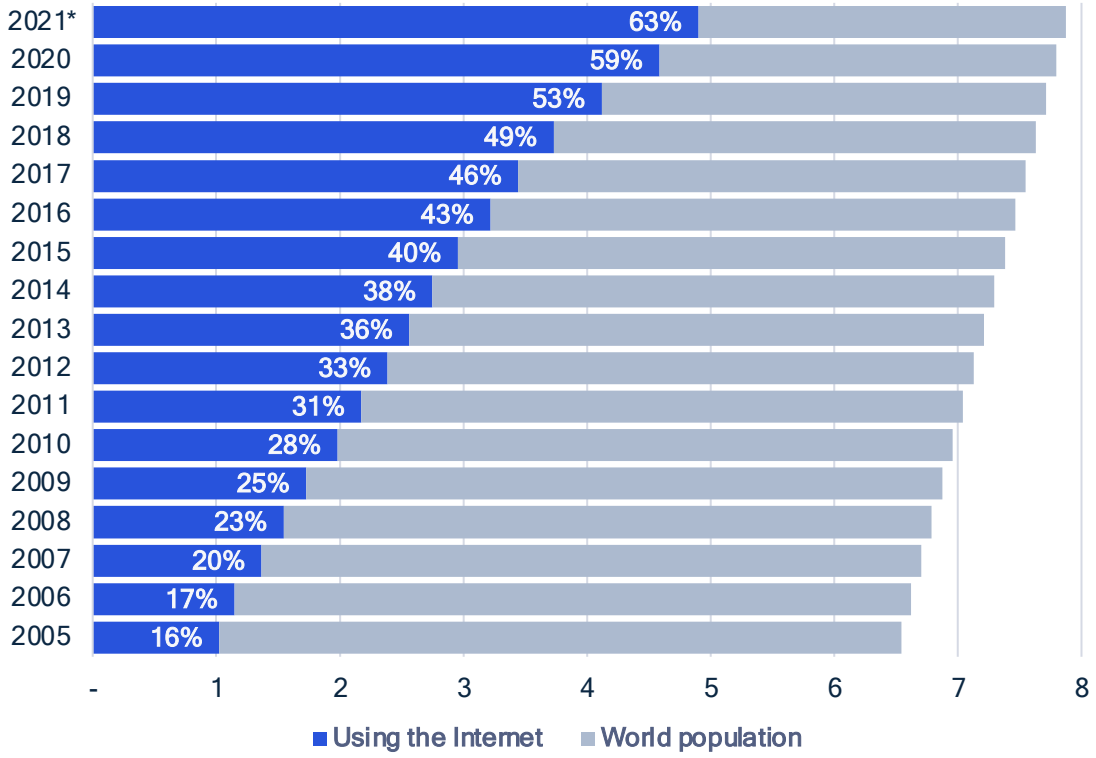
5G technology can go a long way in connecting the unconnected, providing quality internet to all and open wide the doors of the intelligently connected world. Unleashing its full potential will require all actors come together to deploy the right combination of technology.

(i) UN Deputy Secretary-General Amina Mohammed, April 2021

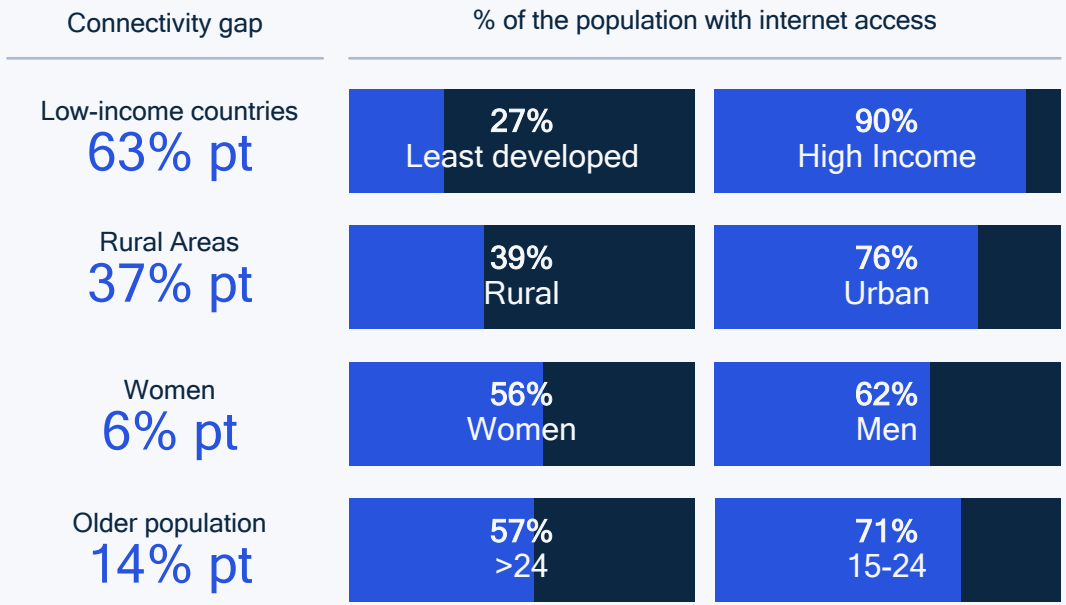
Part 2
The digital divide in numbers

The digital divide has been reduced but persists in most countries around the world

37% of the world population is still offline



The divide persists between, as well as within, countries where it spans over several dimensions such as income, geography, age, gender, and race.

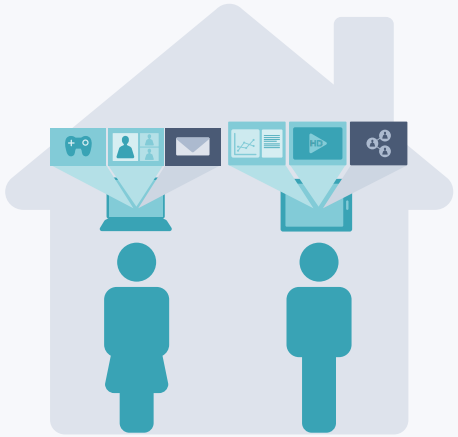


Source: International Telecommunication Union, 2021

The quality of connections is another dimension of the digital divide

Examples of households that need fixed broadband connection over 25 Mbps

4 users or devices at a time using basic functions plus one high-demand application

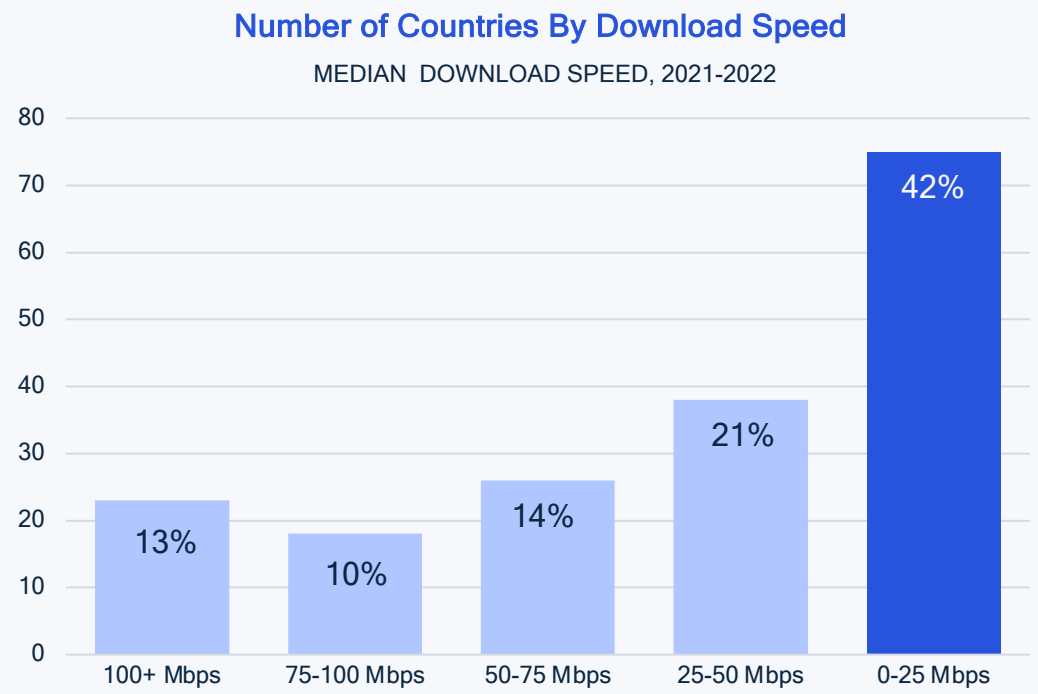


2 users or devices at a time using basic functions plus two or more high-demand application

Source: Broadband Now

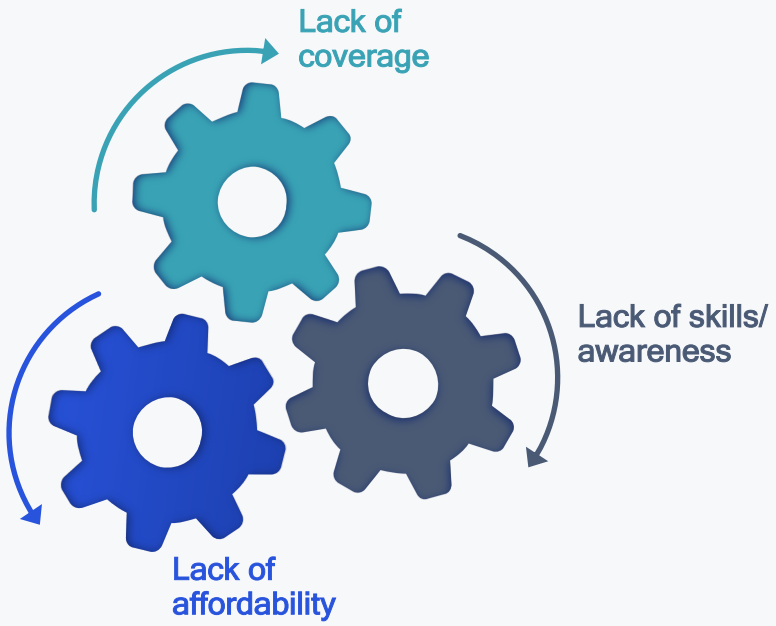
More than 40% of countries have low-speed fixed broadband connections

which does not enable users to make the most of connectivity



Source: Internal calculations based on Speedtest, Global Index (https://www.speedtest.net/global-index)

The lack of digital skills and awareness contributes to the digital divide



The lack of digital skills and awareness of connectivity benefits limits demand for connectivity as well as the ability to make the most of it. This contributes notably to older generations/women divide.

40%

of countries have less than 40% of the population reporting using a basic digital skills activity.(i)

16%

of the adult population in OECD countries don't have basic ICT skills.(ii)

58%

of the 24 million offline US households express no interest or need to be online.(iii)

The adoption of broadband internet by **SME** (and some large businesses in developing countries) is limited by their ability to hire staff with the technical skills needed to select, purchase, and operate ICT infrastructure.

As skills tend to lack the most where broadband penetration is lower. A positive virtuous circle can be expected as penetration increases when coverage and affordability improve resulting in better digital skills and benefits awareness.

(i) ITU (2021) Measuring Digital Development: Facts and Figures 2021 https://www.itu.int/itu-d/reports/statistics/2021/11/15/ict-skills/ . (ii) OECD (2019) Skills Matter Additional results from the survey of Adult skills (iii) These households are more likely to be less educated, outside the labor force, and older. Source: NTIA's Internet Use Survey data October 2022 (https://www.ntia.gov/category/data-central).

Mobile broadband connects people around the world

Mobile broadband with 3G, 4G and now 5G has broadened connectivity coverage and improved its affordability, especially in developing and emerging countries. It has enabled people to communicate and to access other services such as banking, health information, etc. Mobile broadband remains the main source of connectivity in low-income countries.

There are 4.3B unique mobile internet subscribers according to GSMA Intelligence – making mobile the largest technology platform in the world.

World connectivity improvements were driven by mobile in 2015-2020

~2x Active mobile-broadband subscriptions per 100 inhabitants

~90% Of the world population is covered by 4G (54% in 2015)

5G coverage is expanding

501 operators in 153 countries/territories have been investing in 5G networks (GSA, 2022)

Including 225 operators in 89 countries/territories that have launched 5G services (GSA, 2022)

Over 25% of the world population is covered by 5G mid-2022 (GSMA Intelligence)

Sources: Internal calculations based on International Telecommunication Union, GSA, GSMA Intelligence

Part 3
Potential for 5G in closing the digital divide

5G technology is narrowing the digital divide

Mobile broadband

5G is paving the way to faster mobile broadband speeds and more reliable connections benefiting especially those who are more dependent on mobile technology.

- In less developed economies with limited fixed infrastructure, mobile is the main source of connectivity and plays a key role in economic growth.
- Minorities and older populations in developed countries tend to rely more on mobile than fixed broadband.

In addition to smartphones, 5G connected laptops and tablets are enabling the ability to work from anywhere, with enhanced security and reliability.

Fixed broadband

5G Fixed Wireless Access (FWA) or 5G home internet service has become an alternative to fiber for fixed broadband.

- A cost-effective alternative to aging networks, especially DSL, and the deployment of fiber quality broadband in urban, suburban, and rural areas.
- A highly affordable solution for households and businesses thanks to lower costs and increased competition.

In turn, it will enable other connectivity benefits, such as remote healthcare and health monitoring, working from home, access to markets for SMEs, etc.

5G vs 4G

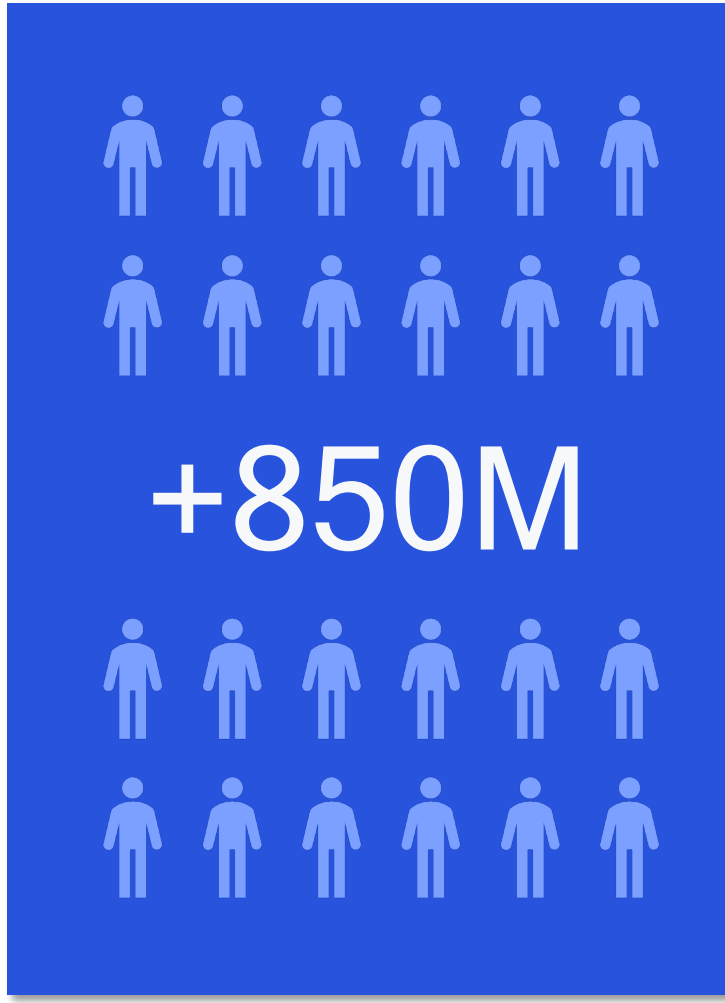
10x	10x	3x	100x	100x	10x
Decrease in end-to-end latency	Experienced throughput	Spectrum efficiency	Traffic capacity	Network efficiency	Connection density

Internal Qualcomm Estimates

5G FWA can expand fiber like fixed broadband and further reduce the digital divide

If fully deployed, 5G FWA could close the digital divide in high-income economies and narrow it substantially in low and middle-income countries in the next 10 years

	Potential impact of 5G FWA full deployment 2022-32	Fixed broadband penetration rate (per 100 homes)	Access to high-speed internet at home
High income economies	• Unserved and underserved rural and suburban areas • Affordable options in already served urban/suburban areas	8pt	+100M
Middle income economies	• Urban areas with issues with fiber deployment • Unserved and underserved rural areas	13pt	+700M
Low income economies	• Urban areas with issues with fiber deployment	8pt	+50M

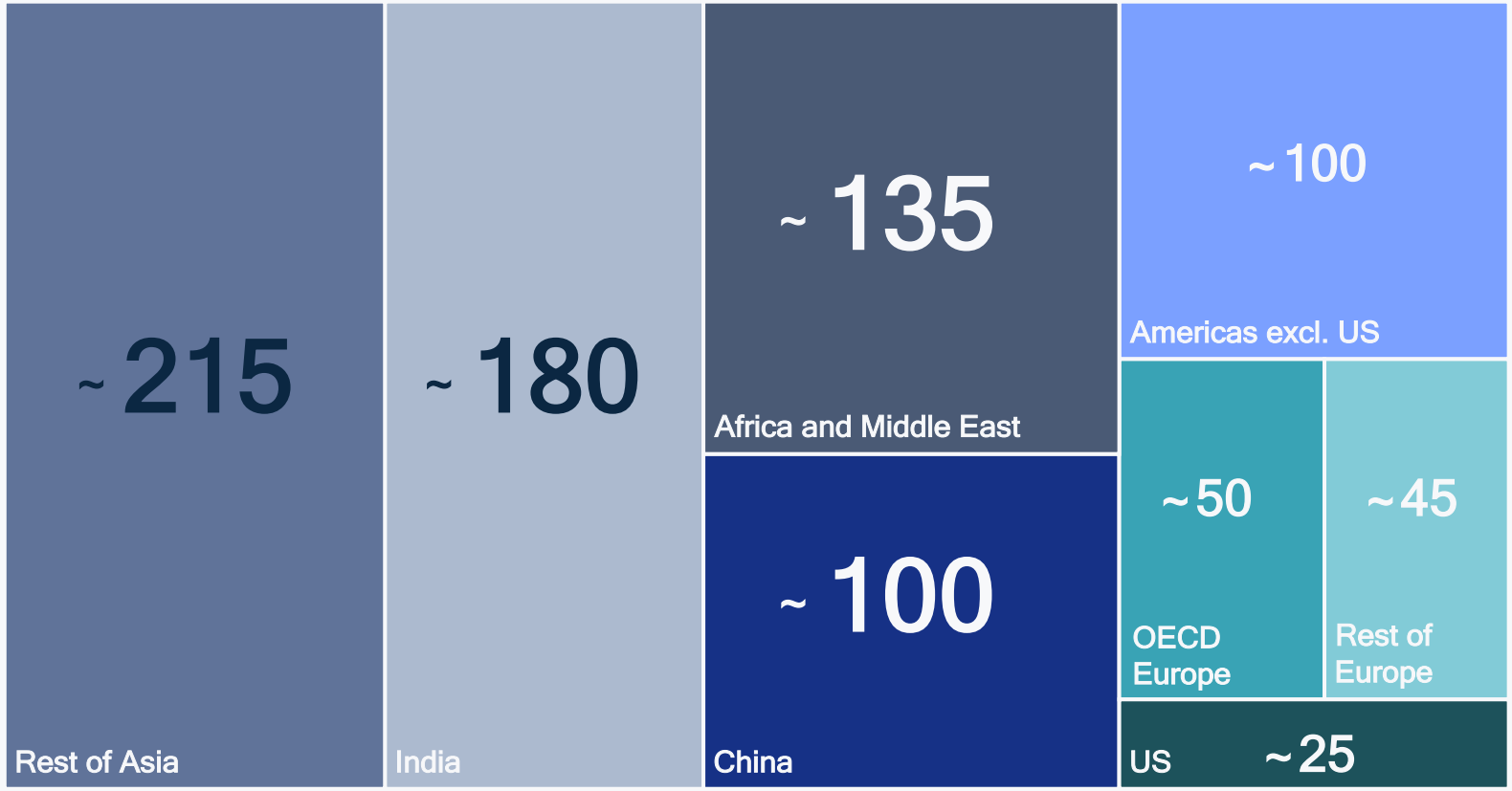


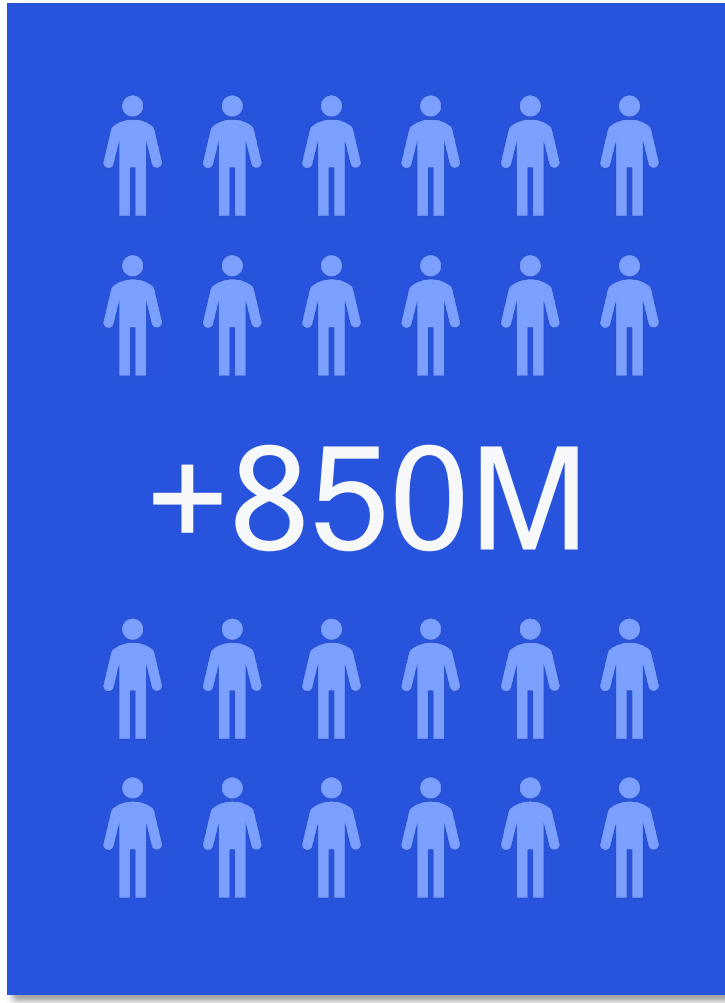
Source: Qualcomm estimates

5G FWA further reduces the digital divide around the world

Impact of fully deployed 5G FWA in the next 10 years by main regions

Number of people getting access to high-speed internet at home for the first time, millions





Source: Qualcomm estimates

Impact on global economic growth

By reducing the digital divide, 5G FWA will enable global GDP gains

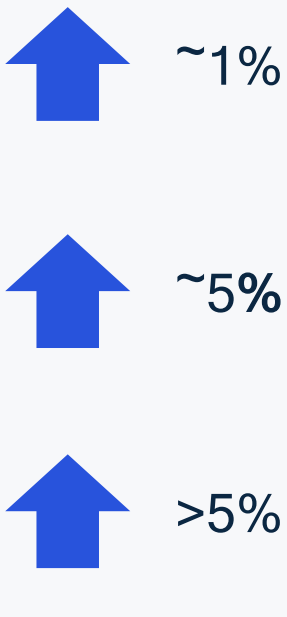
FWA penetration supports economic growth

Connectivity

- Facilitates access of individuals to work, income, information and services such as health care, education, finance.
- Facilitates connections between businesses, suppliers, markets, workers, and new production processes; increases productivity and reduces transaction costs.
- Enables new business models and services.

resulting in income gains and stronger economic growth

Impact of 5G FWA on GDP per capita 2032



By 2032

+2.5% GDP
per capita gains

+$3.3 Trillions
in global GDP

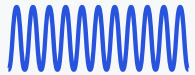
Source: Qualcomm estimates

5G FWA builds on recent radio innovation that improves coverage, capacity and speed

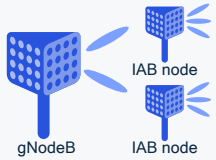
5G Innovations

Massive MIMO

Beamforming



Millimeter Waves



Integrated Access and Backhaul other wireless backhaul solutions

Advantage of wireless technologies (no ducts/polls, limited public work and right-of-way issues that are unavoidable with fiber deployment)

Impact

- Capacity
- Reliability
- Speed
- Coverage
- Cost Savings

Providers

Higher/faster ROI

- Lower deployment costs
- Faster deployment

New market opportunities in un- and under- served areas as well as in served markets

Households

Affordable fiber like quality as replacement of existing connections or as new connections

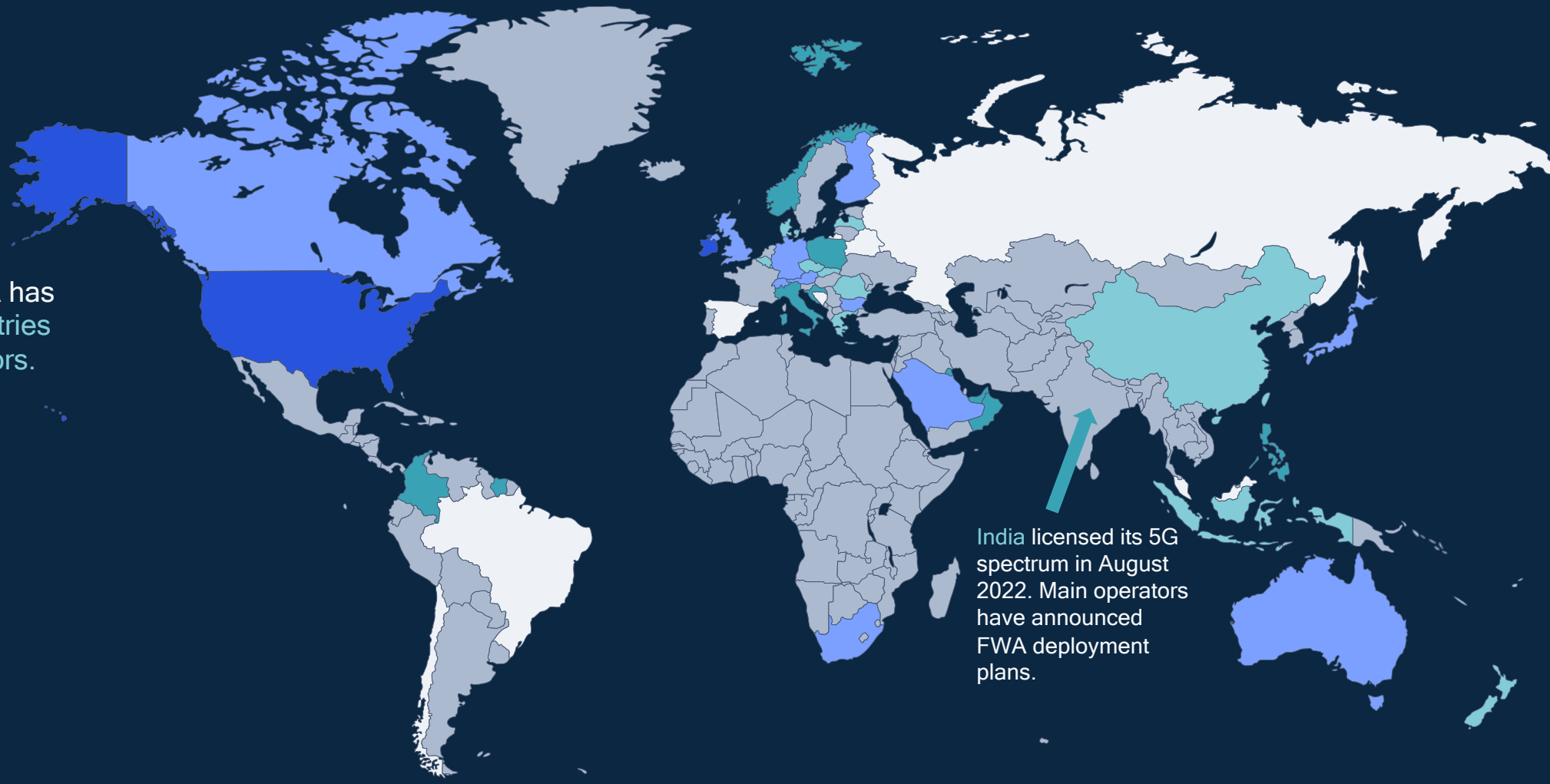
Fast access to connectivity for unserved households and businesses

Better affordability as more competition helps reduce plan prices

5G FWA deployment is underway

As of June 2022, 5G FWA has been launched in 45 countries or territories by 85 operators.

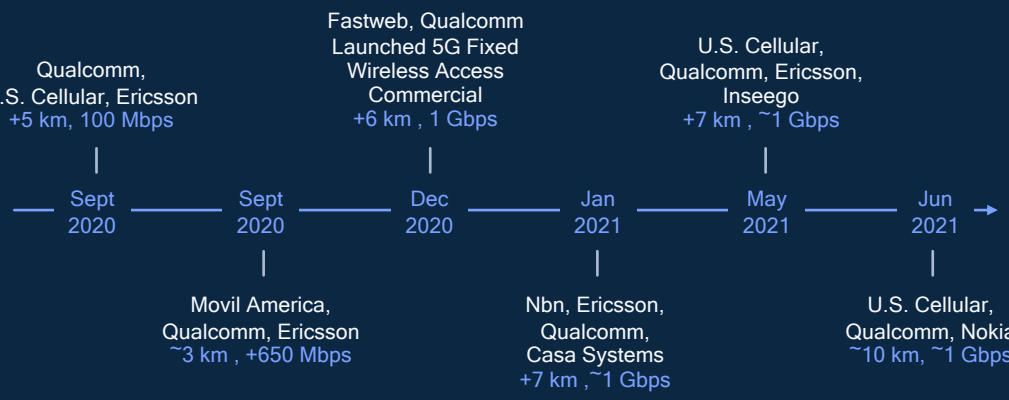
It is planned, in test or in soft launch phases, with 41 additional operators including in 20 additional countries or territories.



Source: GSA

5G mmWave FWA offers ultra-low latency and multi-Gbps data rates and can be utilized to deliver fast, reliable, and cost-efficient connectivity to households and businesses in rural and often underserved areas

5G mmWave FWA



5G mmWave FWA has lower deployment costs than fiber.
It can broaden coverage where fixed broadband growth expansion is limited by the lack of economic returns for providers.

Rural Towns

The most cost-effective solution where fiber cables cannot be deployed using existing rented/shared infrastructure

Up to 80%

Suburban Areas

Cost-effective deployment strategy in several instances where traffic demand is moderate or civil works costs are high

Up to 70%

Urban Areas

Viable solution in areas that suffer from difficult terrain characteristics and regulatory red tape

Up 4 to 5%

Areas with ducts & poles availability

Cost-effective deployment strategy that leverages mid-band spectrum and mmWave spectrum

Up to 30%

Open RAN would further reduce the deployment costs with ORAN solutions 30% less expensive than proprietary radios and software

Sources: GSMA (2022) The 5G FWA opportunity A TCO model for a 5G mmWave FWA network and GSMA (2022) The 5G FWA opportunity: a TCO model for a 5G FWA network using mid-band plus mmWave

Part 4
Social and environmental benefits

If everyone can fully participate in and benefit from the digital world, other divides can be bridged

Providing everyone– regardless of where they live, their income, race, ethnicity, or any other socio-economic characteristic–with reliable fixed or mobile internet connectivity, is a major first step in closing other divides in access to opportunities and services that tend to cumulate for disadvantaged and marginalized populations.

Expanding education access and outcomes

Studies have shown

- A positive link between school Internet connectivity and reading or math performance.
- Online math courses benefit strong students in rural areas where advanced classes are not offered.
- Online education via MOOC tends to increase education enrollment in tertiary and adult education.
- One additional year of education increases future wages by about 10%.

Case study: +0.12 GPA for US rural students with home broadband vs cell phone-dependent students. (i)

Improving efficiency and reach of public services and policies

As government services move on-line to increase efficiency, connectivity gives vulnerable populations better and faster access to:

- Information on social programs or pensions rights.
- Financial aid via digital transfers.
- Training and job search support.
- Unemployment insurance benefits.
- Access to government services from obtaining a birth certificate to registering a business.

Case study: Over 750 million people receive digital payments for social assistance associated to COVID-19. (ii)

Expanding access to health care services and information

Telehealth can improve access to healthcare by reducing travel needs for:

- Those living in areas where there is a shortage of health providers (rural/remote areas).
- Older or disabled and therefore less-mobile individuals.
- Access to internet also improves health care information and prevention.

Case study: Across all US community types, places with better internet access had lower COVID mortality rates.

Improving financial inclusion and reducing financial transaction costs

Wireless technology enables access digital financial services that make financial transactions more affordable, secure and transparent.

- Providing accessible formal financial services to those relying on cash only (1.4bn people unbanked globally).
- Allowing all individuals to better manage their finances, including savings, loans and insurance.
- Enabling cheaper international transfers including of remittances.

Case study: the global average cost for digital remittances is 26% cheaper than for non-digital remittances. (iii)

Sources: Broadband_Gap_Quello_Report_MSU.pdf (i),https://openknowledge.worldbank.org/handle/10986/33635 (ii), Internal calculations & https://www.worldbank.org/en/topic/financialinclusion/publication/digital-financial-inclusion (iii)

Bridging the digital divide generates environmental benefits

Bridging the digital divide with 5G mobile and FWA technology will accelerate the adoption and diffusion of new products and processes to support environmental sustainability and climate change responses.

Accelerating the adoption of sustainable technologies in agriculture

Bringing connectivity to uncovered farmland

Enables farmers to rely on data driven insights from drones, trackers and censors for soil, crop and cattle management.

- Contributes to a more efficient use of water/ energy/ emission/ pesticides.
- Helps reduce food waste and tackle future food scarcity concerns.

Case study: The use of drones for remote sensing and spray application can reduce pesticide use by 50%.

Increasing telecommute options for those with the longest commute

Working from home benefits the environment by reducing the need to commute and related congestion and GhG emissions.

- The largest potential commute time reduction are for those living the furthest away from employment centers.
- This would also avoiding rural desertification in advanced countries and prevent unstainable city growth in emerging and developing countries.

Case study: Accenture estimates that in the US 5G FWA could reduce the average commute for a rural worker by 4,600 miles a year through teleconferencing and remote work.

Contributing to climate change understanding and mitigation

Data are essential for tracking and understanding climate change patterns.

Mobile technologies and remote sensing can improve the monitoring of forests, wildlife, flood areas, etc and prevent climate related disaster.

- Greater connectivity in vulnerable geographies is key role for early warning systems and would help support people in the wake of climate related disasters.

Example: A project using 5G and AI to detect and fight wildfires has been launched in Finland in 2021.

Accelerating the deployment of smart energy devices in rural areas

Home/business internet connectivity

- Enables the use of energy efficiency technologies such as automated thermostats and appliances, autonomous circuit breakers, and connected LED lighting.
- Can help rural households to reduce their energy consumption and bills which represent 40 percent more of their annual income than urban households.

Case study: 5G-connected smart grids will reduce US gas and electricity consumption by 12%.

Sources:, https://blogs.worldbank.org/climatechange/digital-divide-challenge-overcome-tackling-climate-change, https://www.aceee.org/sites/default/files/publications/researchreports/u1806.pdf , Accenture (2022) 5G Connectivity: A Key Enabling Technology To Meet America's Climate Change Goals, https://api.ctia.org/wp-content/uploads/2022/01/5G-Connectivity-A-Key-Enabling-Technology-to-meet-Americas-Climate-Change-Goals-2022-01-25.pdf, https://www.telecompaper.com/news/telia-finland-supports-forest-fire-detection-project-using-5g-and-ai--1408473, https://www.qualcomm.com/content/dam/qcomm-martech/dm-assets/documents/5g_and_sustainability-_the_transformative_role_of_5g_-_10.4.2021.pdf

Part 5
Qualcomm’s Role

Qualcomm is working with the global ecosystem to bridge the digital divide

Qualcomm is a leader in advanced technologies and solutions that are essential to bridge the digital divide, including wireless connectivity, high-performance, low power systems.

- ☑ Qualcomm brought to market second generation FWA platform featuring extended-range mmWave and providing 35% coverage and 25% capacity improvements.
- ☑ As of mid- 2022, more than 40 OEMs with more than 125 FWA designs have been announced or are in development using Qualcomm 5G Fixed Wireless Access Platforms.
- ☑ Qualcomm partners through the ecosystem to develop ORAN solution that support high performance 5G networks while simplifying and lowering the cost of 5G deployments.

Qualcomm works with the ecosystem to deploy devices and services that will help reduce the digital divide.

- ☑ Qualcomm long-term R&D drives technology standards that by ensure scale and drive interoperability.
- ☑ With 5G FWA, Qualcomm provides operators a cost-effective way to deliver fiber-like internet speeds wirelessly over 5G to rural, suburban and dense urban communities, while driving adoption by helping to reduce costs.
- ☑ Device manufacturers: Qualcomm is a leader in solutions for connected, secure, power efficient devices.
- ☑ Qualcomm actively engages with local regulators to foster a supportive environment for digital divide initiatives around the world.

Qualcomm partners with communities around the world to increase access to connectivity in cities, education institutions, etc.

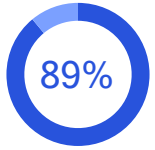
- ☑ Qualcomm supports local initiatives designed to increase access to low-cost devices and connectivity including in the US, China, Japan, Vietnam, Spain, Italy, Portugal and Turkey.
- ☑ Qualcomm® Wireless Reach™ initiative, our tech-for-good initiative, brings advanced wireless technologies to people and communities who need it most. The initiative focuses on pioneering uses of mobile innovations to help close the digital divide and increase equity. Over the last 15 years, Wireless Reach has grown to support 137 programs in nearly 50 countries, impacting more than 24 million beneficiaries.

Qualcomm is working on digital solutions to facilitate access to new connectivity capabilities.

- ☑ Investing in STEM and digital skills programs that provide equitable access to 21st century skills that lead to high paying, high demand jobs, as well as providing access to always connected devices to students around the globe and across rural communities.
- ☑ Collaborated with industry-leading healthcare companies to make it more cost effective for hospitals and care providers to implement a connected health solution.

Part 6
Call for Action

United States



US population using the internet

US households with home internet

+25-30M

Potential coverage increase with FWA full deployment

Recognizing the role of 5G technologies in closing the digital divide

- The US has allocated $65 billion to ensure 100% of US households have broadband connectivity. There has never been as much funding directed to close the digital divide. Most of the spending decisions regarding deployment for underserved communities will be made by the States ($100 million each) or subregional levels which are expected to chose the most appropriate technology for their coverage needs. How and when this funding is spent will affect how fast the digital divide can be closed and when the economic, social and environmental benefits of universal connectivity can be reaped.
- To achieve the goal of connecting all American households under the current budget allocation, it is critical that for similar connectivity performances, priority goes to the most cost-effective technologies and fastest deployment options given the local circumstances.
- 5G FWA, which can deliver reliable high-speed home internet connections, is a powerful solution when local circumstances (remote location, low population density, challenging topography, low income) result in high costs and low returns on investment of fiber deployment.

Creating conditions for affordable deployment of 5G and 5G FWA

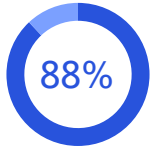
- By supporting the wireless ecosystem from equipment manufacturers to network providers and carriers.
- By working with the ecosystem to implement the right combination of existing and planned infrastructure, including mmWave.
- By lessening permitting/zoning requirements near schools, libraries, parks and public transportation hubs in order to enable enhanced internet connectivity for everyone .
- By ensuring the funding earmarked for ORAN accelerates its penetration to further reduce 5G deployment and operation costs and increase competition on the broadband market.

Creating conditions for adoption and reap the benefits of broadband use

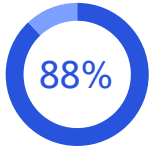
- By continuing to support affordability beyond the $14.2 billion subsidy for qualified low-income users, including through broader poverty reduction programs, device subsidies and agreement with providers for low priced packages.
- By improving digital skills at home, at school and in the workplace with a focus on least connected populations including older adults and women.
- By further promoting internet safety/cyber security.
- By supporting the digital transformation of public services, education and healthcare.

Europe

(European Union and the UK)



European population using the internet



European households with home internet

+45-50M

Potential coverage increase with FWA full deployment

Strengthening the role of 5G technologies in closing the digital divide

- While the digital divide is narrower in Europe than in many other regions, important disparity remains and some Europeans households and businesses still lack access to quality broadband, especially where geography is challenging, and fiber cannot be deployed in a cost-efficient manner.
- The European Commission is committed to invest in secure and performant sustainable digital infrastructure and has recognized the role of 5G and FWA in closing quality connectivity gaps. The UK has also committed to deliver nationwide gigabit-broadband by 2030, covering at least 99% of premises and FWA plays an important role in that strategy especially for hard-to-reach premises.
- Public investment to support increased coverage needs to continue considering complementary solutions depending on geography and existing infrastructure. For similar connectivity performance, the priority should be given to cheapest technologies and fastest deployment given the local circumstances.

Creating conditions for affordable deployment of 5G and 5G FWA

- By accelerating the deployment of 5G networks, especially mmWaves.
- By supporting the European wireless ecosystem from equipment manufacturers to network providers and carriers, notably as it comes to the monetization of investment including in underserved areas.
- By investing in future ORAN projects with EU actors to be part of the new ORAN ecosystem and to support opportunities for new players.

Creating conditions for adoption and reap the benefits of broadband use

- By strengthening poverty-reduction programs, including targeted support on ICT access and use (broadband plans and device) that improve affordability for the most disadvantaged groups.
- By further improving digital skills at home, at school and on the workplace with a focus on least connected populations including older adults and women.
- By continuing to promote Internet safety/cyber security.
- By accelerating the digital transformation of public services, education and healthcare as planned with the EU digital Compass and UK digital strategy.

PART 6 Call to Action

Largest potential gains in middle and-low income countries

~ 750M

Potential coverage increase with FWA full deployment

Recognizing the role of mobile technologies including 5G in closing the digital divide

- Middle and low-income have very diverse circumstance regarding broadband coverage and access. A few common feature emerge though. The costs of fixed broadband deployment and usage, means that mobile broadband remains the main source of connectivity for many, especially in lower income countries and for most disadvantaged groups everywhere.
- The deployment of 5G FWA in advanced economies will benefit middle income and low-income countries by bringing the technology to sufficient scale. 5G FWA can then help leapfrog fiberization the same way mobile phone connectivity has leapfrogged phone landline deployment. National and international public funding to support increased coverage needs to consider complementary solutions depending on geography and existing infrastructure and avoid technology bias. 5G and 5G FWA should be among them.
- In the meantime, there is room to further advance the use of mobile internet, upgrading from 3G to 4G and deploying 4G FWA solutions, especially in the low-income countries where the potential of 4G is still untapped.
- Investment in backbone infrastructure and complementary infrastructure such as electricity where those are still lacking is necessary to support the deployment of connecting/last miles technologies. In rural areas access to electricity has been found to increase smartphone ownership by 3% points (4%point for women).

Creating conditions for affordable deployment of 5G and 5G FWA

- By ensuring adequate spectrum is allocated and licensed for the provision of 5G services.
- By supporting the wireless ecosystem from equipment manufacturers to network providers and carriers and reducing barriers to FDI in digital infrastructure.
- By considering ORAN deployment to further reduce 5G deployment and operation costs and increase competition on the broadband market
- there is need for less stringent permitting/zoning requirements near schools, libraries, parks and public transportation hubs to enable enhanced internet connectivity for everyone

Creating conditions for adoption and reap the benefits of broadband use

- By expanding poverty reduction programs, including targeted support on ICT access and use (broadband plans and device) in order to increase affordability
- By promoting general and digital literacy programs.
- By promoting Internet safety/cyber security
- By continuing the digital transformation of public services, education and healthcare and development of content accessible to all.

Source: Houngbonon et al (2021) https://www.nature.com/articles/s41599-021-00848-0

SUMMARY

5G and the digital divide

Closing the digital divide is a priority

The intelligently connected world cannot become a universal reality when 37% of the world population remain offline and many others do not have access to reliable internet connections.

Mobile has already played a key role

Mobile broadband has broadened connectivity coverage and improved its affordability. This is especially the case in developing countries where it is the main source of connectivity enabling access to services such as banking, health information, etc.

5G is now paving the way to faster mobile broadband speeds and more reliable connections that would especially benefit those who are most dependent on mobile technology.

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5G FWA needs to be part of the solution

5G Fixed Wireless Access has become a cost-effective alternative to fiber for fixed broadband. Thanks to enhanced capabilities in MIMO technology, beamforming and mmWaves it can deliver fast, reliable, and cost-efficient connectivity to households and businesses in rural and often underserved areas.

If fully deployed, FWA could provide home internet access for the first time to 850M people globally during the next decade.

Enabled benefits are important

Better access to information, work, markets, and services enabled by FWA would benefit global economic growth and generate an additional ~$3.3T of world GDP in 2032.

Improved access to quality education, social services, health care, and financial services will narrow other divides that tend to accumulate for disadvantaged populations.

Will facilitate the adoption and diffusion of products and processes to support environmental sustainability and climate change responses.

Thank you

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