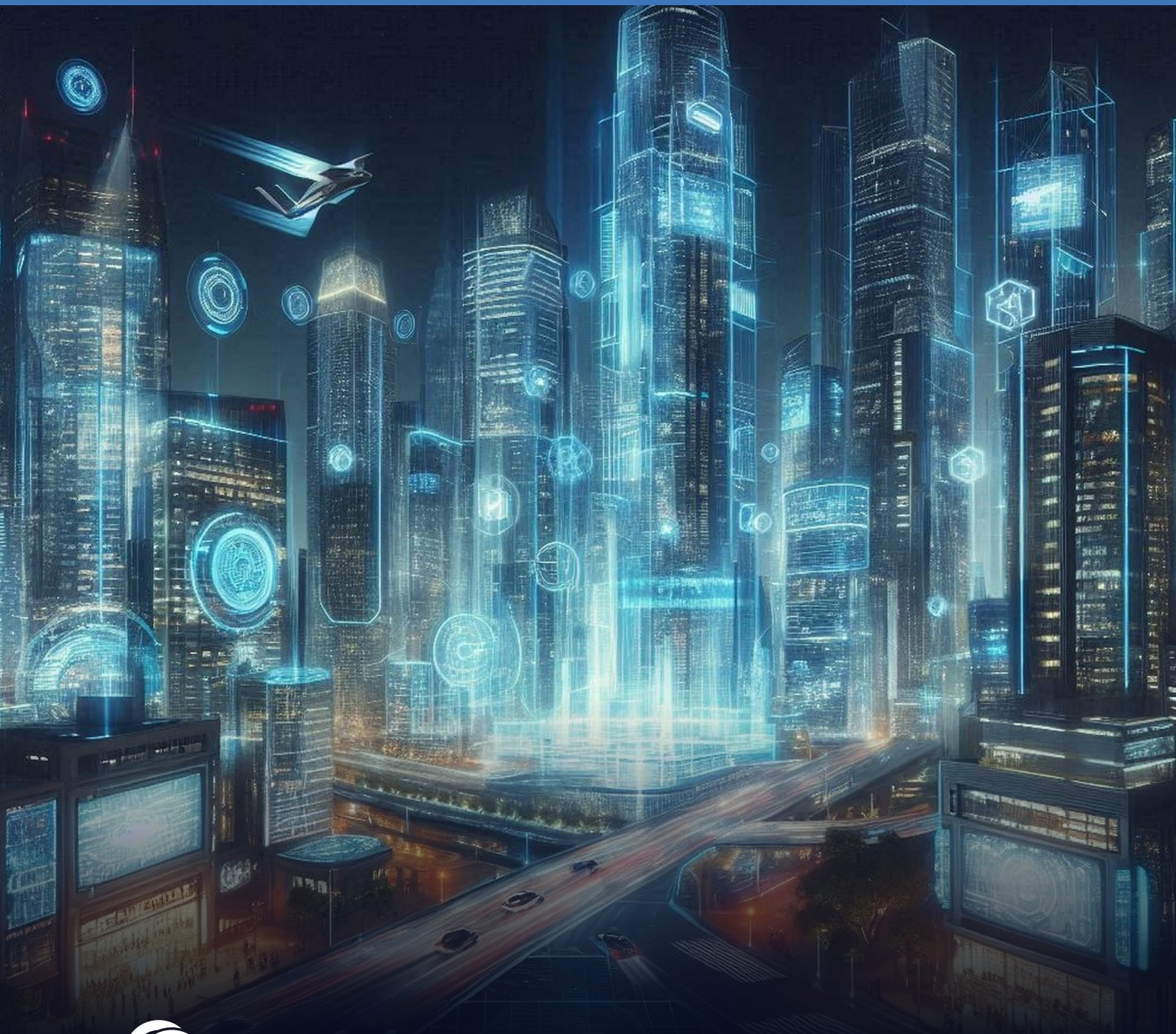
FIBER DEVELOPMENT INDEX ANALYSIS 2024



WORLD BROADBAND ASSOCIATION

OMDIA

Brought to you by Informa Tech

This report provides an analysis of Omdia's Fiber Development Index (FDI). The FDI quantifies and ranks the level of investment in fiber optical networks across nine metrics on a country-level basis. This analysis helps industry stakeholders, including policymakers, regulators, service providers, and suppliers, support the development and growth of the fiber industries in their respective countries. WBBA members include the following companies.*

FOUNDING MEMBERS

MEMBERS

MEMBERS

MARAVEDIS Wireless Infrastructure Analysts

MetaBlox

Metaverse STANDARDS FORUM

微网优联 Micronet Union

MTN

NLTVC EDUCATION

OMDIA

OpenValley Transforming Networks

P2P NETWORK COMMUNICATIONS LIMITED Onland- Onboard- Offshore

Prodapt

Pulse FIBRE

RAISECOM 瑞斯康达科技

Safaricom

Senall

SENTECH connecting You

SST 信天通信

SLTMOBITEL The Connection

SMART INDUSTRY

stc

Suburban

Summit Communications Limited

TANIM Innovative Solutions

TEJAS® NETWORKS

Telkom Indonesia the world in your hand

tfl

TIANYI 天邑

TRUE MERIDIAN

Ultrapower 神州泰岳

UZTELECOM

VERSE

Whale Cloud

XONA PARTNERS

YOFC Smart Link Better Life.

友华通信 YOUHUA TECHNOLOGY

zain

zayo

ZTE

OBSERVERS

HKT

nt National Telecom

VNPT

*This is not a comprehensive list of members; please visit https://worldbroadbandassociation.com/ for the full list.

CONTENTS

AUTHORS

Michael Philpott
Research Director, Service Provider, Omdia

Alzbeta Fellenbaum
Principal Analyst, Service Provider, Omdia

Sarah McBride
Principal Analyst, Service Provider, Omdia

Stephen Wilson
Senior Principal Analyst, Service Provider, Omdia

EXECUTIVE SUMMARY

FDI tracks and benchmarks fiber development across 93 countries and territories. Fiber investment is crucial for ensuring the high-quality delivery of all data services and requires a comprehensive contextual analysis. Unlike other fiber benchmarks that largely track household coverage, penetration, or both, the FDI includes a wider set of fiber investment metrics, including:

- Fiber-to-the-premise (FTTP) coverage
- Fiber-to-the-household (FTTH) penetration
- Fiber-to-the-business (FTTBusiness) penetration
- Mobile cell-site fiber penetration
- Advanced wavelength division multiplexing (WDM) technology investment

In addition to the fiber investment metrics, the FDI, based on Omdia's analysis of Ookla Speedtest data, then quantifies the overall broadband quality of experience (QoE) improvements driven by that investment, namely:

- Median download speed
- Median upload speed
- Median latency
- Median jitter

The FDI currently covers 93 countries and territories of varying sizes, demographic and geographical profiles, and levels of broadband development. These widely differing characteristics make it difficult to compare countries directly; to do so would, in Omdia's opinion, only lead to unfair and unhelpful conclusions and recommendations.

Therefore, to compare individual results, the FDI splits territories into three different country clusters:

- **Cluster 1:** Countries with highly developed fiber-based broadband networks
- **Cluster 2:** Developed broadband countries that are moving toward greater fiber broadband adoption
- **Cluster 3:** Emerging broadband countries with low levels of broadband household penetration

Singapore continues to lead Omdia's FDI, with maximum scores in six out of the nine metric categories, followed by the UAE and Qatar. Romania, Europe's leading FDI territory, continues its development and moves up into fourth place, followed by Chile, Latin America's leading territory, which continues to climb up the Index for several years in a row. China, South Korea, Japan, Denmark, and Spain make up the rest of the top ten. Further down the ranking, the US continues to be the leading North American territory, at number 28 place, with Mauritius being the leading African nation (number 46 place).

KEY MESSAGES AND RECOMMENDATIONS

- **Gigabit broadband networks are essential for future growth and development:** Networks are quickly expanding from connecting individuals and homes to connecting things, including everyday objects (inside and outside our homes) and items that we wear. By 2030, there will be 13.7 million new consumer devices connected daily with most of these devices relying, at least for part of the time, on home broadband connectivity. Moreover, industrial digitization is happening at a great pace, driven by use cases such as campus/commercial center digitalization, e-government, smart finance, Industry 4.0, or smart mobility and healthcare.

- **Multi- and 10Gbps services are becoming the premium, high-end offering:** With 1Gbps broadband services gaining popularity in developed broadband markets, premium tiers are shifting toward multi-gig and 10Gbps offerings. Such offerings today are focused on high-end users. However, in the future, they are expected to support bandwidth-hungry applications, such as cloud storage, extended reality (XR), and other cloud and artificial intelligence (AI)-based applications.

- **The digital divide in access to high-quality, gigabit broadband services is increasing:** Although by 2028, more than 80% of people will be connected to broadband internet using either mobile or fixed technologies, access to advanced gigabit broadband services will be far from equal, and heavily skewed regionally. While the first digital divide was about basic connectivity, the second digital divide is about access to high-quality fixed-broadband connectivity, and this divide will grow, not shrink.

- **Next-generation fiber networks will be the key to unlocking the benefits of gigabit broadband and enabling true gigabit societies:** The majority of passive optical networks (PONs) today are known as GPON or Gigabit PON. GPON systems offer various speed options ranging from 622Mbps symmetrical to up to 2.5Gbps down and 1.25Gbps up. As a point-to-multipoint network, this bandwidth is shared across all multiple optical network units (ONUs). As average traffic per connection continues to grow and subscriptions of gigabit and multi-gigabit services increase, it will be necessary to upgrade to XGS-PON technology to maintain QoE and allow true symmetrical gigabit connectivity.

- **New technologies, such as fiber-to-the-room (FTTR) and Wi-Fi 6/7, help deliver outstanding QoE in the home network:** The home network is a critical element of the end-to-end broadband network. Therefore, significant investments have been put into next-generation Wi-Fi networks and management systems, such as Wi-Fi 6/7 and interference reduction techniques (e.g., dynamic band and channel steering). Furthermore, innovations such as the FTTR technology can resolve any remaining performance issues by using a wired backbone around the home to shorten the distance between the Wi-Fi transceiver and receiver. The FTTR system uses a centralized coordination architecture to enable the coordination between the fiber links and the Wi-Fi access links to ensure the quality of service (QoS) improvement and true gigabit connectivity in every room of the house.

- **Regulatory policies are accelerating the expansion of gigabit societies:** Governments should ensure that telecommunications infrastructure can be deployed in the most efficient manner by requiring all new developments or real estate to be equipped with in-building mini ducts, fiber in-building access points, or other physical infrastructure. This is to accelerate deployment and reduce rollout costs. Moreover, regulators should adopt policies that demand high QoE for consumers, such as guaranteed speed provision.

- **Some of the best-practice regulatory policies include:** Implementing regulatory flexibility, including removing outdated or non-essential regulations.

- **Network deployment policies:**
  - Facilitating deployment through municipality approvals, using existing resources (e.g., government buildings, streetlights, ducts, and so on) and sharing infrastructure/facilities.
  - Improving access to telecoms facilities and physical infrastructure, improving procedures for rights of way, and accessing public infrastructure and broadband mapping.
- **Funding policies:**
  - Introducing flexibility in partnership arrangements, such as allowing agreements between players/co-financing/collaborative models/public-private partnerships/innovative partnerships.
  - Providing financial support through investment support, incentives, and subsidies (e.g., universal service funds (USFs).
- **Universal availability and QoS policies:**
  - Setting coverage/minimum speed targets through a national broadband plan or universal service obligation (USO).
  - Introducing requirements for consistent, guaranteed provision of gigabit speeds for consumers on gigabit plans.
  - Supporting innovation, research, and development to improve connectivity, its use, and its applications.

In addition to the case studies outlined in this report, further good policy practices can be found in the World Broadband Association's *WBBA Broadband Investment Guidebook 2024* report.

DRIVERS OF A GIGABIT ALL-FIBER NETWORK

THE BENEFITS OF GIGABIT BROADBAND SERVICES

Although complex to fully quantify, the importance of broadband connectivity in socioeconomic development is undeniable. The global broadband subscription market alone was valued at $330bn in 2023, rising to just under $500bn in 2029. Broadband networks also underpin a wider information and communications technology (ICT) industry that drives economic growth, creates jobs, and spurs greater business and technology innovation. Typically, the total value added of the ICT sector accounts for between 2 and 7% of a country's overall GDP, and, according to the World Bank, the global ICT sector was responsible for just over 2% of all employment in 2022, up from approximately 1.5% in 2010.

Additionally, broadband networks support the digitization of a vast range of other industries, including manufacturing, health institutions, and educational facilities, leading to greater efficiency and business success. Based on analysis from the World Bank, when fast internet becomes available, employment per firm increases by up to 22%, and exports nearly quadruple.

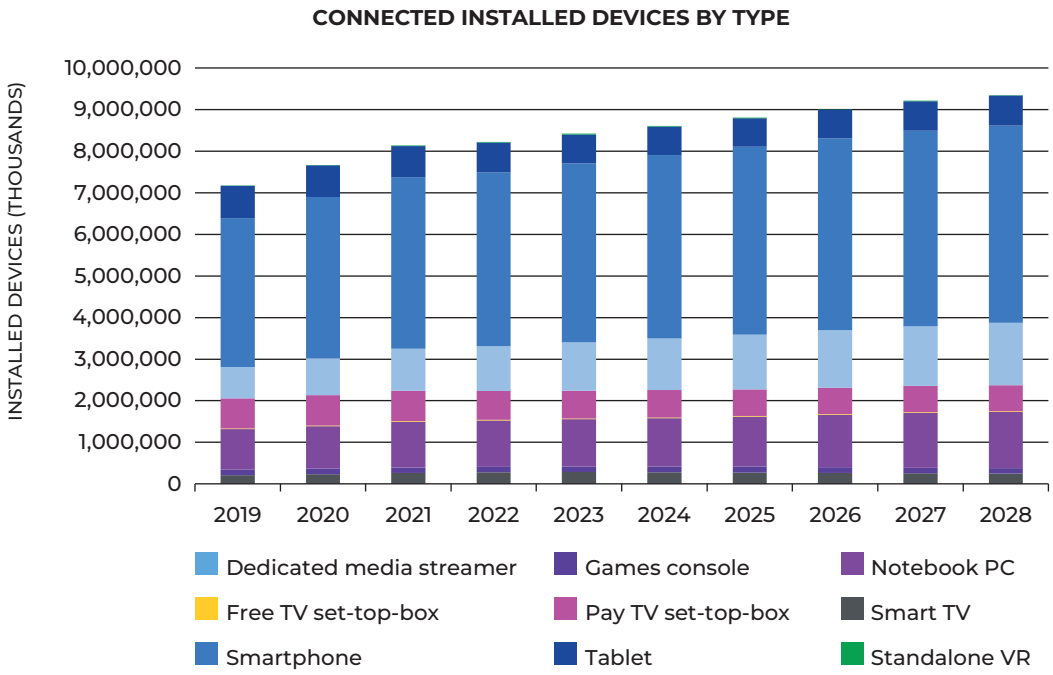
As well as enabling greater economic growth, the social benefits of fast internet should also not be forgotten. Education is just one example. In education, high-speed internet access can enable teachers and students to access more stimulating and up-to-date educational material. It also enables greater communication between classmates and between students and teachers when not physically located in the same place. This allows educational facilities to keep running during school shutdowns (e.g., during the COVID-19 pandemic) and to facilitate remote learning for students unable to physically attend school for any reason.

Other social benefits include remote working, remote health services, and providing banking to the unbanked through online banking and payment systems. Although difficult to fully quantify, the benefits that broadband brings in these areas are equally, if not more, important than those that can be monetizable directly.

THE NEED FOR HIGHER-SPEED SERVICES

Faster and more widely accessible broadband is accelerating digitalization and spurring unprecedented data growth. By the end of 2023, there were 6 billion connected people and 8.4 billion installed connected devices, increasing to over 9.3 billion in 2028. Some 5 billion of these connected devices will be smartphone devices, but devices like smart TVs will have also increased by 30% to just over 1.5 billion, making them the second most popular connected device on a global basis. By 2028, there will be 1.4 billion and 718 million connected notebook PCs and tablets, respectively (**Figure 1**).

FIGURE 1: BY 2028, THERE WILL BE OVER 9 BILLION CONNECTED DEVICES

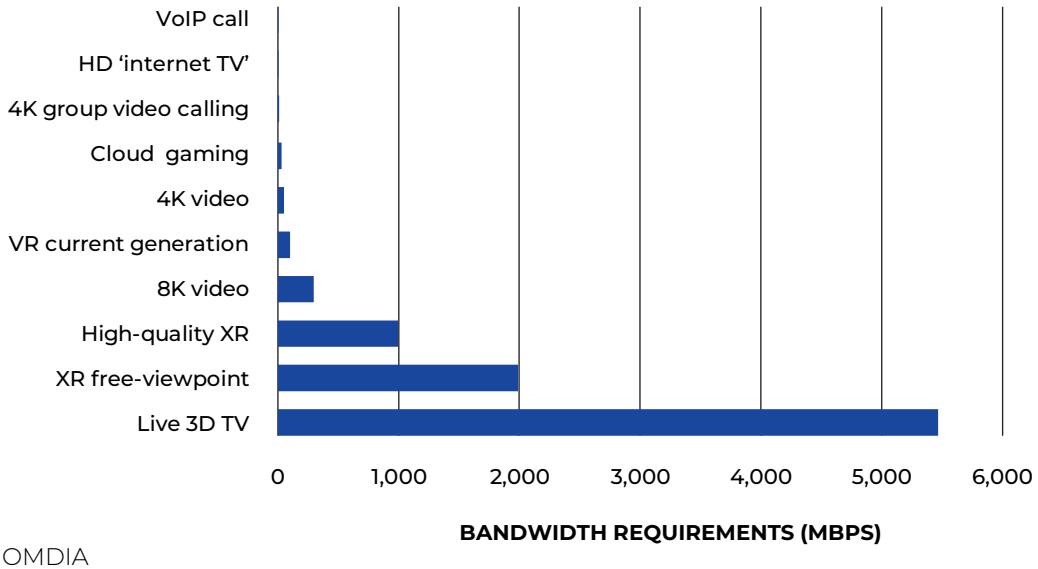


SOURCE: OMDIA

The increasing availability of connected devices, along with high-quality internet applications and media, is driving increased internet usage. For example, YouTube now has approximately 2.5 billion monthly active users and streams and approximately 1 billion hours of video content daily. TikTok, now the biggest social media channel, has just under 2 billion monthly active users who spend an average of 95 minutes per day and accumulate over 1 billion video views.

Of course, it is not just the sheer growth in applications but also that they are becoming increasingly bandwidth-hungry. Using compression techniques, today's video streaming services can offer HD videos using less than 5Mbps. However, high-quality 4K video streams can require speeds of up to 50 to 60Mbps, and 8K video streams up to 300Mbps (**Figure 2**).

FIGURE 2: ADVANCED VIDEO AND XR APPLICATIONS WILL HAVE HIGH BANDWIDTH REQUIREMENTS

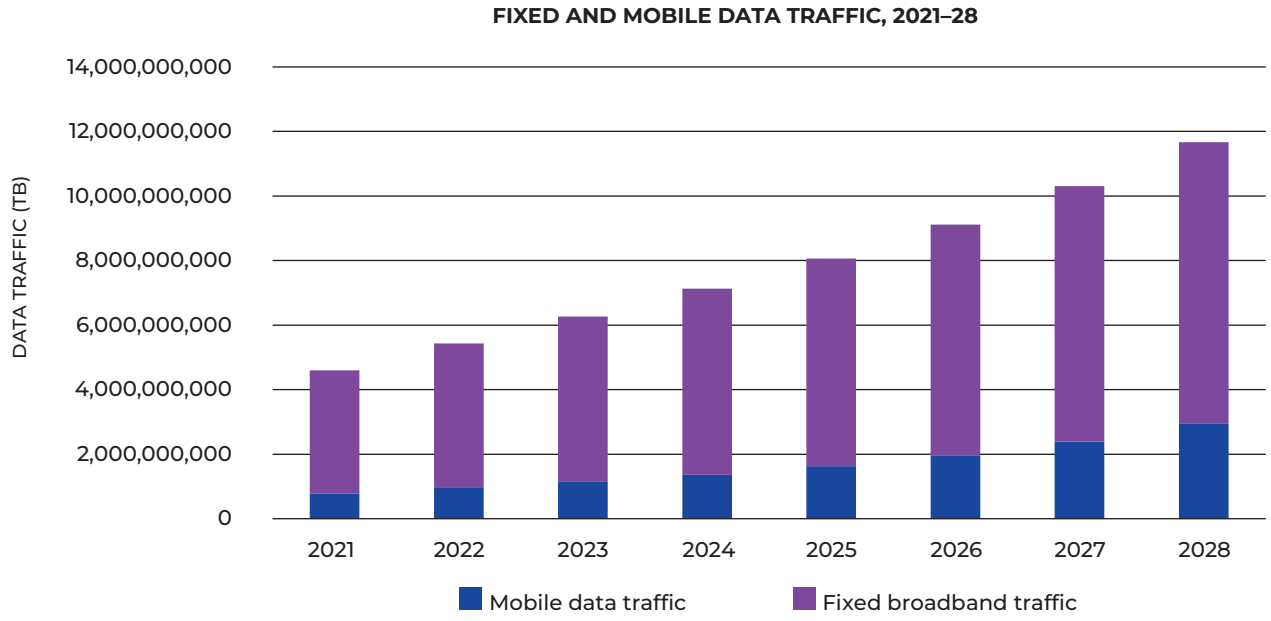


SOURCE: OMDIA

XR technologies (see the **Metaverse and the future of the Internet** section) will see a further step change in terms of network demand. Advanced applications could require speeds of 1 to 2Gbps as well as a maximum and consistent latency of less than 5ms. Today, augmented reality (AR) glasses and mixed reality (MR) headsets are almost entirely used for enterprise applications. However, consumer virtual reality (VR) headsets are becoming more common, largely driven by increased investment from organizations like Meta (Facebook). Consumer-grade AR glasses will also go mainstream from 2025 onward.

All of this adds up to exponential growth in data and an increasing reliance on high-speed networks. As shown in **Figure 3**, mobile data traffic will reach 2.9 zettabytes and fixed broadband traffic 8.7 zettabytes in 2028, representing an increase of 151% and 51% from 2023, respectively. To cope with such levels of increase, service providers worldwide have been investing in fiber networks. By 2028, the global number of fiber broadband connections will reach 1.5 billion.

FIGURE 3: FIXED BROADBAND TRAFFIC WILL GROW BY OVER 50%



SOURCE: OMDIA

RESIDENTIAL AND BUSINESS DRIVERS OF GIGABIT BROADBAND

CONSUMER BROADBAND DEMANDS WILL GROW EXPONENTIALLY

Networks are quickly expanding from connecting individuals and homes to connecting things, including everyday objects (inside and outside our homes) and items that we wear and even integrate with our bodies. By 2030, there will be 13.7 million new consumer devices connected daily, with a total of over 9 billion consumer mobile connections and 33 billion consumer Internet of Things (IoT) devices. Most of these devices will rely, at least part of the time, on home broadband connectivity.

This level of connectivity will create a world where digital information and content are ever-present and instantly accessible. Additionally, the way we experience the internet is changing. We are moving from largely 2D experiences to ones in which digital and physical worlds merge using AR or to fully immersive 3D through a mix of AR and VR (also known as MR).

INDUSTRY TECHNOLOGICAL DRIVERS FOR GIGABIT BROADBAND

Industrial digitization is happening at a great pace. The drivers for high-speed, high-quality broadband networks are increasing across various industries. The following section is a summary of the drivers from different industry verticals.

Campus/commercial center digitalization

The aim of the campus network is to achieve an all-in-one network for office work, security, and production with a simplified passive optical LAN (POL) network architecture, accelerating the wide application of cloud services and improving the office efficiency of enterprises. University campuses can form gigabit clusters for high-speed connectivity across premises (e.g., the University of Cambridge in the UK). Gigabit districts and regions are emerging in various locations globally, ranging in coverage from certain business districts and urban regeneration zones to entire cities, metropolitan areas, and wider regions (e.g., Singapore, Seoul, and Kansas City).

E-government

E-government technology and tools enable a more efficient way for governments and businesses to function and achieve increased transparency and greater participation by citizens in political life. The use of ICT within government bodies is not new. However, e-government goes beyond simple technology adoption. It enables a rethinking of processes and how bodies are organized and behave, with the aim of dramatically increasing the efficiency of public service delivery. This can save money for both governments and businesses.

The potential cost savings from e-government are significant. For instance, electronic invoicing saves taxpayers €150m ($164m) a year and businesses €50m ($55m) a year in Denmark.

Smart finance

Banking is shifting to a digital-first approach, including an omnichannel customer experience and AI-driven applications and processes. Generative AI (GenAI) will play a key role in helping customers and staff members make better decisions in real time. Because these processes are data-heavy and require ultra-low latency, gigabit connectivity is becoming a necessity.

Industry 4.0 and the future

Industry 4.0 and the emerging Industry 5.0, which is a more value-focused model with humans working alongside AI, are highly data-driven. They require fast and uninterrupted connectivity for operating automated production lines, autonomous vehicles, and robotics, as well as IoT-based analytics for operational efficiency, quality control, and worker safety. This requires actions to be taken within milliseconds. Compatibility with legacy systems is important, in addition to gigabit networks, to support new workloads. Systems also need to support the convergence of IT and operational technology (OT), meaning that data traffic needs to be routed as efficiently as possible instead of just with high bandwidth.

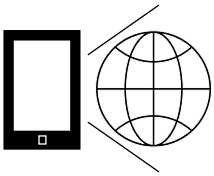
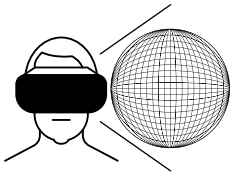
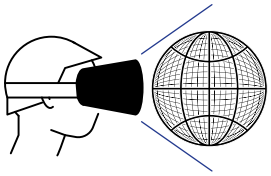
Smart mobility/hospital

Key healthcare use cases enabled by gigabit networks include remote patient monitoring, remote care, real-time professional consultations with specialists via HD-quality videoconferencing, and faster access to health records (e.g., digital X-rays). For example, Karolinska University Hospital in Sweden uses gigabit connectivity to provide a home-based treatment program for patients with Parkinsons with specific exercises monitored by neurologists via videoconferencing. Another example is Shandong Provincial Hospital in China, which has established a gigabit Ethernet campus network focusing on high security and reliability with the capacity to handle large data volumes for its medical imaging systems, further enabling robotic and video-assisted surgery.

METAVERSE AND THE FUTURE OF THE INTERNET

Although there is no firm definition, the term metaverse broadly refers to virtual worlds where physical and virtual spaces converge. XR is a key associated technology, which the 3GPP defines as "real and virtual combined environments and associated human-machine interactions generated by computer technology and wearables." XR is an umbrella term that spans three immersive concepts, which are AR, VR, and MR.

FIGURE 1: XR AND IT ASSOCIATED DEFINITIONS

EXTENDED REALITY (XR)		
AUGMENTED REALITY (AR)	**VIRTUAL REALITY (VR)**	**MIXED REALITY (MR)**
		
Virtual information and objects are overlaid in the real world, enhancing the experience with digital details, such as images, text, and animation. It can be accessed through AR glasses or via standard device screens, such as tablets and smartphones.	Users are fully immersed in a simulated digital environment. Requires specialist equipment, such as a VR headset or head-mounted display.	A more advanced form of AR, where digital and real-world objects coexist and can interact with one another in real-time.

SOURCE: OMDIA

Although AR applications, as mentioned in **Table 1**, can be accessed through AR glasses or via standard device screens, such as tablets and smartphones, glasses-free 3D screen devices are also available on the market. Headset devices are generally required to gain a fully immersive XR experience. While prices of headset devices have reduced in recent years (high-quality standalone VR devices like the Meta Quest 3 and Pico 4 are now sub-$500), hardware cost still represents a barrier to greater adoption, with some pro-models costing over $3,000. This is especially the case in the consumer market, where the continued launch of other gaming hardware, together with a lack of attractive VR content, reduces the priority of VR spending for consumers.

However, brands like Meta are attempting to attract more customers to their VR platforms by increasing the amount of appealing content and creating partnerships with brands that have established audiences. One example is its recent partnership with Roblox that was launched on Meta's Quest platform in September 2023, which as of April 2024, had 78 million daily active users. After a slight dip in post—COVID-19 pandemic sales, Omdia expects that consumer VR hardware sales revenue will gradually pick up after 2024 owing to the availability of more affordable devices and attractive content.

With clearer use cases, the demand for enterprise XR technology is already well underway. Based on Omdia's enterprise survey data, nine out of 10 enterprises can identify compelling uses for XR services, and almost a fifth are already investing in them. Based on Omdia's survey data, top priority use cases in the enterprise space include:

- **Safety:** Reducing human exposure to operational hazards (e.g., dangerous machinery and chemicals)
- **Efficiency:** Improving navigation, picking, and problem resolution, notably among field workers (e.g., diagnosis, fault fix, and maintenance)
- **Compliance:** Faster and more accurate inspection processes (e.g., for quality control, audit, proving chain of custody for goods)
- **Insight:** Applying data/knowledge from immersive interactions in business operations (e.g., enabling real-time decision-making)

For more information on the metaverse and its impact on broadband networks, see the World Broadband Association's *The Impact on Broadband Networks of Deploying Metaverse Applications at Scale* report.

AI AND ADVANCED DATA CENTER NETWORKS (DCNS)

Connected devices today tend to use local compute capabilities to perform most of their functions, relying on the cloud only partially of the time. For AI applications, however, this is flipped 180%. This is because although some devices will have strong AI capabilities, the AI computing will be offloaded to the cloud for the majority.

While text and chat-related AI applications do not really cause any strain on telco networks, video analytics will lead to significant amounts of traffic in areas where they are commonly used. Omdia believes the first wave of AI traffic to be driven by video-related AI applications will occur between 2024 and 2027.

Starting from 2028, Omdia expects consumer-led entertainment and collaboration, driven by new media and XR, to comprise the second wave of growth for AI-related traffic. These AI applications will have significant consequences for downstream and upstream traffic, as well as low latency requirements to ensure a good application experience.

Enterprises are increasingly adopting industrial variants of consumer technologies to help their businesses. The knowledge workers' 2030 toolkit includes MR for complex human visualization and response; AI and machine learning (ML) to assist or take over human decision-making; rich data collected from video collaboration and video streams with cognitive analytics; and the metaverse, which is a social space and virtual work environment. While each of these technologies existed a decade ago, they have grown significantly in the past ten years, empowering a new talent pool of enterprise knowledge workers.

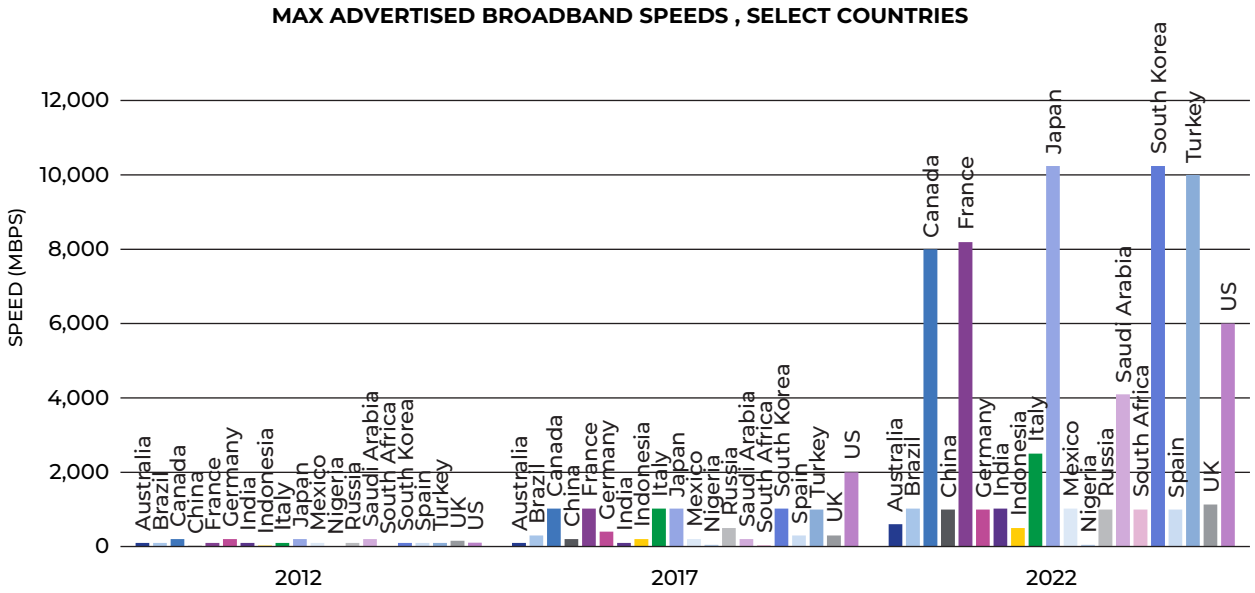
For application-driven enterprises, a DCN is an important channel for data transmission. It is also the key to promoting the upgrade of computing power service capabilities of data centers and fully releasing computing power. DCN connects user terminals and computing and storage devices in the data center to ensure efficient and secure data transmission on network links. DCNs are classified into data center internal (DCI) networks. DCI networks ensure efficient data transmission between computing and storage devices, ensuring efficient service processing. The network between data centers and between data centers and users ensures high-speed, agile, secure, and reliable data transmission on the communication network. WDM technology in the metro and core network helps support this trend for high-quality DCN and DCI connectivity. As of 2024, 45% of WDM units shipped are 400G or higher, and by 2029, 75% will be at 800G or higher.

TODAY'S GIGABIT MARKET

TRENDS IN GIGABIT BROADBAND AVAILABILITY

Broadband services with gigabit and multi-gigabit advertised download speeds are now commonplace in many markets around the world and across all regions. Omdia's *Mobile and Broadband Pricing Interactive Tracker* shows the change in advertised broadband speeds over the last five years (see **Figure 4**). In 2017, across the 20 countries analyzed in Omdia's *Mobile and Broadband Pricing Interactive Tracker*, the highest broadband speed on offer was 2Gbps in the US; 1Gbps services were available in six markets. By 2023, gigabit broadband services were available in 17 of the 20 countries, with multigigabit services offered in eight and 10Gbps services in five. However, in 2Q24, Omdia has also seen operators roll back their multigigabit offers as market and regulatory conditions proved such a move premature. This has been the case in Canada, where Bell began offering 8Gbps plans in 2023 but has since reevaluated its strategy and capped its current offering at 3Gbps.

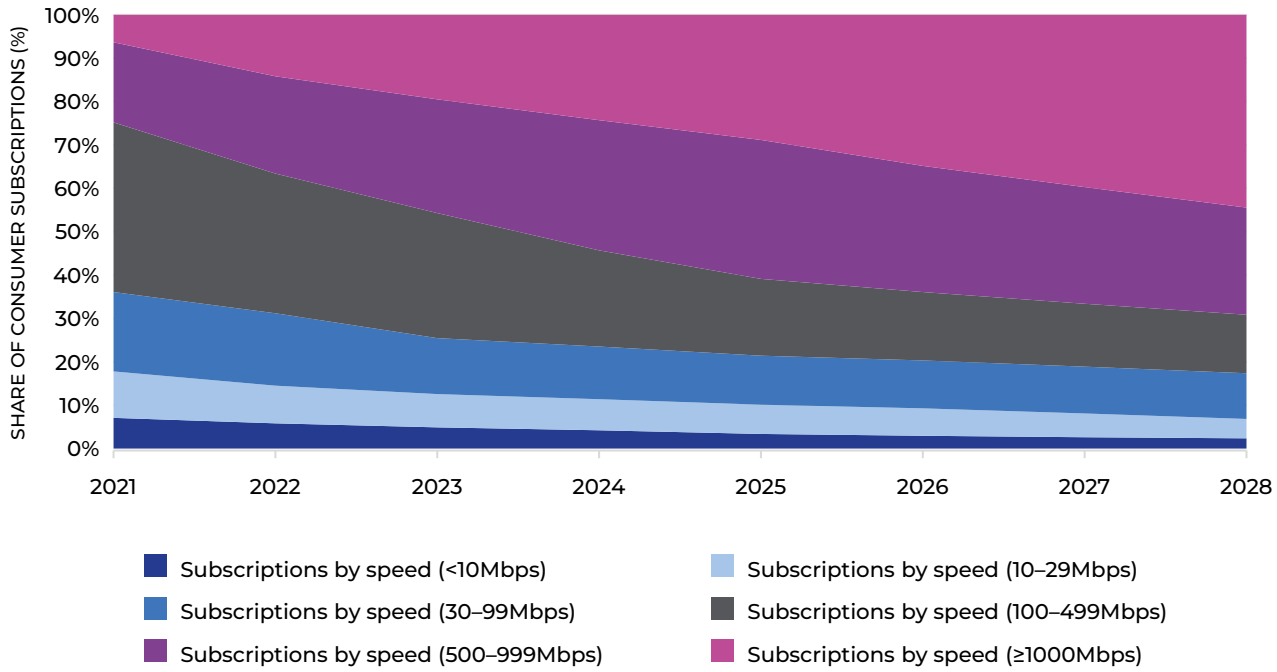
FIGURE 4: THE CASE FOR MULTIGIGABIT SERVICES MUST BE CAREFULLY EVALUATED



SOURCE: OMDIA, *MOBILE AND BROADBAND PRICING INTERACTIVE TRACKER*

Yet overall, we see a growing demand for gigabit services. Omdia forecasts the percentage of global broadband subscriptions to gigabit or multigigabit broadband services to increase from 19% in 2023 to 44% by 2028 (**Figure 5**).

FIGURE 5: SHARE OF GIGABIT BROADBAND SUBSCRIPTIONS IS ON THE RISE



SOURCE: OMDIA

Moreover, service providers are increasingly offering additional value-added services (VAS) along with their gigabit broadband plans (either bundled or as an add-on for a separate fee). These can include online video subscriptions, gaming subscriptions, passes, and others that can help service providers differentiate themselves in markets where gigabit connectivity has become commonplace. They can also help justify the need for a 1Gbps broadband plan for consumers. Multi- and 10Gbps services have also been recently marketed alongside VAS, such as cloud network-attached storage (NAS), which is a file storage device that allows multiple users to securely access and store large amounts of data over a network. VR and AR headsets are also being offered by a few service providers to boost the uptake of premium 10Gbps broadband plans. Soon, the use of VR/AR applications in education, healthcare or remote working will be a driver for 10Gbps broadband adoption.

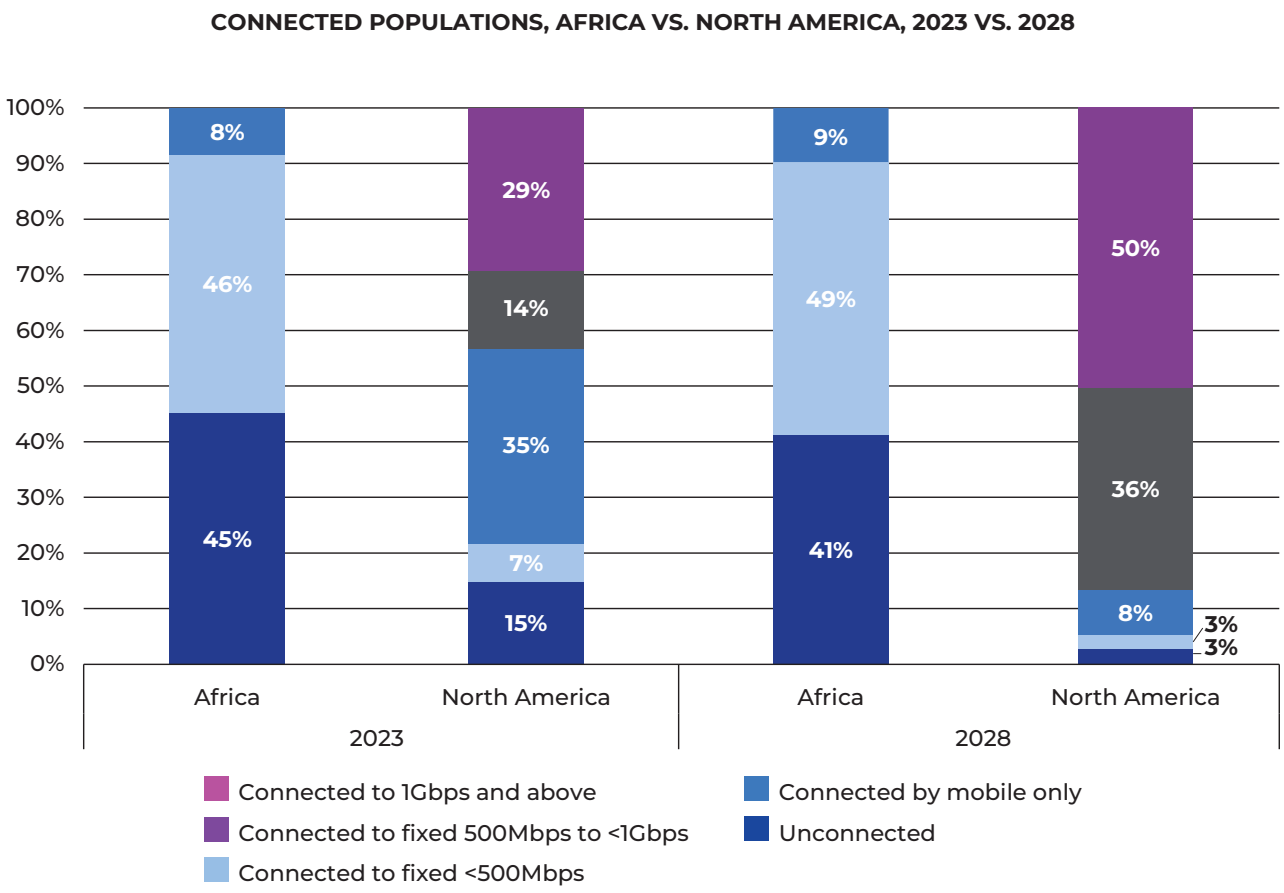
THE GROWING GIGABIT DIGITAL DIVIDE

Investments in all-fiber networks have been significant, but the distribution of advanced fiber broadband infrastructure and services remains far from equal.
As a society, we have been relatively successful, at least on a global level, in getting people connected. By 2028, approximately 80% of the world's population will be connected, 83% if you exclude those under four years of age. However, the picture is not an even one on a regional and country-by-country basis.

In 2028, 41% of the African population will remain unconnected, compared with only 3% in North America. However, this is only part of the picture. As shown in Figure 6, although 59% of people in the African markets will be connected in 2028, 49% will only be connected through their mobile phones, with only 10% connected to a fixed broadband network, and less than 1% will be connected to gigabit broadband. This compares with 95% of people in North America who will be connected via fixed broadband technology, and 50% will have gigabit broadband services.

Although the first digital divide was about basic connectivity, the second is about quality, and that requires access to high-speed, high-quality fixed-broadband connectivity. In summary, the digital divide will only grow, not shrink, especially when quality is considered.

FIGURE 6: IN REALITY, THE DIGITAL DIVIDE IS GROWING, NOT SHRINKING



SOURCE: OMDIA

ALL-FIBER-BROADBAND NETWORKS ARE ESSENTIAL FOR A GIGABIT EXPERIENCE

While there are other technologies that can deliver gigabit speeds, such as cable DOCSIS 3.1 and 4.0, as well as 5G fixed wireless access (FWA), their reach is limited, and there is a higher likelihood of network performance issues. Cable broadband accounts for only 12% of all global consumer broadband connections and will decline by 10% over the next five years.

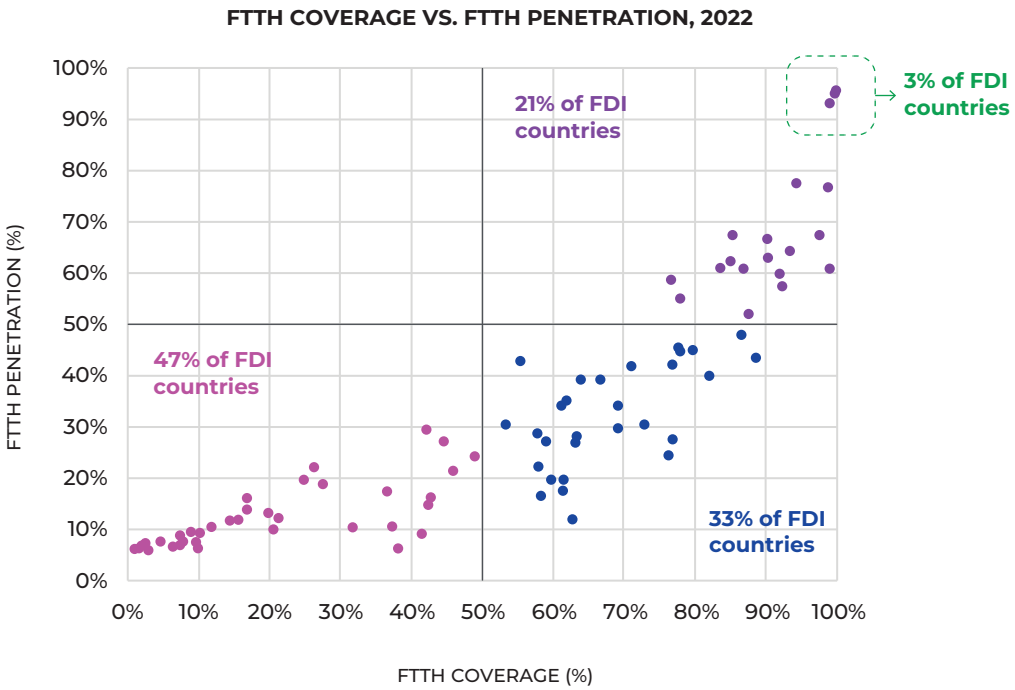
FWA is growing in popularity, largely due to the rollout of 5G networks, but will still only account for 6% of broadband connections by 2028. Certainly, FWA is an important component of the overall broadband mix, at least in the medium term, as it can enable high-speed broadband services to be deployed in more rural areas where FTTH is still too cost-prohibitive. However, even here, it is critical that those 5G-base stations are supported by optical fiber backhaul if they are to provide a good quality broadband experience. Meanwhile, the long-term efficiency and sustainability of fiber networks mean that they are essential for the evolution toward gigabit societies.

In this context, the use of low Earth orbit (LEO) satellite technology also needs to be considered as a vital alternative to providing broadband connectivity in hard-to-reach areas. However, the bandwidth achievable over LEO satellite connections is not likely to reach gigabit and higher speeds. LEO may, therefore, provide an alternative connection in areas where optical fibers are not developed. However, as long as service providers can provide high-speed optical fiber services in a timely manner, optical fibers will remain the first choice for users owing to their superior experience, stability, and consistency.

THE AVAILABILITY OF FIBER SERVICES MUST IMPROVE

Currently, less than half (42%) of countries in Omdia's FDI have FTTH coverage rates of 70% or more, with just three (Qatar, Singapore, and South Korea) having reached 100%, with a further four (China, Japan, Mauritius, and UAE) on 99%. The bottom third of countries in the Index have a coverage rate of less than 35%, and 15 of the 95 countries have less than 10%. If we are to evolve toward a gigabit society as a global population, it is essential to find a way to increase FTTH coverage in all countries.

FIGURE 7: ONLY 3% OF FDI COUNTRIES REACH UNIVERSAL FTTP COVERAGE AND PENETRATION



SOURCE: OMDIA

Adoption of FTTH services, even in markets where full fiber networks have been rolled out, is often hampered by high prices of fiber services when compared with legacy broadband technologies and new technologies, such as 5G FWA. Moreover, installation fees can also tend to be higher for FTTH compared with other technologies. For example, in the US, T-Mobile's 5G FWA plan is priced at $50 ($40 if bundled with a mobile plan), which is only 60% of the cost of AT&T's cheapest FTTH offer at $80. If FTTH operators are to bolster penetration rates in markets where infrastructure competition is strong, then they must play to fiber's strengths and offer high-speed services at competitive prices, as well as marketing other benefits, such as high service consistency and reliability.

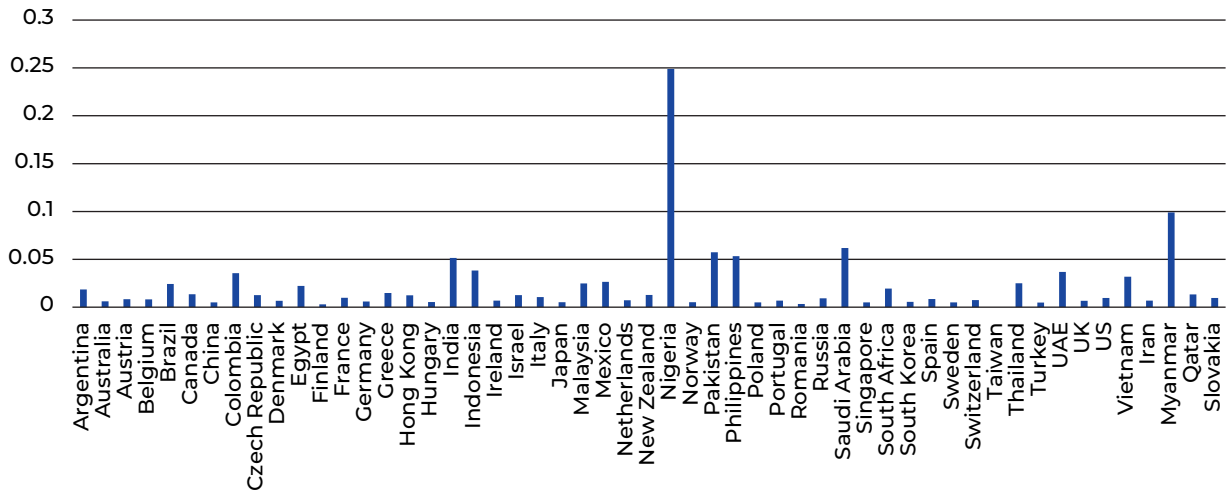
AFFORDABILITY IS ESSENTIAL TO DRIVE GREATER PENETRATION

One of the biggest barriers to wider adoption of broadband services, especially high-speed broadband, is affordability. This is especially true in developing countries, where average incomes tend to be lower, and inflation and income inequality (i.e., when large portions of a country's wealth are controlled by a small percentage of the population) tend to be higher.

Numerous studies have been conducted to show the positive impact of fixed broadband connectivity on the overall wealth of countries through increased education, occupational mobility, and expansion of the digital economy, leading to shrinking of income inequality. However, for fixed broadband connectivity to proliferate, it must be available and affordable for all. This is true not only for developing countries but also for developed countries where certain economically disadvantaged groups lack access to affordable broadband services, the necessary equipment, and digital skills.

Many countries have introduced social tariffs and subsidized broadband plans for people claiming government benefits or meeting other eligibility requirements. Under these policies, high-quality broadband connectivity is increasingly recognized as a basic right rather than a nice-to-have service.

FIGURE 8: DEVELOPING COUNTRIES ARE AT A HIGHER RISK OF BROADBAND AFFORDABILITY GAP



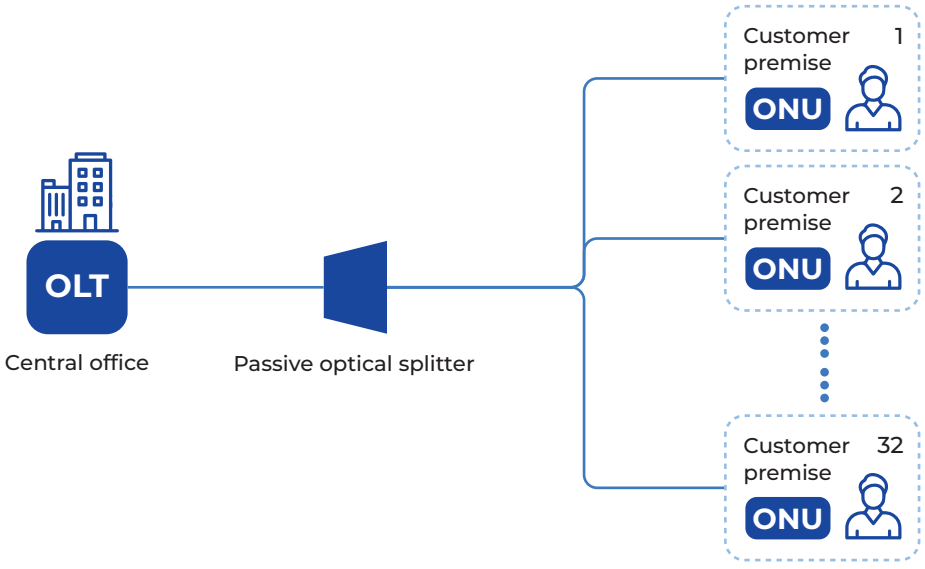
SOURCE: OMDIA

THE INFRASTRUCTURE FOR A TRUE GIGABIT SERVICE

10GPON NETWORKS WILL BE NEEDED TO ENSURE A GIGABIT EXPERIENCE

PONs are commonly used for fiber-to-the-building (FTTB) and FTTH deployments. A PON is a point-to-multipoint system that consists of an OLT situated in the central office and then multiple ONUs situated at the customers' premises (Figure 9). The typical split ratio for a PON is 1:32, but 64 can also be considered if the distance between the OLT and ONUs is not too great. The word passive simply then refers to the fact that there is no active (i.e., powered) electronic equipment between the OLT and ONU.

FIGURE 9: EXAMPLE OF PASSIVE OPTICAL NETWORK SCHEMATIC



SOURCE: OMDIA

The main benefits of a PON over a point-to-point network are its cost-effectiveness in deployment, reduced energy and space requirements in the central office, and simplified and more affordable maintenance owing to its absence of active equipment in the field. Most PON networks today are what are known as GPON, or Gigabit PON. GPON systems offer a variety of speed options ranging from 622Mbps symmetrical to a maximum of 2.5Gbps down and 1.25 Gbps up. Being a point-to-multipoint network, it does mean that this bandwidth is shared across all ONUs. However, all transmission networks use aggregation at some point, just sometimes further back in the network. Therefore, delivering gigabit services over a GPON network is still perfectly viable.

However, as fixed broadband traffic rates continue to grow, as discussed earlier in this report and illustrated in **Figure 3**, the traffic per connection should grow to several hundred gigabytes per month. There is an argument, therefore, that GPON networks, especially those with higher subscriber numbers and split ratios, will need upgrading to XGS-PON over the next few years. Even assuming modest overall traffic growth rates of 10% per year, traffic will still be 4x higher in 15 years' time. Annual traffic growth rates per connection could also be higher than 10%, and many operators are likely to see continued growth in connection numbers.

Internet traffic is also becoming increasingly bursty in nature as we move to more cloud-based applications, such as video-on-demand (VOD), cloud gaming, and VR. Traditionally, operators have based their upgrade logic on 15-minute traffic averages. However, this method can hide sharp spikes in traffic, misleading the operator into believing that PON ports have plenty of spare capacity. In reality, the spikes are causing application issues, such as jitter and video frame freezing. As the number of gigabit users is added to the PON port, the likelihood of poor application experience can increase rapidly, although there still looks to be spare capacity. Increasing the monitoring frequency to the millisecond rate can more accurately record the bursty nature of the traffic in the port, flagging up more accurately when a PON port should be upgraded, and helping maintain application experience.

Application experience aside, there is also a growing trend among regulatory authorities to ensure that operators can deliver the speeds they promise in their marketing in the real world. With such stringent regulatory requirements, it may, for example, be challenging to offer a symmetrical 1Gbps plan using GPON. In this way, regulatory requirements can act as a driver for upgrades to 10G-PON technologies.

Finally, 10G-PON networks also offer the benefit of allowing operators to move beyond gigabit services and launch multi-gigabit plans. Such plans could offer multiple benefits, for instance, as a differentiator versus alternative cable and FWA operators. 10G-PON technologies will also allow operators to keep delivering a superior experience for customers as their expectations for broadband performance and speeds continue to increase. Omdia's data shows that as of 2Q24, 41% of all OLT ports shipped were XGS-PON, 73% if XG-PON 1 OLT ports are also counted.

FTTR TECHNOLOGY ENSURES FULL GIGA COVERAGE

The home network is a critical element of the end-to-end broadband network as it forms the final connection between the telco's access network and the end user's device. As a result, telcos have made significant investments in both more advanced Wi-Fi hardware and Wi-Fi management systems in recent years. However, even with such investments, there can still be a significant gap today between the broadband speed reaching the broadband router and what is experienced on the end user's device. According to Ookla's *ISPs Need to Do More to Improve Wi-Fi Performance in the Home* article, Wi-Fi speeds typically only range from between 30–40% of Ethernet speeds as of 1Q23.

Part of the issue is that many, especially consumer, Wi-Fi routers are still operating previous generation Wi-Fi 4 and 5 technologies. Theoretically, Wi-Fi 5 is capable of a maximum speed of 6.9Gbps **(Table 2)**. However, based on Omdia's research, real-world speeds are much lower than this, typically between 300–800Mbps. Wi-Fi 4 real-world speeds are only typically between 100Mbps and 300Mbps. Therefore, it is critical that gigabit broadband service providers upgrade Wi-Fi hardware to Wi-Fi 6 and above, which should be able to achieve gigabit broadband speeds in most situations.

TABLE 2: SUMMARY OF WI-FI GENERATION CHARACTERISTICS

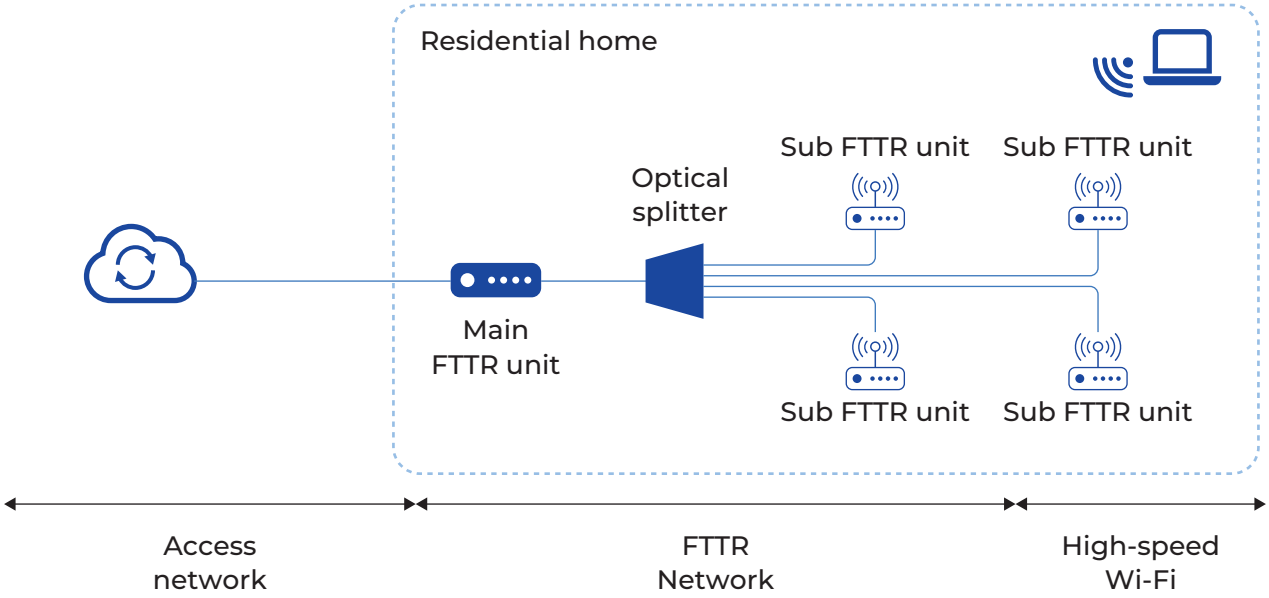
WI-FI GENERATION	MAXIMUM THEORETICAL SPEED	MODULATION TECHNIQUE	APPROXIMATE INDOOR RANGE	YEAR OF RELEASE
Wi-Fi 4 (802.11n)	72–600Mbps	MIMO-OFDM (64-QAM)	70m	2009
Wi-Fi 5 (802.11ac)	430Mbps–6.9Gbps	MU-MIMO-OFDM (256 QAM)	35m	2014
Wi-Fi 6 (802.11ax)	574Mbps–9.6Gbps	MU-MIMO OFDMA (1024-QAM)	30m	2019
Wi-Fi 6E (802.11ax)	574Mbps–9.6Gbps	As above Additional 6GHz band	30m	2021
Wi-Fi 7 (802.11be)	1.3–46Gbps	MU-MIMO OFDMA (4096-QAM)	30m	2024
Wi-Fi 8 (802.11bn)	100G	Multilink MU-MIMO + OFDMA (8192-QAM)	30m	2028

SOURCE: OMDIA

However, even with Wi-Fi 6/7, customer experience may still vary. Wi-Fi 6 and above technologies utilize higher frequency bands, which naturally have a higher attenuation and, therefore, have a shorter range. For some premium customers, it may be necessary to deploy FTTR technology that then guarantees gigabit broadband speeds in every corner of the home.

FTTR technology resolves any Wi-Fi issue by using a wired backbone around the home to shorten the distance between the Wi-Fi transceiver and receiver (**Figure 10**). Optical fiber is the optimum cabling technology for this internal backbone as it is the most future-proof, cost-efficient, sustainable, and consistent of all cabling options.

FIGURE 10: FTTR NETWORK SCHEMATIC



SOURCE: OMDIA

The FTTR system uses a centralized coordination architecture to enable the coordination between the fiber links and the Wi-Fi access links to ensure QoS improvement. This coordination architecture consists of the central main FTTR unit, which dynamically collects data on the network transmission demand, identifies the local network environment, and generates the required coordination strategy. The outcome is that the transient network operation and control, including air interface signaling, device handover, and real-time link visibility, can be achieved.

Replacing the in-home backhaul with a centralized FTTR architecture has been proven in both lab test results and service provider pilots to reduce the impact of the in-home backhaul network to provide a greater and more consistent experience across the whole of the home.

One big issue with FTTR technology is the cost of deployment, as, at least based on today's technology, professional installation is required. Regulators could help ease future investment strategies by setting legislation that would simplify in-building network deployments of any nature, especially in new buildings. Although not FTTR specific, the Telecommunications and Digital Government Regulatory Authority (TDRA) in the UAE, for example, issued an update of its Telecommunications Network Box Specification Manual for buildings, which sets out the technical specifications and standards adopted for the design of internal and external networks in new buildings and areas. The manual was designed to help reduce the sizes and costs of in-building telecom boxes by 30%, reduce room spaces, sizes and costs by 50%, as well as significantly reduce energy use and developer costs by at least 50%. Another example is in Saudi Arabia, where the Communications, Space & Technology Commission set out ICT construction guidelines for buildings, including a guideline that every residential room (except wet rooms, such as bathrooms and laundry rooms) or office room should be equipped with at least one network termination point (NTP) connected with a 2-core fiber cable.

ENSURING A GIGA-EXPERIENCE CASE STUDY: AT&T

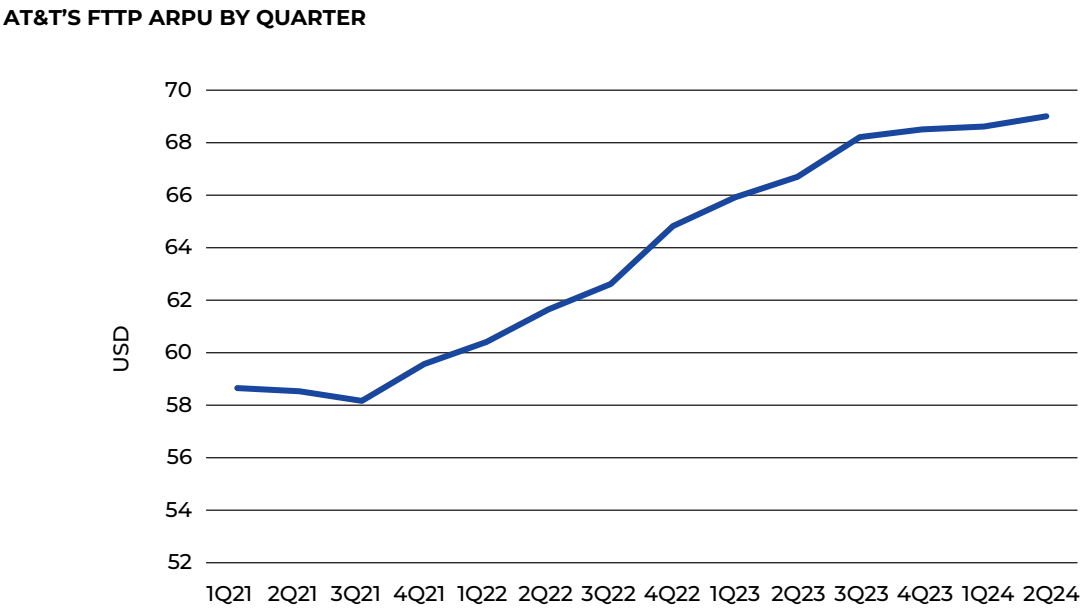
AT&T has placed a strong emphasis on deploying XGS-PON as part of its FTTP rollout. The operator announced the launch of 1Gbps speeds in 40 cities on its XGS-PON network early in 2020 and has continued to expand its fiber coverage with the technology in recent years.

AT&T's focus on XGS-PON across large parts of its fiber footprint has enabled it to promote the quality of its network. For example, in August 2024, the operator announced that AT&T Fiber had taken first place in Ookla's Fastest category for broadband speeds in the USA. In addition, as part of Ookla's analysis, AT&T Fiber had the highest score of all operators in the USA in terms of fixed network consistency, which importantly reflects the fact that AT&T had the most reliable internet speeds in the country. The fact that AT&T's fiber plans offer consistent and reliable speeds is also used by AT&T in its marketing.

Such results are significant for an operator like AT&T because they demonstrate how the XGS-PON rollout provides room for differentiation versus cable and FWA competitors. The performance of cable broadband and FWA is likely to be much more variable compared with XGS-PON-based FTTP. This is because for both cable broadband and FWA, there are many connections per node or cell site, and the overall network capacity will also be more constrained. The ability to stand out against competitors using alternative technologies can play a role in improving subscriber acquisition, and AT&T increased its FTTP subscriber base by 33% in the two years ending in 2Q24.

AT&T has also successfully managed to achieve ARPU growth with its XGS-PON-led strategy. The use of XGS-PON not only allows AT&T to deliver its symmetrical 1Gbps plan reliably but also provides opportunities to offer multi-gigabit speeds. The ARPU of AT&T's new FTTP customers stood at around $70 in 2Q24 (**Figure 11**). This is significantly more than AT&T's non-gigabit offer (300Mbps retail plan at $55 per month and its 500Mbps plan at $65 per month), suggesting that the average FTTH user is on a gigabit service or more.

FIGURE 11: AT&T MONTHLY FTTP ARPU, 1Q21–2Q24



SOURCE: AT&T, OMDIA

THE FDI 2024

INTRODUCING OMDIA'S FDI 2024

Owing to the importance of fiber investment and its impact on global development, Omdia has created a fiber benchmark known as the Fiber Development Index (FDI). Unlike other benchmarks that only track a single development metric, such as coverage or household penetration, the FDI aims to capture all elements of fiber network investment, such as overall fiber access coverage, FTTH penetration, FTTBusiness proportion of total business broadband, mobile fiber backhauls, and advanced fiber WDM core technology.

The FDI also aims to measure the outcome of this investment in terms of the country's overall broadband experience, measured in median download and upload speeds, as well as median network latency and jitter. A definition of all the metrics used in the index is outlined in **Table 3**.

TABLE 3: INDIVIDUAL METRICS USED IN THE FDI 2024

GROUP	METRIC	DEFINITION	IMPORTANCE
Coverage	FTTP coverage	The total number of premises covered by the optical fiber network divided by the number of households.	Represents the current potential of the fiber access network. A limited coverage means that only a small selection of households and businesses can gain access to the full benefits of a fiber network.
	WDM density	The total 100Gbps WDM port shipments (multi-100 gigabit ports are counted as multiple ports) over the past five years, divided by the number of households.	Fiber throughout the network supports the necessary QoE and reliability that broadband services need. Therefore, a more advanced core fiber network drives greater reliability and performance for broadband networks.
Penetration	FTTH penetration	The number of FTTH subscriptions divided by the total number of households.	FTTH household penetration represents the current take-up of FTTH services. The greater the percentage, the higher the number of households that can take advantage of fiber network characteristics.
	FTTBusiness proportion	The number of FTTBusiness subscriptions divided by the total number of business broadband subscriptions.	FTTBusiness penetration represents the current take-up of FTTBusiness services. The greater the take-up, the more businesses will be taking advantage of FTTBusiness services, enabling a more efficient and more dynamic enterprise.
	Mobile cell-site fiber penetration	The percentage of total mobile cell sites that are fiber-connected.	Mobile cell sites need high-speed and high-quality backhaul capabilities to optimize mobile-access performance. Therefore, high fiber-to-the-site (FTTSite) penetration will mean a more optimized mobile data network.

Experience*	Download speed	The median end-user download speed in Mbps.	Advanced fiber networks can deliver very high-speed broadband services. Although not the only important network metric, speed is essential for delivering bandwidth-hungry applications, such as 8K video, in a quality fashion.
	Upload speed	The median end-user uplink speed in Mbps.	Unlike most other access network technologies, fiber networks can also offer symmetrical services. Although historically deemed more suitable for business, symmetrical services are becoming increasingly important in the residential market.
	Latency	The median end-user latency in ms.	Latency is the response time between an input and an outcome. This is particularly important in applications such as online gaming but can affect most online activities.
	Jitter	The median end-user jitter in ms.	Low jitter is important for streaming services, such as video streaming, online gaming, and video conferencing.

Notes: * Broadband experience measures are based on Omdia's analysis of Ookla Speedtest data

SOURCE: OMDIA

FDI CLUSTERS

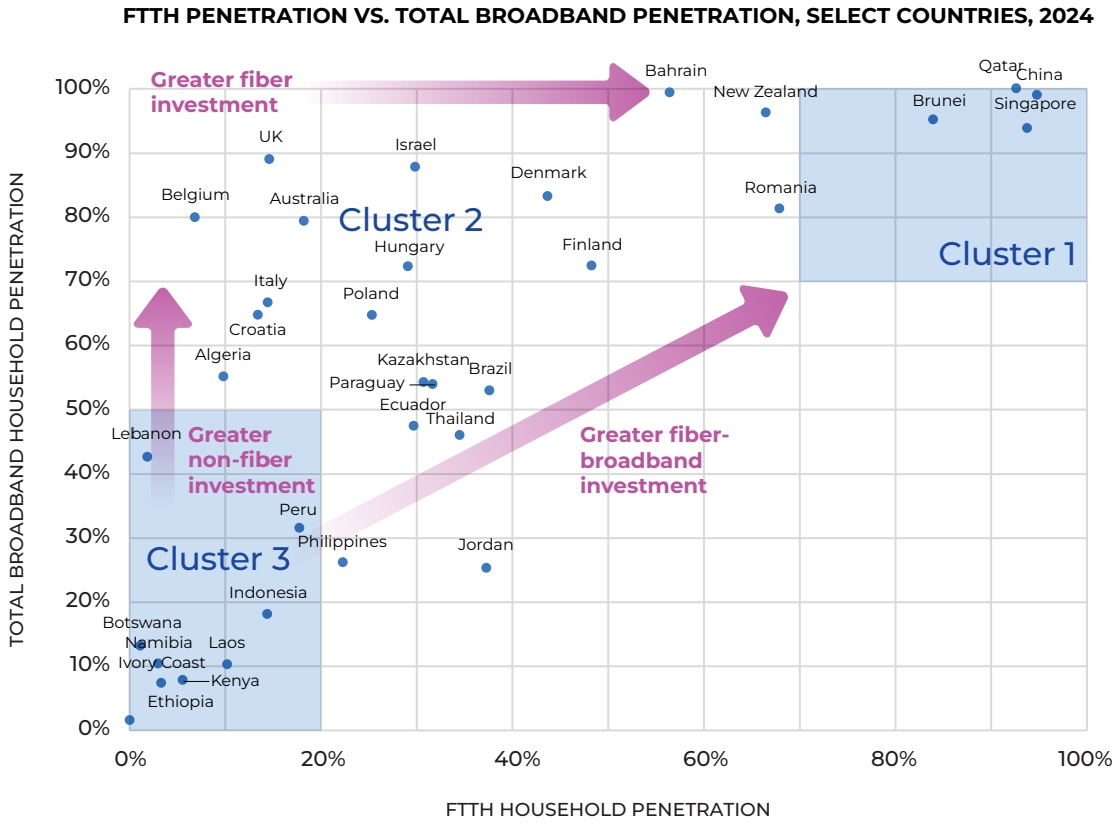
The FDI currently covers 93 countries and territories of varying sizes, demographic and geographical profiles, and levels of broadband development. These widely differing characteristics make it difficult to compare countries directly; to do so would, in Omdia's opinion, only lead to unfair and unhelpful conclusions and recommendations.

Therefore, to compare individual results, the FDI splits territories into three different country clusters:

- **Cluster 1**: Countries with highly developed fiber-based broadband networks
- **Cluster 2**: Developed broadband countries that are moving toward greater fiber broadband adoption
- **Cluster 3**: Emerging broadband countries with low levels of broadband household penetration

In terms of future development, countries or territories in Cluster 2 must move from left to right (**Figure 12**) by replacing legacy broadband technologies with more advanced fiber networks. However, Cluster 3 countries can move up by investing in alternative technologies first (fixed wireless technologies, for example) and then move toward greater fiber access over time. Alternatively, they can go in a diagonal direction where fiber investment goes together with broadband development.

FIGURE 12: FDI CLUSTERS ENABLE MORE FOCUSED RECOMMENDATIONS



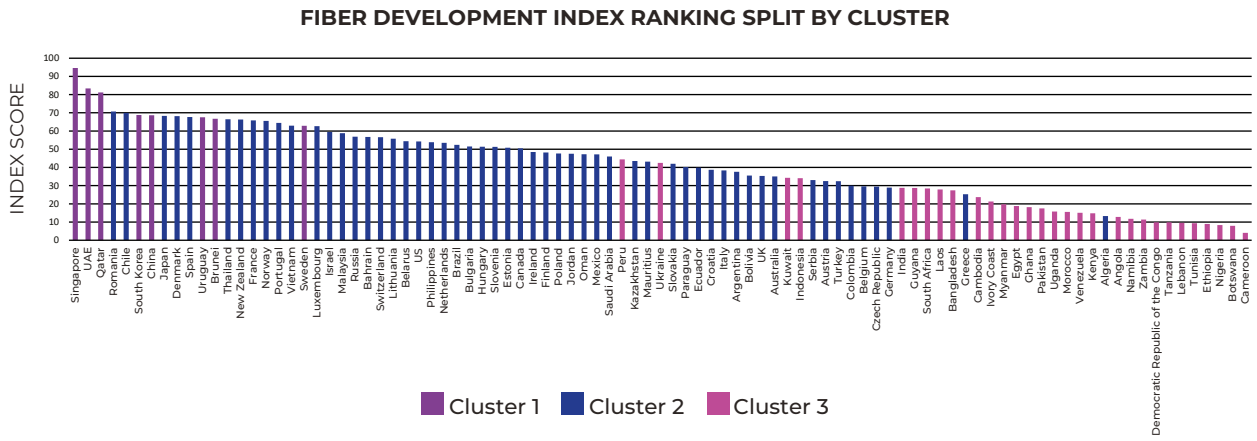
SOURCE: OMDIA

FDI 2024 RANKING RESULTS

Singapore continues to lead Omdia's FDI, with maximum scores in six out of the nine metric categories. China has dropped places for the second year in a row, dropping down to seventh position. This is because although the country scores highly in fiber coverage and penetration metrics, it scores lower than some of the other top countries for median download speed, upload speed, and latency. UAE and Qatar remain in the second and third positions, respectively.

Romania, Europe's leading fiber-developed territory, continues its development and moves up into fourth place, followed by Chile, Latin America's leading territory, which continues its own impressive climb up the index, jumping six places this year. South Korea, Japan, Denmark, and Spain make up the rest of the top ten. Further down the ranking, the US continues to be the leading North American territory, at number 28 place (down one place), with Mauritius being the leading African nation (number 46 place).

FIGURE 13: FDI 2024 RANKING



SOURCE: OMDIA

CLUSTER ANALYSIS

Cluster 1: Movers and shakers

Singapore remains the top Cluster 1 territory as it continues its path toward a gigabit society, followed by the UAE and Qatar. China has impressive results in terms of FTTP coverage and penetration, as well as download speed, but has yet to increase its results significantly around upload speed and latency. As a result, China has dropped further down the rankings to seventh place as other territories have improved in those areas.

FIGURE 14: CLUSTER 1 SCORES AND CHANGES IN THE FDI RANKING

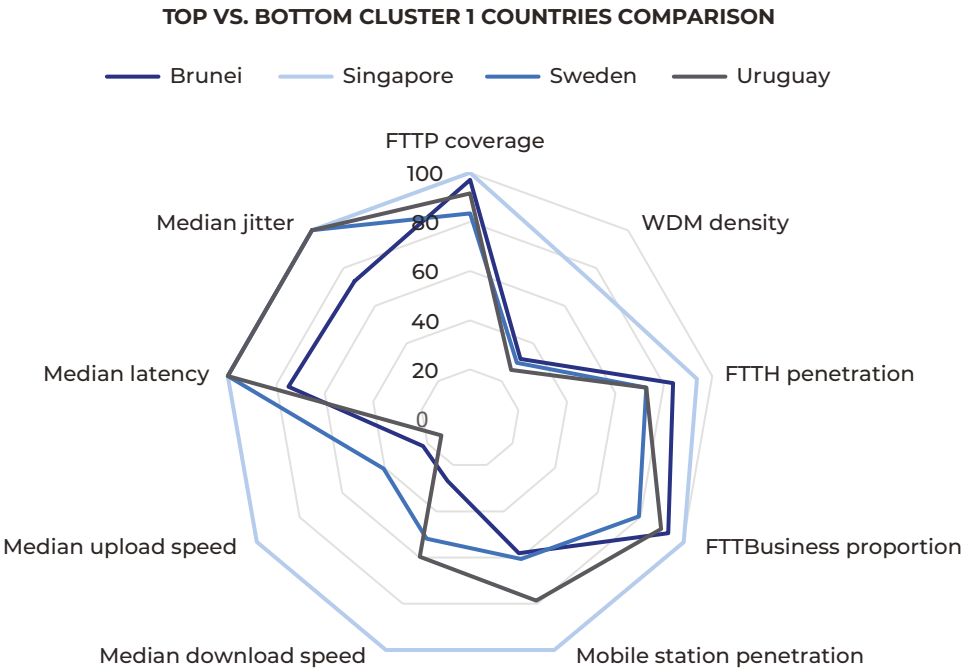
Cluster 1

Rank	Country/Territory	Region	Rank change 2023–24	2020 Index score	2021 Index score	2022 Index score	2023 Index score	2024 Index score
1	Singapore	Oceania Eastern & South-Eastern Asia	0	84	98	97	90	95
2	UAE	Middle East	0	68	83	83	80	83
3	Qatar	Middle East	0	69	83	84	76	81
6	South Korea	Oceania Eastern & South-Eastern Asia	-1	73	85	84	73	69
7	China	Oceania Eastern & South-Eastern Asia	-3	69	83	85	74	69
11	Uruguay	Latin America & the Caribbean	-1	N/A	N/A	N/A	66	68
12	Brunei	Oceania Eastern & South-Eastern Asia	2	43	60	65	63	67
19	Sweden	Western Europe	-2	58	72	68	63	63

SOURCE: OMDIA

Uruguay, Sweden, and Brunei are classed as Cluster 1 territories because they have high broadband and FTTP penetration levels. However, they are dropping down in the actual FDI ranking as they are increasingly falling behind on broadband experience scores relative to other territories, even those that have lower FTTP penetration. **Figure 15** shows how these territories rank in each metric area in comparison to Singapore, the FDI 2024 leader.

FIGURE 15: COUNTRIES WITH HIGH FIBER PENETRATION MUST CONTINUE TO EVOLVE INTO GIGABIT SOCIETIES



SOURCE: OMDIA

Cluster 2: Developed broadband markets

There is significant movement in the rankings in Cluster 2 as territories continue to evolve to fiber-based broadband networks. France has made some significant ground this year with significant improvement in broadband experience scores. Switzerland, Australia, Netherlands, and Jordan were also amongst the companies to climb significantly, largely due to increased FTTP penetration and broadband experience scores.

FIGURE 16: CLUSTER 2 SCORES AND CHANGES IN THE FDI RANKING

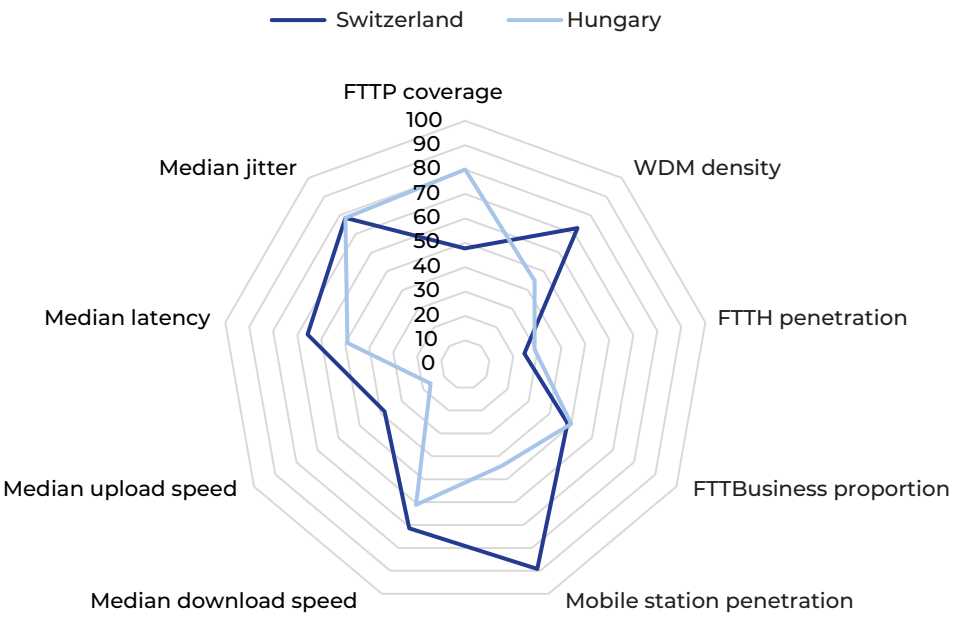
Cluster 2

Rank	Country/Territory	Region	Rank change 2023–24	2020 Index score	2021 Index score	2022 Index score	2023 Index score	2024 Index score
4	Romania	Eastern Europe	↑2	53	66	73	71	71
5	Chile	Latin America & the Caribbean	↑6	27	47	64	66	70
8	Japan	Oceania Eastern & South-Eastern Asia	↓-1	60	77	78	68	68
9	Denmark	Western Europe	↓-1	48	61	65	67	68
10	Spain	Western Europe	↓-1	52	66	68	67	68
13	Thailand	Oceania Eastern & South-Eastern Asia	↑3	55	65	66	63	66
14	New Zealand	Oceania Eastern & South-Eastern Asia	↓-2	50	65	71	65	66
15	France	Western Europe	↑5	32	45	55	59	66
16	Norway	Western Europe	↓-3	50	63	64	64	66
17	Portugal	Western Europe	↓-2	49	64	67	63	64
18	Vietnam	Oceania Eastern & South-Eastern Asia	↑1	N/A	N/A	N/A	59	63
20	Luxembourg	Western Europe	↓-2	47	62	62	60	63
21	Israel	Middle East	↑5	34	46	49	54	59
22	Malaysia	Oceania Eastern & South-Eastern Asia	↑2	40	49	55	55	59
23	Russia	Eastern Europe	↓-2	52	64	67	57	57
24	Bahrain	Middle East	↑1	40	58	59	54	57
25	Switzerland	Western Europe	↑9	40	47	48	49	57
26	Lithuania	Eastern Europe	↓-3	50	59	62	56	56
27	Belarus	Eastern Europe	↑2	44	55	60	53	54
28	US	North America	↓-1	N/A	N/A	N/A	53	54
29	Philippines	Oceania Eastern & South-Eastern Asia	↓-1	28	51	59	53	54
30	Netherlands	Western Europe	↑5	35	41	47	48	54
31	Brazil	Latin America & the Caribbean	↑1	26	39	47	49	52
32	Bulgaria	Eastern Europe	↓-1	45	59	60	51	51
33	Hungary	Eastern Europe	↓-11	49	62	62	57	51
34	Slovenia	Eastern Europe	↓-1	38	50	54	49	51
35	Estonia	Eastern Europe	↓-5	40	52	54	51	51
36	Canada	North America	→0	33	41	45	48	50
37	Ireland	Western Europe	↑1	27	38	46	44	48
38	Finland	Western Europe	↑2	33	41	42	43	48
39	Poland	Eastern Europe	→0	30	41	45	43	48
40	Jordan	Middle East	↑6	24	32	38	39	47
41	Oman	Middle East	↓-4	27	38	40	45	47
42	Mexico	Latin America & the Caribbean	↑3	22	34	40	40	47
43	Saudi Arabia	Middle East	↓-1	39	48	49	42	46
45	Kazakhstan	Central & Southern Asia	↓-2	32	43	44	42	43
46	Mauritius	Africa	↓-2	22	35	36	42	43
48	Slovakia	Eastern Europe	↓-1	29	38	42	39	42
49	Paraguay	Latin America & the Caribbean	↓-1	17	25	33	38	40
50	Ecuador	Latin America & the Caribbean	↑1	19	23	31	35	40
51	Croatia	Eastern Europe	↑1	20	27	30	34	39
52	Italy	Western Europe	↓-3	22	30	35	36	38
53	Argentina	Latin America & the Caribbean	↑1	16	23	28	33	38
54	Bolivia	Latin America & the Caribbean	↑3	25	33	35	32	36
55	UK	Western Europe	↑4	19	23	25	30	35
56	Australia	Oceania Eastern & South-Eastern Asia	↑6	27	31	32	29	35
59	Serbia	Eastern Europe	↓-3	19	22	27	32	33
60	Austria	Western Europe	↓-2	20	26	28	31	33
61	Turkey	Middle East	↓-1	23	31	33	30	32
62	Colombia	Latin America & the Caribbean	↑5	14	19	24	26	30
63	Belgium	Western Europe	↑1	21	23	23	28	30
64	Czech Republic	Eastern Europe	↓-3	27	33	31	30	29
65	Germany	Western Europe	↑4	20	24	24	26	29
71	Greece	Western Europe	→0	13	15	21	23	25
82	Algeria	Africa	↑3	4	6	6	9	13

SOURCE: OMDIA

On the flip side, countries such as Hungary, Estonia, Oman, Italy, Serbia, and the Czech Republic all moved significantly down the rankings, not because individual metrics have declined, but simply owing to lack of investment and their scores have not improved as fast as other countries and territories around them. For example, **Figure 17** shows that Switzerland and Hungary have similar scores when it comes to FTTH penetration and FTTBusiness proportion. However, the lack of investment in the core networks in Hungary means that its broadband experience metrics are much lower than in Switzerland, especially around the download and upload speed and latency.

FIGURE 17: BIGGEST CLIMBER VS. BIGGEST DECLINE IN CLUSTER 2



SOURCE: OMDIA

Cluster 3: Emerging broadband markets

Unfortunately, most Cluster 3 countries have seen their rankings go down in 2024 as more developed markets increase their fiber investment at a faster rate. Only Peru and Ukraine are now punching above their weight owing to early investment in at least FTTP coverage and then a gradual increase in penetration, leading to slight increases in broadband experience scores.

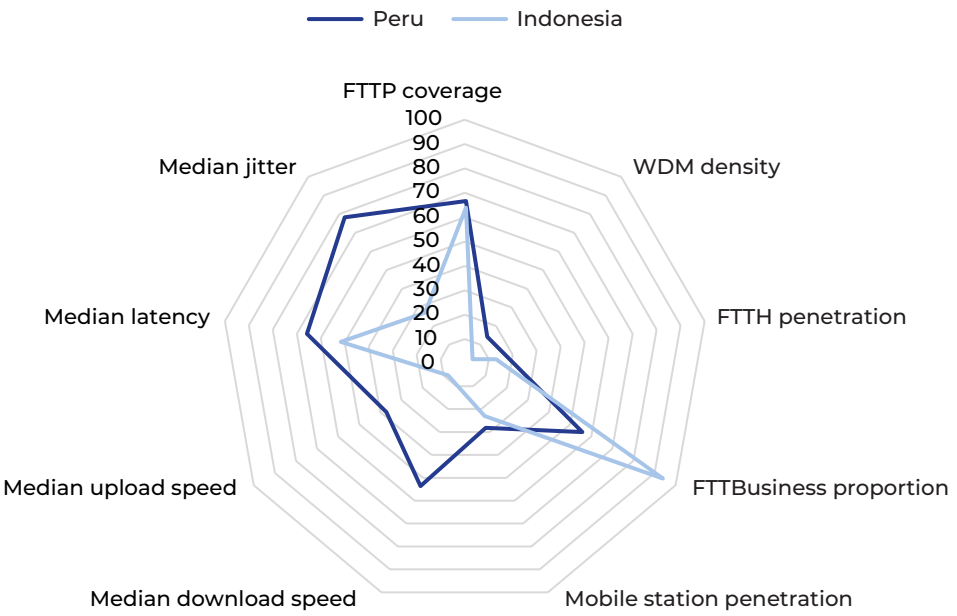
FIGURE 18: CLUSTER 3 SCORES AND CHANGES IN THE FDI RANKING

Cluster 3

Rank	Country/Territory	Region	Rank change 2023–24	2020 Index score	2021 Index score	2022 Index score	2023 Index score	2024 Index score
44	Peru	Latin America & the Caribbean	↑11	15	22	27	32	44
47	Ukraine	Eastern Europe	↓-6	38	47	48	42	42
57	Kuwait	Middle East	↓-4	22	31	32	34	34
58	Indonesia	Oceania Eastern & South-Eastern Asia	↓-8	29	39	42	35	34
66	India	Central & Southern Asia	↓-3	18	22	26	29	29
67	Guyana	Latin America & the Caribbean	↑1	1	3	7	26	29
68	South Africa	Africa	↓-3	20	23	27	28	28
69	Laos	Oceania Eastern & South-Eastern Asia	↓-3	12	14	16	28	28
70	Bangladesh	Central & Southern Asia	→0	18	23	24	25	27
72	Cambodia	Oceania Eastern & South-Eastern Asia	→0	17	19	19	20	24
73	Ivory Coast	Africa	→0	6	15	16	19	21
74	Myanmar	Oceania Eastern & South-Eastern Asia	→0	17	19	18	19	20
75	Egypt	Africa	↑3	7	10	12	14	19
76	Ghana	Africa	↓-1	11	13	15	16	18
77	Pakistan	Central & Southern Asia	↓-1	6	10	15	15	17
78	Uganda	Africa	↑1	11	12	15	14	16
79	Morocco	Africa	↑1	6	8	9	13	16
80	Venezuela	Latin America & the Caribbean	↑4	N/A	N/A	N/A	9	15
81	Kenya	Africa	↓-4	12	12	14	15	15
83	Angola	Africa	→0	2	2	3	10	13
84	Namibia	Africa	↓-3	7	9	11	11	12
85	Zambia	Africa	↓-3	N/A	N/A	N/A	11	11
86	Democratic Republic of th	Africa	↑7	2	2	2	3	10
87	Tanzania	Africa	→0	8	6	7	9	10
88	Lebanon	Middle East	↑3	5	7	7	7	10
89	Tunisia	Africa	↓-3	6	7	7	9	9
90	Ethiopia	Africa	↑2	3	2	4	6	9
91	Nigeria	Africa	↓-3	6	8	8	8	8
92	Botswana	Africa	↓-3	6	6	6	7	8
93	Cameroon	Africa	↓-3	6	4	4	7	4

SOURCE: OMDIA

FIGURE 19: BIGGEST CLIMBER VS. BIGGEST DECLINE IN CLUSTER 3



SOURCE: OMDIA

BEST PRACTICES FOR PROMOTING FIBER DEVELOPMENT AND ENABLING FASTER DEPLOYMENT

REGULATORY POLICIES TO FACILITATE GIGABIT BROADBAND SERVICES

Customers have been increasingly prioritizing the QoE with their broadband connections, such as speed, reliability, and content bundling. As the requirements for broadband services evolved to include supporting a range of applications, such as media streaming and video calling, full fiber (FTTH/FTTB) networks are becoming the preferred solution.

Operators face several challenges when deploying fiber that require intervention from regulators and governments. These challenges include adoption rates, the switch-off of the copper network, duplication of resources that reduces ROI, Rights-of-Way accessibility and approval, construction costs, lack of information and collaboration regarding construction, as well as access problems to physical infrastructure. There are also concerns about whether sufficient financial resources will be available to ensure full fiber coverage. A range of regulatory tools and public policies on the demand and supply side can be used to improve broadband affordability, adoption, coverage, and access.

Some regulatory policies that are seen as best practices in encouraging the deployment of very high-capacity networks include:

- Facilitating deployment through municipality approvals, using existing resources (government buildings, streetlights, ducts, and so on) and sharing infrastructure or facilities.
- Introducing flexibility in partnership arrangements, such as allowing agreements between players/co-financing/ collaborative models/public-private partnerships (PPPs)/innovative partnerships.
- Providing financial support through investment support, incentives, and subsidies (e.g., USFs).
- Implementing regulatory flexibility, including removing outdated or non-essential regulations.
- Improving access to telecoms facilities and physical infrastructure, enhancing procedures for rights of way and accessing public infrastructure, as well as broadband mapping.
- Setting coverage/minimum speed targets through a national broadband plan or USO.

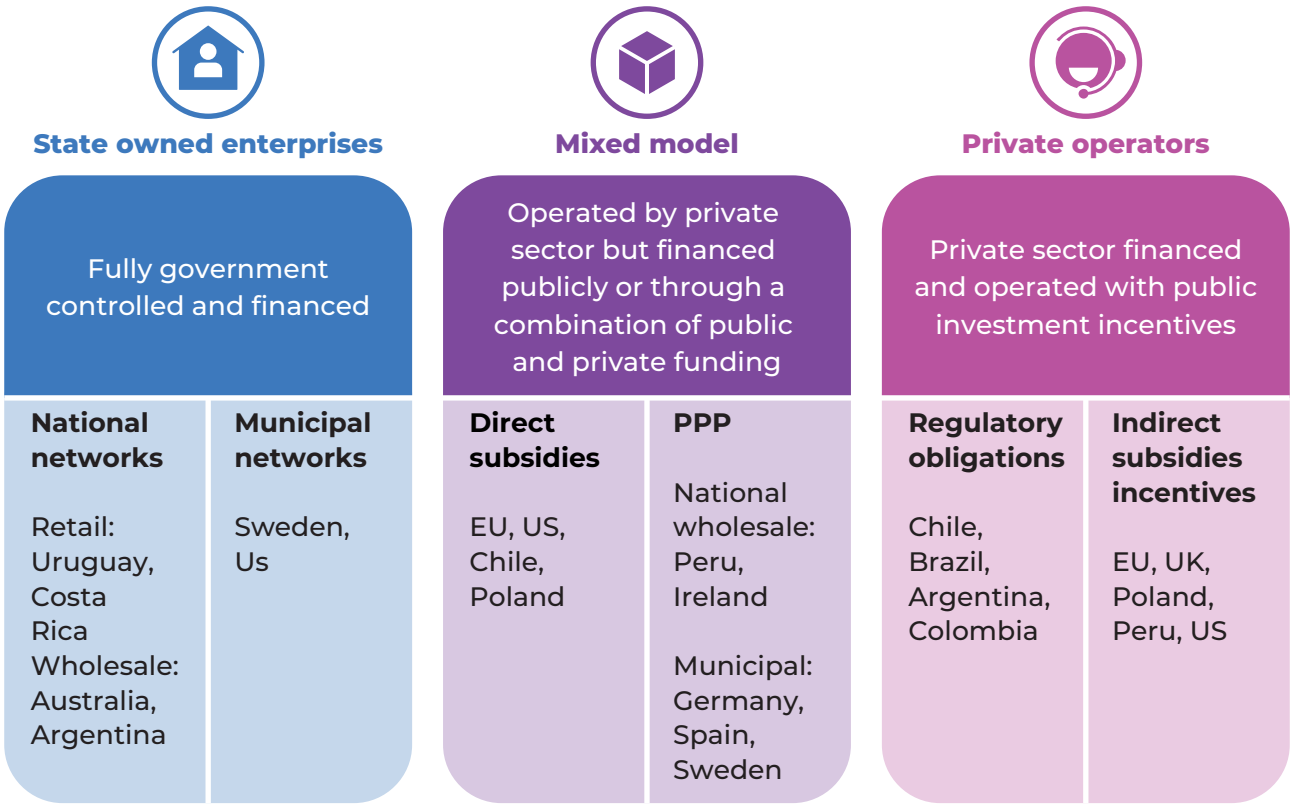
FINANCING TOOLS

Ubiquitous broadband access is an essential element in any country's digital agenda. However, high-speed network rollout is often only commercially viable in densely populated areas. Therefore, nationwide deployment will require some form of government funding to ensure that these areas are not left behind. This funding can take various forms, such as:

- Publicly built networks (e.g., Australia and Argentina)
- Publicly built municipal networks (e.g., Sweden and Germany)
- PPPs (e.g., Mexico and Peru)
- Direct or indirect subsidies (e.g., the EU)
- Physical resources access, such as ducts, poles, and land access (e.g., Mexico and Sweden)
- Regulatory coverage or service obligations (e.g., Chile and Brazil)

Regardless of the model, best practice dictates that any state intervention must limit the risk of crowding out or replacing private investments, altering commercial investment incentives, or distorting competition.

FIGURE 20: INVESTMENT MODELS



SOURCE: OMDIA

NATIONAL BROADBAND PLAN TARGETS AND USOS

	NATIONAL BROADBAND PLAN	USO
Description	Most countries around the world have outlined some form of national broadband plan to varying degrees of detail which builds the case for fiber deployment and encourages more investment by setting clear connectivity targets.	Many regulators look to implement a USO to ensure that basic telecoms services are available at an affordable price to all households and businesses.
Less economically developed nations	For the less economically developed nations, these plans should focus on improving broadband coverage before looking to expand high-speed networks such as fiber.	For many countries, functional internet access has been included in USOs for some time. This has usually been defined as basic dial-up speeds.
More economically developed nations	The more progressive countries should focus on developing national digital strategies, which ensure citizens can use connectivity in a transformative way to bring about innovation and growth. Governments that have seen the most success have been those that proactively prioritize developing their own unique, integrated, and comprehensive national digital strategy for both broadband infrastructure (e.g., setting coverage objectives) and a strategy to get citizens to use it effectively (e.g., addressing the challenges, such as jobs, skills, and trust).	As demand for greater data volumes increases and with improvements in average connection speeds, more mature nations have been introducing a broadband USO. However, these are usually fairly low, ranging from 1Mbps to a potential 30Mbps.
Evaluation	The national broadband targets of many countries have not been achieved, so the gaps are widening. Several advanced countries have already defined their national digital strategy (e.g., UK and Singapore). Others should be doing so in the coming years.	Smaller countries seem to be ahead on this issue generally, but larger countries are catching up. Most of the countries where broadband USOs have been introduced are geographically relatively small. That is hardly surprising since small countries are more easily covered in a ubiquitous way (e.g., Singapore). Rather than explicitly setting USOs to install fiber connections, many countries have, instead, been using the USFs as a source of financing to support one-off investment projects to deploy higher-capacity networks.

SOURCE: OMDIA

COPPER SWITCH-OFF RULES, REGULATING FIBER SERVICES, INFRASTRUCTURE SHARING, AND IN-BUILDING ACCESS

REGULATORY MEASURE	COPPER SWITCH-OFF RULES AND REGULATING FIBER SERVICES	INFRASTRUCTURE SHARING	IN-BUILDING ACCESS
Best practice	As legacy copper networks become harder to maintain, operators around the world are starting to consider phasing them out. To ensure the switch off process runs smoothly, this generally requires input from regulators to varying degrees. It is important to retire legacy copper networks so that incumbents do not encounter the unnecessary costs of running two parallel networks and free up investment for further fiber deployment. Best practices for countries heavily reliant on copper include: 1. Ensuring migration away from copper does not cause disruption for consumers. 2. Imposing minimum notice periods to minimize the effect on the market and ensure the transition is carried out under fair and competitive terms. 3. Removing regulation on the incumbent's copper products in areas where full fiber is built and transfer of regulation, including price protections, from copper to new fiber services during the transition. This would encourage customers to switch over to the new fiber network while also protecting them during the transition period and thereby building the case for more investment in underserved areas. 4. Continuing not to regulate full fiber services until the deployment of fiber is sufficiently accelerated.	Facilities sharing is increasingly becoming a priority for regulators as the desire for competition in NGN deployments grows. To encourage private investment in fiber: 1. Address barriers to entry and costs of laying fiber, 2. Simplify access to ducts and poles, 3. Maintain a stable, clear, and simple regulatory environment, 4. Put an effective dispute-handling process in place, 5. Outline maximum repair and installation timelines, 6. Encourage transparency (e.g., use online broadband network maps). Best practice often involves regulators adopting a combination of symmetric and asymmetric regulation. Symmetric regulation has been extended in some markets to include utilities and asset owners beyond the communications industry because there is increasing recognition of the need for not only coordination of investment within the sector, but with other infrastructure verticals. Meanwhile, asymmetric regulation recognizes the ownership of bottleneck assets by incumbent service providers. Duct and pole access regulation can also be limited to certain use cases (e.g., allowing access to ducts to support fiber-to-the-x (FTTx) deployments). The early adoption of a facilities-sharing policy contributes to improved fiber availability. In places with significant uptake of duct access, this has driven infrastructure-based competition in next-generation access (NGA) broadband. Requiring incumbents to grant duct and pole access to all alternative providers makes it quicker and easier for them to build their own full fiber networks. It cuts upfront costs associated with laying fiber by approximately 50% and acts as a considerable investment incentive. Access to other civil engineering and rights of way are also vital to rolling out fiber networks. Ensuring a streamlined approach to permit-granting procedures for civil works is essential, and the best way of achieving this is to adopt a single information point where operators can access information and apply for permits for civil works.	The final few meters of a wired broadband network can often be the most complex part, and that is because it often will cross privately owned land or be located in certain types of buildings such as an apartment block (often referred to as a Multi-Dwelling Unit or MDU). For wired-broadband operators, however, to gain access to the building or to cross private land, they must have a written agreement (known as a wayleave agreement) from the land or property owner, which can cause a significant bottleneck to deployment. If not regulated properly, in-building access agreements in the case of large MDUs can also lead to a form of service monopoly where residents of that MDU can only access a certain service provider as only that service provider has access to the building. To stimulate greater FTTH deployments therefore, it is vital that regulators simplify the wayleave agreement process and wholesale agreements are put in place that provide fair access to all operators looking to access that building. To accelerate future rollouts, property developers could help by pre-installing fiber infrastructure both in the buildings as well as the local area. Pre-installation of fiber optic cables reduces the cost and disruption caused by any future deployments. Governments should, therefore, explore schemes that guarantee, such investment as part of the planning process.

SOURCE: OMDIA

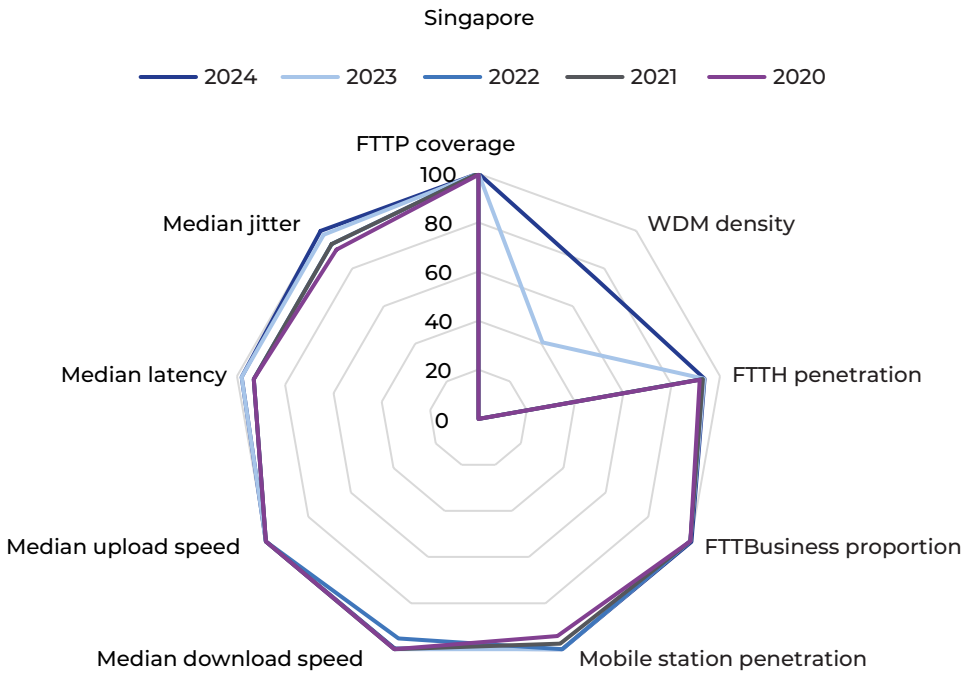
CASE STUDIES

Singapore: Long-time fiber leader powered by the National Broadband Network (NBN) is currently upgrading to XGS-PON

Singapore has been leading the FDI since its inception in 2020, reaching nearly a 100 score in all metrics except WDM density. The country has been a virtually 100% FTTH market since 2019 when other networks were decommissioned, and service providers moved to offer full fiber service through the wholesale National Broadband Network (NBN), which was first launched in 2007.

All leading broadband providers have started offering symmetrical 10Gbps broadband services using XGS-PON optical network routers (ONR). While 2Gbps plans currently account for most subscribers, adoption of 10Gbps plans is gaining pace. Moreover, in 1H24, Singtel and Starhub have launched 5Gbps services, filling the gap between 2Gbps and 10Gbps plans. The addition of 5Gbps plans makes giga-speed internet more affordable in Singapore, offering a cheaper alternative to the pricier 10Gbps offers. Singtel's 5Gbps plan is 32% cheaper than its 10Gbps plan, while StarHub's 5Gbps plan is 55% cheaper.

FIGURE 21: SINGAPORE, FDI METRIC RANKING



SOURCE: OMDIA

Singapore is also using the NBN's XGS-PON network to power its Smart City applications, such as traffic management.

Policy and regulation assessment

Key points:

- Singapore's national broadband plan, known as Intelligent Nation 2015 (iN2015), was adopted in 2006 with the key aim to provide 90% of the population with competitively priced broadband speeds of 1Gbps by 2015.
- As part of the iN2015, the government funded a single national fiber broadband wholesale network (state investment of approximately S$750m). All retail service providers rapidly migrated to FTTH, resulting in a very high take-up of FTTH services.
- In 2013, the regulator, the Infocomm Media Development Authority (IMDA), established a USO that required the NBN operator, NetLink, to fulfill all reasonable requests to install fiber termination points in homes, offices, and buildings.
- As of 2020, legacy copper and cable networks have been switched off, and all operators offer minimum 1Gbps speed plans.
- In February 2024, IMDA announced its intention to allocate a further S$100m ($75m) for the enhancement of the NBN to XGS-PON technology, which will allow nationwide provision of up to 10Gbps services and innovative offerings. The upgrade is scheduled to occur from mid-2024 to 2026.

Singapore has one of the most advanced telecoms markets in the world, a status achieved through well-targeted regulatory support over the years. A key development is the implementation of the Code of Practice for Competition in the Provision of Telecommunication and Media Services (TMCC) in 2022. The TMCC aims to promote fair and efficient competition and boost consumer protection. It covers dominance and anticompetitive conduct rules, resource-sharing rules, as well as telecoms interconnection rules, to name a few.

The country has already moved toward an all-fiber broadband market. As of 2020, Singtel completely switched off its copper network, and StarHub migrated all its cable TV and broadband subscribers to fiber by the end of 2019. The adoption of the TMCC has led to the withdrawal of legacy requirements for accessing wholesale copper products. This includes unbundled network elements, unbundled network service, and co-location facilities from the schedule of regulated services (e.g., Interconnection Related Services (IRS) and Mandated Wholesale Services (MWS). This ensures operators are not overburdened by unnecessary regulation and can focus their efforts on investing in and maintaining their fiber networks.

There are several other initiatives that have also supported the country in being a leading market. The country is an interesting case; while publicly retaining its policy of encouraging infrastructure-based competition, the government and regulator have moved in the opposite direction, having established a single national fiber broadband network. The country has embarked on a less traditional model of having a state-commissioned and funded (state investment of approximately S$750m) FTTH network through operational separation, which was one of the terms of the next-generation broadband network tendering processes. It focuses on open access to prevent any competition bottlenecks, and the regulator has issued passive and active remedies and pricing regulations. This approach has been successful because all retail service providers quickly transitioned to FTTH, resulting in a high adoption of passive products and a corresponding high retail uptake of FTTH services. In addition, the decision to define a roll-out schedule within the contract of the passive network operator (NetCo) has been critical in ensuring timely deployment.

The national broadband plan has played a crucial part in the country's progress, too. The government embarked on its iN2015 master plan back in 2006. While most countries were still focused on improving basic broadband coverage, one of the aims of the master plan in Singapore was to provide 90% of the population with competitively priced broadband speeds of 1Gbps. The NBN was to be operational in all households by February 2024, with over 85% of residential homes having access to at least 1Gbps services. Singapore is now pushing toward becoming the world's first Smart Nation under its Infocomm Media 2025 plan, which was introduced in 2015 and builds on the iN2015 plan. The Next Gen NBN initiative, which falls under the country's master plan, aims to provide ultra-high-speed internet access across mainland Singapore and its connected islands. It involves a mandatory three-layer structural separation, with a NetCo, an active network operator (OpCo), and retail service providers who can purchase bandwidth connectivity from the OpCo. NetLink Management Pte Ltd (as a trustee of the NetLink Trust) was the NetCo responsible for designing, building, and operating passive infrastructure (including ducts, manholes, fiber cables, and central offices). As per the NetLink NBN's Annual Report 2023, the company connected more than 1.5 million homes and 52,120 non-residential premises. A total of S$1bn ($743m) of government investment has been invested into building and operating the FTTH network.

In February 2024, the regulator, IMDA, announced its intention to allocate a further S$100m ($75m) for the enhancement of the NBN, ensuring its readiness for the future. The enhanced NBN will serve as the foundation for future applications and innovations, offering speeds up to 10 faster than current capabilities. It is anticipated that over half a million households will enroll, thus gaining access to faster speeds of up to 10Gbps by 2028. This investment will facilitate the upgrading of the back-end network infrastructure and the front-end user equipment, enabling the provision of up to 10Gbps services and innovative offerings. This upgrade aims to offer more competitive prices to both businesses and consumers alike. The NBN upgrade is scheduled to occur from mid-2024 to 2026. With the deployment of 5G mobile services and improved Wi-Fi networks, the 10G NBN will offer enhanced symmetric end-to-end 10Gbps connectivity.

Since January 1, 2013, as part of the IMDA's Next Gen NBN initiative, OpenNet has been subject to a USO that required it to fulfill all reasonable requests to install fiber termination points in homes, offices, and buildings. OpenNet's USO also required it to progressively roll out ultra-high speed fiber to new homes and buildings as they were built over time. Since October 2014, NetLink Trust has been responsible for the provision of those services that were previously offered by OpenNet. However, Singapore does not have a USF. Instead, the government co-funds the Next Generation Broadband Network.

Ensuring the regulatory framework in the country is robust and effectively reflects market conditions and requirements has been fundamental to supporting successful fiber rollout programs in Singapore. The IMDA regulatory framework includes extensive provisions for the sharing of passive infrastructure. Dominant licensees have a duty to offer wholesale services and access to ducts, monopoles, manholes, dark fiber, and so on. Originally, these provisions only applied to facilities-based operations (FBO) licensees. However, in the 2021 update, the regulator extended the resource-sharing provision to services-based operations (SBO) licensees. The infrastructure access requirements have boosted competition and passive access to the PON is particularly working well. However, it has also been critical that the regulator recognizes that passive-only remedies for FTTH are insufficient in enabling FTTH competition everywhere, so both active wholesale remedies and passive remedies have been implemented.

France: Rapid fiber development in recent years owing to increased AltNet competition and regulatory support

France is one of the rising countries in the FDI, reaching number 16 place in 2024 after climbing up four ranks since the 2023 edition of the Index and by 20 spots since 2020.
In the last several years, French operators have started expanding and upgrading their legacy networks to FTTH aggressively. Both fiber coverage and consumer fiber subscriptions increased dramatically, with the number of households passed by FTTH networks growing from 44% in 2019 to 86% in 2023. By the end of 2023, 61% of households subscribed to fiber broadband services.

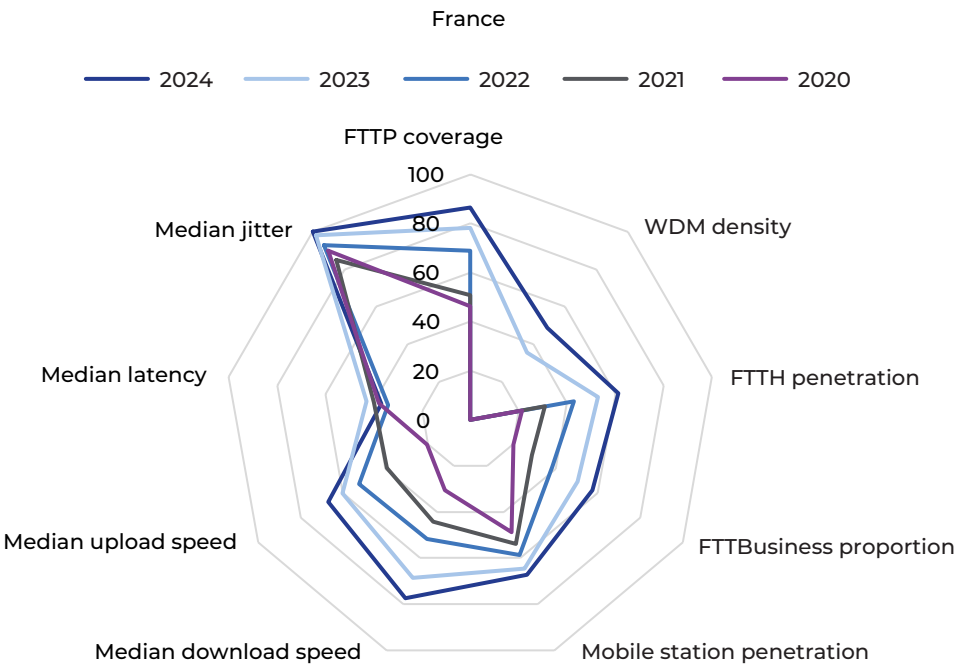
Also, the share of fiber broadband subscriptions among total broadband subscriptions is forecast to increase from 67% in 2023 to 91% by 2028. The incumbent Orange has started to decommission its copper network and plans a nationwide shutdown by 2030.

All four leading ISPs—Orange, Free, SFR, and Bouygues Telecom—offer multi-gigabit broadband plans. In 1H24, Free and SFR offered 8Gbps plans as the highest tier, Orange had 5Gbps highest plan, and Bouygues Telecom's highest speed plan was 2Mbps.

Orange has been deploying XGS-PON networks since 2020 with a single OLT providing both PON and P2P and a shared aggregation interface. Orange plans that 30% of the operator's domestic customers should be eligible for XGS-PON by the end of 2024 and is aiming for 100% by the end of 2026. For customers, the technology is enabled by the Orange Livebox 7, launched in October 2023 and compatible with XGS-PON and enabling up to 5 Gbps downstream and 1 Gbps upstream speeds for residential customers; and 8 Gbps downstream and 2 Gbps upstream for business customers.

Nevertheless, Orange has been slower to deploy XGS-PON in the market compared with its competitors. In February 2022, SFR was the first to launch an 8Gbps-capable service with its Box 8X, followed by Bouygues Telecom in July 2023, albeit only in Paris at the time. Meanwhile, Iliad-owned Free relies on 10G-EPON and advertises speeds of up to 8Gbps. This is because two French operators are already providing higher speeds using XGS-PON.

FIGURE 22: FRANCE, FDI METRIC RANKING



SOURCE: OMDIA

Policy and regulation assessment

Key points:

- In 2020, the French government set an ambitious target to achieve 100% fiber coverage by 2025 under its Very High Speed (Très Haut Débit: THD) national broadband program. It allocated a €240m ($264m) stimulus fund dedicated to extending the reach of fiber networks in rural areas.
- National telecoms regulator Regulatory Authority for Electronic Communications and Posts (Autorité de Régulation des Communications Électroniques et des Postes: ARCEP) has set a target of 100% copper withdrawal by 2030. In response, the incumbent, Orange, has committed to complete the nationwide FTTH network deployments by the end of 2025.
- ARCEP has adopted policies encouraging facilities sharing, such as nationwide duct access and symmetric FTTH wholesale access to the final segment.
- To further support the copper-to-fiber transition, ARCEP has set a very low cost for using civil engineering infrastructure for fiber access, with a roadmap for gradual cost increases at specific milestones.
- Non-incumbent operators have been actively building FTTH networks in France using duct access and dark fiber, as well as following a co-investment model, often with the incumbent.

There has been a significant rise in fiber deployments in France, largely due to sustained operator investments, government financial support, and regulatory focus on ensuring a smooth copper-to-fiber network transition. The regulator, ARCEP, has been actively involved in encouraging the migration from copper to fiber networks for ten years. The country has set a target of 100% copper withdrawal by 2030. In response, the incumbent, Orange, has committed to complete the nationwide FTTH network deployments by the end of 2025 and is planning to switch to the fiber network nationwide between 2023 and 2030. To support the copper switch-off transition, ARCEP has imposed fewer constraints on Orange regarding local loop unbundling (LLU) access charges during the latest market analysis for 2024–28, completed in October 2023. This allows the operator to charge higher prices, specifically in areas planned for copper switch-off, with the aim of encouraging service providers to migrate customers to the fiber network instead.

Encouraging facilities sharing is becoming a growing priority for regulators, and ARCEP is no exception. The regulator has focused on passive remedies, such as nationwide duct access, and has legislated symmetric FTTH wholesale access to the entire network and vertical access obligations across the country. As a result, France has seen a significant uptake of duct access that has helped to drive infrastructure-based competition in NGA broadband and has been one of the key reasons for good levels of fiber deployment. Non-incumbent operators have been actively building FTTH networks in France using duct access and dark fiber, as well as following a co-investment model, often with the incumbent. In October 2023, ARCEP concluded its seventh cycle of market analysis for the period 2024–28. The objective of the analysis is to further streamline fiber rollouts in the future and ensure efficient access to poles and underground ducts. The regulator has obligated Orange to continue to provide access to its civil engineering infrastructure of the local loop and to offer passive optical fiber access services (all ducts and poles for the installation of fiber cables).

ARCEP also adapted the obligations imposed on Orange, particularly regarding the use of infrastructure for last-mile connections, to reduce the turnaround time on rehabilitation work and, thereby, the waiting time for users wanting to be connected to the network. To further support the copper-to-fiber transition, the regulator has set a very low cost for using civil engineering infrastructure for fiber access, with a roadmap for gradual cost increases at specific milestones. Orange's civil engineering infrastructure is the main nationwide infrastructure and, in many cases, the only available infrastructure at the local level for deploying a new fiber-optic local loop. Therefore, it has been critical for ARCEP to ensure that competitors have access to this infrastructure to roll out their own networks.

The previous fixed market analysis of the fixed broadband wholesale markets 3a, 3b, and 4 for the period 2021–23 also included regulations related to the transition from copper to fiber networks and will have played a part in the fiber coverage levels we see today. The market analysis focused on regulating pro-investment to make fiber the new benchmark fixed infrastructure and promoting competition in the B2B segment by deploying fiber networks. The updates to the framework included:

- Asymmetric access obligation to be imposed on Orange to fix the competition imbalances observed in the telecoms market. The asymmetric access obligation applies to the existing infrastructure, such as copper local loop, poles, ducts, and other associated facilities. The regulator decided not to lift this asymmetric regulation too early until more users have been migrated.
- Symmetric obligation imposed on FTTH network operators to preserve fair competition in the new fiber market and encourage operators to expedite their migration plans.
- Determine the maximum wholesale prices that Orange can charge for accessing the copper local loop during 2021–23 to accommodate Orange's request to set a higher rental fee for the maintenance of copper infrastructure in areas where the operator has planned to replace legacy networks with fiber. This makes it less financially attractive to use copper-based services and encourages migration to fiber.

The national broadband plan has played an important role in the country's progress too. Back in February 2020, the government set an ambitious target to achieve 100% fiber coverage by 2025 under its THD national broadband program. Setting coverage targets is only one part of the story, though. For these targets to be achieved, particularly in rural areas, sufficient funding needs to be made available. While most deployments have been privately funded, FTTH roll-out in more rural areas has been fulfilled through public initiative networks. Therefore, the government opened a public consultation on a revised set of rules for those local authorities that still need to apply for public funds to bring FTTP connectivity to rural areas. It reopened the applications for public funds and has allocated €280m toward the application process. These funds are available in underserved areas where public initiative networks have been deemed necessary to complete the planned national roll-out of FTTP services. In September 2020, the government also announced a new stimulus package worth €240m ($264m), which has helped extend the reach of fiber networks in rural areas.

An essential aspect of France's deployment program has been to not only set targets or impose obligations but also to monitor progress and issue fines for non-compliance. In November 2023, ARCEP fined Orange €26m ($27.99m) for not meeting the fiber deployment obligations from a 2018 agreement, where Orange had committed to covering 2,978 municipalities and nearly 11.1 million premises by 2020. Orange planned to appeal, arguing that the fine was disproportionate considering the fiber footprint the operator had managed to achieve. The dispute concerns private initiative fiber deployment in the Call for Expression of Interest for Investment (Appel à Manifestation d'Intention d'Investissement: AMII) areas, which cover midsized towns in approximately 3,000 French municipalities. However, Orange has since pledged new commitments to replace the 2018 ones and now aims to achieve 100% FTTH coverage by 2025, equating to 1.12 million more premises and over 300,000 additional premises in high-density areas. In March 2024, ARCEP agreed to Orange's new fiber rollout targets for 2025.

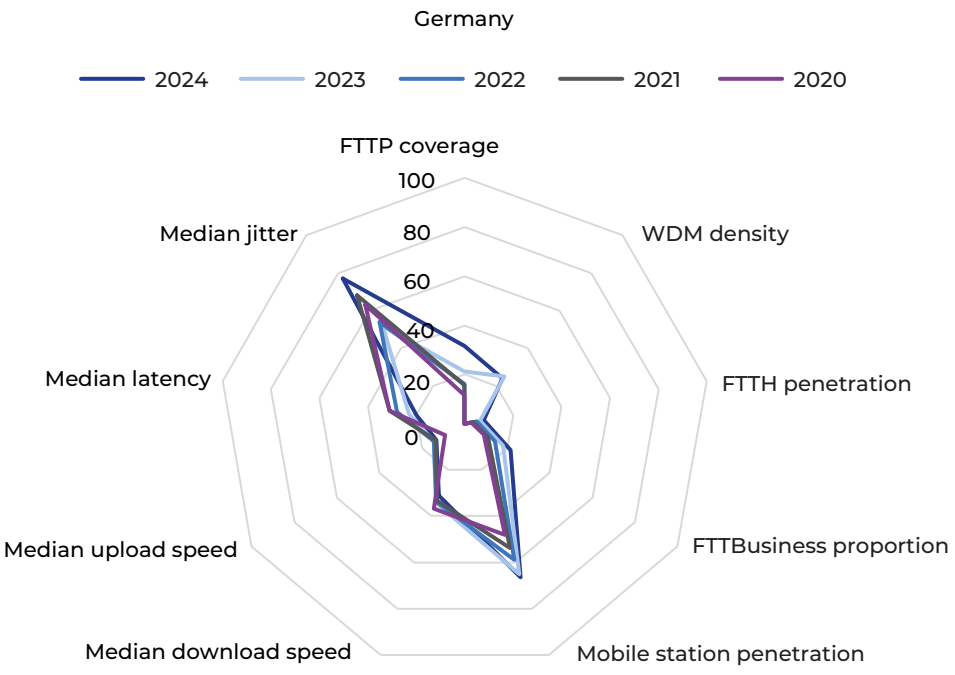
Germany: A FTTH laggard among European countries ramping up fiber investment
Germany has also seen some progress in its FDI ranking, albeit on a limited scale compared with France. The country ranked number 67 in the FDI 2024, climbing two spots from FDI 2023. However, in the previous years, Germany's standing in the Index had been declining as other countries invested more heavily in fiber rollouts, and QoE metrics were included in the Index.

While the German fixed broadband market is mature, with residential broadband penetration reaching 81% of households in 2023, most broadband connectivity is delivered via legacy DSL and cable networks. At the end of 2023, nearly two-thirds (64%) of broadband customers were still using DSL technology, while 22% used cable networks. Only 11% of total fixed broadband subscriptions were delivered over FTTH networks.

The two largest players, incumbent Deutsche Telekom and cable operator Vodafone, whose combined market share accounts for two-thirds (66%) of the fixed broadband market, have historically focused on upgrading their legacy copper and cable networks.

In recent years, FTTH has become a priority for German operators, regulators, and the government in the pursuit of gigabit goals. While Germany ranks among the European countries with the lowest fiber coverage to date, it plans to cover half of all households and businesses with FTTH/FTTB networks by 2025. Since 2021, operators ramped up their own investments, launched FTTH joint ventures with financial investors, entered partnerships with smaller players, and took up government-subsidized projects to drive fiber expansion.

FIGURE 23: GERMANY, FDI METRIC RANKING



SOURCE: OMDIA

Policy and regulation assessment

Key points:

- In 2022, a new national broadband plan, the Gigabit Strategy 2030, was adopted along with an amendment to the telecoms law to make voice and broadband access a legal right for all citizens. The Gigabit Strategy 2030 has the following aims:
  - Expand fiber network coverage to all households by 2030
  - Tripling the number of fiber-optic connections
- Extending the coverage of FTTH/FTTB networks to 50% of households and companies by 2025
- To close the significant urban-rural broadband divide in the country, the European Commission (EC) approved a €12bn ($12.9bn) scheme in 2020 to financially support the deployment of gigabit broadband networks in rural and underserved areas of Germany. Additionally, an annual funding of €3bn ($3.2m) was announced in 2023 through the Gigabit Funding 2.0 to further deploy fiber connections in white spot areas.
- The government and the regulator, Federal Network Agency (Bundesnetzagentur: BNetzA), established a monitoring body to address the potential issue of overlapping fiber-optic expansion projects. It involves an assessment of the competitive situation in the market, including any impairments, with the aim of obtaining insights into the planning and expansion processes being adopted.
- The regulatory framework aims to facilitate more extensive access to ducts, poles, and support systems for above-ground lines to accelerate fiber network expansion by alternative operators. The non-discriminatory access to the incumbent's Deutsche Telekom infrastructure is secured by alternative operators in accordance with the equivalence of input (EOI) principle.

Germany has good fixed broadband coverage, supported by a new national broadband plan introduced in 2022 known as the Gigabit Strategy 2030 and a recent amendment to the telecoms law to make voice and broadband access a legal right for all citizens. The Gigabit Strategy 2030 has supported steady fiber deployment progress in the country over the past couple of years. It aims to expand fiber network coverage to all households by 2030, tripling the number of fiber-optic connections, as well as extending the coverage of FTTH/FTTB networks to 50% of households and companies by 2025. The strategy should have a major impact on fiber deployment in the coming years as it also simplifies the process for obtaining building and site permits, with the possibility of initiating construction before the building permit is granted, as well as supporting new laying techniques to help deploy fiber-optic cables faster. Additionally, the government announced reforms to the Telecommunications Act (Telekommunikationsgesetz: TKG) in August 2023, aiming to accelerate the expansion of fiber networks by revising the gigabit strategy to incorporate the gigabit land register. This is important for providing essential information for network expansion by outlining the collection, scope, and provision of information for portals.

Extensive support from government funding features heavily in Germany's fiber development program. Overall, the Network Alliance and the Federal Government plan to jointly invest about €100bn ($107.5bn) in upgrading the network infrastructure between 2014 and 2025. Funding is not limited to national sources; Germany has also accessed broader funding resources from the European Union (EU). To close the significant urban-rural broadband divide in the country, the EC approved a €12bn ($12.9bn) scheme in November 2020 to financially support the deployment of gigabit broadband networks in rural and underserved areas of Germany. As part of the scheme, the German government initially prioritized rolling out fiber to grey spots (areas with internet access speeds below 100Mbps). From 2023, the funding has been used to deploy gigabit network infrastructure to all areas with access speeds of more than 100Mbps but less than 1Gbps.

As a federal state, some funding has been handled at a local government level in Germany. This approach can ensure that the subsidies are more targeted. For example, in 2020, several local governments announced multi-annual subsidies (including contributions from the EU) to deploy fiber networks covering around 124,000 households, over 12,000 companies and 1,000 schools, and more than 700 public institutions (including hospitals). By April 2020, around 12,600km of fiber cables had been deployed, especially covering rural areas.

Additional annual funding in April 2023 of €3bn ($3.2m) through the Gigabit Funding 2.0 is being used to deploy fiber connections further. Under the scheme, an annual funding cap is set for each state, and applicants must meet set criteria to be eligible for funding. Priority is given to areas with significant coverage gaps, known as white spots, and where private-sector network expansion is complete but has sections lacking coverage with no foreseeable private-sector expansion plans. In July 2023, the government and the regulator, BNetzA, established a monitoring body to address the potential issue of overlapping fiber-optic expansion projects. It involves an assessment of the competitive situation in the market, including any impairments, with the aim of obtaining insights into the planning and expansion processes being adopted.

The country has been working toward improving connectivity, especially fiber connections, for many years now. The previous national broadband plan, the Gigabit Germany initiative, which was published in March 2017, aimed to develop infrastructure for the use of gigabit applications by the end of 2025 by deploying the network in four phases:

- Phase 1: To achieve national coverage with at least 50Mbps by the end of 2018
- Phase 2: To deploy fiber connections to poorly connected business areas by the end of 2019
- Phase 3: To deploy nationwide infrastructure to roll out 5G services by the end of 2020
- Phase 4: To achieve converged gigabit-ready infrastructure by the end of 2025

This national plan proved too ambitious, with the Phase 1 target being missed. However, progress has been made, with 94.2% of households having broadband coverage with speeds of at least 30Mbps by June 2022. Additionally, 91% of households have access to broadband speeds of at least 100Mbps, and 68.6% have access to gigabit speed connectivity. Nevertheless, the adoption of faster connections has been somewhat subdued.

For several years, BNetzA has been pushing for operators to offer open access to competitors and has been encouraging other parties to make voluntary agreements on the shared use of their respective networks to help the country achieve its rollout targets. Significant progress has been made in this regard. In October 2020, BNetzA approved Deutsche Telekom and Telefónica's decision to continue their fixed network cooperation and extend it to include full fiber connections as well as very-high-bitrate digital subscriber line (VDSL)/vectoring connections. The arrangement delivers greater planning certainty for the operators' investments in the construction and expansion of their gigabit networks and allows them to accelerate deployment. Telefónica has contractually agreed that access to Deutsche Telekom's network is subject to sector-specific telecoms regulation, and BNetzA oversaw that the agreement met regulatory requirements.

By ensuring there is a suitable regulatory framework in place that encourages competition and does not hinder network expansion, Germany is laying the foundations for catching up to its European neighbors in terms of accelerating fiber deployment. An area that can have a dramatic effect on improving fiber availability and driving infrastructure-based competition is the adoption of duct and pole access policies. Encouragingly, in October 2021, the regulator embarked on updating the general framework under which other operators can access Deutsche Telekom's network, including its physical infrastructure. This has led to around 80% of the rise in gigabit connections being attributed to alternative network providers that compete against the incumbent Deutsche Telekom.

Sometimes, incumbents are hesitant to invest in fiber infrastructure owing to the high investment needed, as well as a lack of customer awareness regarding the benefits of migrating. Deutsche Telekom has previously focused on enhancing its copper local loop with vector technology instead of expanding its fiber network. Therefore, to encourage the incumbent, BNetzA has introduced a light regulatory regime for new gigabit networks as part of its wholesale fixed services review in June 2022, implying that Deutsche Telekom's fiber network will not be regulated as intensely as its copper network. Fiber-based wholesale products, including fiber VULA, saw the removal of Deutsche Telekom's obligation to provide access to its competitors to its physically unbundled fiber local loop, with the aim to encourage it to invest more in fiber. At the same time, the regulatory framework aims to facilitate more extensive access to ducts, poles, and support systems for above-ground lines to accelerate fiber network expansion by alternative operators. The non-discriminatory access to Deutsche Telekom's infrastructure is secured by alternative operators in accordance with the EOI principle. Under this, the operators can obtain access under a similar system and process as is available to Deutsche Telekom itself. In areas where access to ducts is not possible, Deutsche Telekom is required to provide access to its dark fiber infrastructure. The regulator has also maintained the obligation on Deutsche Telekom to provide colocation and other forms of sharing of associated facilities.

Crucially, an area that has not received much attention in Germany so far is the implementation of a copper switch-off timeline, which other countries, especially in Europe, have begun tackling. The German government has not imposed any obligations as to when the copper network must be phased out or when operators must stop selling copper-based services. However, Deutsche Telekom is obligated to disclose its copper migration and switch-off plan well in advance, though no specific timeframe for this has been outlined either. Without clear regulatory direction, including appropriate protection mechanisms for vulnerable customers, there might be some delay before copper networks are retired.

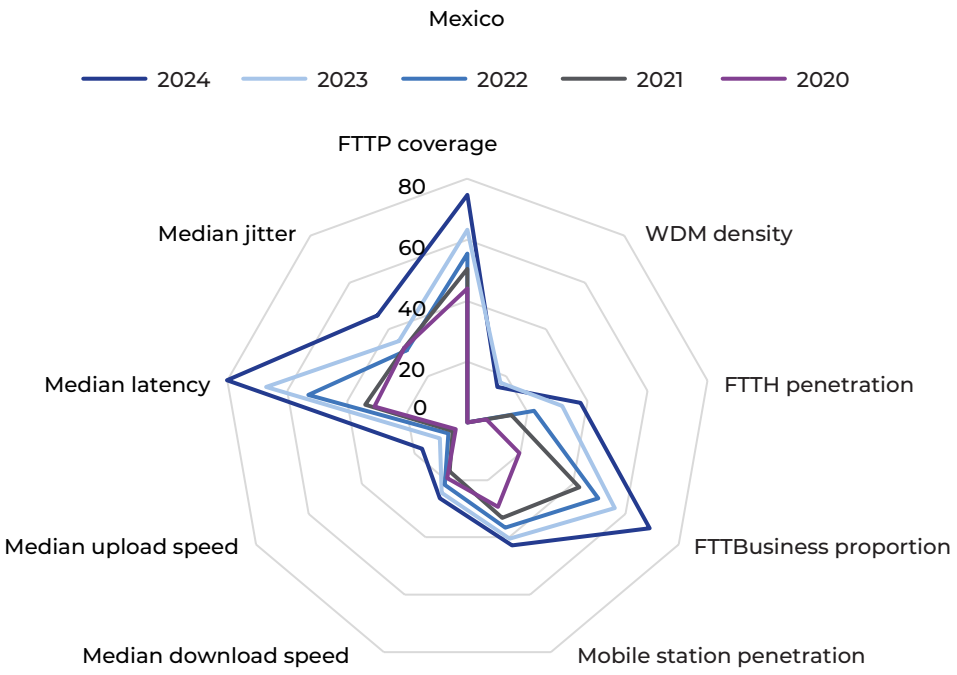
Mexico: Shift from strong cable market to fiber network development

Mexico's position in the FDI has been slowly improving since 2020, when it ranked number 48. In FDI 2024, Mexico moved up to number 44 place, 11 spots behind Brazil, which, while reaching nearly identical scores for FTTH coverage and penetration, outperforms Mexico in QoE metrics. Brazil and Mexico are the two largest Latin American countries, accounting for almost 50% of the region's GDP. Nonetheless, these two leaders have developed starkly different fixed broadband markets.

In Mexico, Telmex (owned by América Móvil) dominates the market with 38% fixed broadband subscription market share, while small alternative ISPs only make up 3% of the market. In Brazil, there are no dominant players in the fixed broadband market, and regional fiber ISPs make up 50% of fixed broadband subscriptions. Although Mexican ISPs started upgrading their networks to full fiber, the progress has so far been slower than in Brazil. By the end of 2023, 59% of the broadband connections were fiber, compared with 70% fiber subscriptions market share in Brazil by the end of 2023. More than a quarter (26%) of Mexican subscriptions are still connecting via cable modems, and 10% are DSL connections.

However, fiber development in the Mexican broadband market has been accelerated by challengers Megacable and Totalplay's focus on fiber rollout. Total play is purely a fiber network operator, and Megacable is a traditional cable broadband provider that has recently shifted its strategy to fiber migration with a planned $2 billion investment in fiber network rollout. Totalplay and Megacable are the only two providers that have seen market share growth in 2023. At the end of 2023, cable provider Izzi was the second largest player in the fixed market with a 21% share, followed by Totalplay with 18% and Megacable with 17%.

FIGURE 24: MEXICO, FDI METRIC RANKING



SOURCE: OMDIA

Policy and regulation assessment

Key points:

- In 2019, the Mexican government established the non-profit entity CFE Telecomunicaciones by using the Federal Electricity Commission's wholesale fiber-optic network (Red Troncal). The initiative, called Internet for All (Internet para Todos), aimed to provide comprehensive internet coverage to all inhabitants in rural areas by 2024.
- In March 2023, the regulator Instituto Federal de Telecomunicaciones (IFT) granted a wholesale shared network concession to CFE Telecomunicaciones. This concession allows CFE to lease infrastructure, network capacity, and telecoms services to other concessionaires without discrimination.
- In 2020, the structural separation of the incumbent Telmex was finalized following the regulator ruling it a "preponderant economic agent," which established an obligation on Telmex to provide wholesale access to its networks. Two new companies, Last Mile National Network (Red Nacional Ultima Milla: UMT) and Last Mile Network (Red Ultima Milla Del: UMNOR), were created to manage the Telmex infrastructure and to provide access to passive infrastructure, such as rights of way, ducts, and poles. The prices and terms associated with these services are subject to IFT regulation.
- In 2022, a successful migration plan from copper to fiber networks was facilitated by operator investments totaling Mex$96.5bn ($5.68bn), with over Mex$80bn ($4.71bn) allocated for infrastructure enhancements and rollouts. However, many gaps in rural areas persist.

Since the government established the Pact for Mexico in December 2012, broadband access has become a constitutional right in the country, paving the way for increased focus from regulators, government, and operators on deploying fixed networks. The pact involves a PPP model that initially aimed to achieve 50% coverage of the population with 4Mbps downlink per 1Mbps during peak hours by 2019 and 92.2% of the population with 4Mbps downlink per 1Mbps during peak hours by 2024. Moreover, a successful migration plan from copper to fiber networks was facilitated by operator investments totaling Mex$96.5bn ($5.68bn) in 2022, with over Mex$80bn ($4.71bn) allocated for infrastructure enhancements and rollouts. However, many gaps in rural areas persist.

There are several regulatory initiatives that have supported the progress of fiber deployment in Mexico. The country's telecoms regulator, the Federal Telecommunications Institute (IFT), has been prioritizing increasing competition in the market to roll out more networks by taking measures and forming regulations to reduce América Móvil's dominance. Fundamental to this has been the regulator declaring América Móvil as a "preponderant economic agent," which led to the implementation of functional separation and the obligation on América Móvil's Telmex to provide wholesale access to its networks. In June 2018, two new companies, UMT and UMNOR, were created to manage the Telmex infrastructure, and the functional separation of Telmex was fully implemented in March 2020. UMT and UMNOR are obligated to provide wholesale services to local access, including dedicated local access links, and to provide access to passive infrastructure, such as rights of way, ducts, and poles. The prices and terms associated with these services are subject to IFT regulations.

Meanwhile, in 2019, the government established the non-profit entity CFE Telecomunicaciones by using the Federal Electricity Commission's wholesale fiber-optic network (Red Troncal). The initiative, called Internet for All (Internet para Todos), was aimed at fulfilling the Mexican president's commitment to providing comprehensive internet coverage to all inhabitants in rural areas by 2024. In March 2019, CFE Telecomunicaciones was announced as the winner of a controversial tender to deploy 50,000km of fiber-optic network to provide free internet to schools, hospitals, parks, and main roads over a period of three years. In January 2020, CFE Telecomunicaciones awarded a $38m cable contract to Prysmian for the Fiber Optic Connectivity Project Smart Electrical Network (Proyecto de Conectividad Fibra Optica Red Electrica Inteligente) project, which connected remote regions of Mexico with high-speed broadband. In March 2023, the IFT granted a wholesale shared network concession to CFE Telecomunicaciones, which allows it to lease infrastructure, network capacity, and telecoms services to other concessionaires without discrimination.

Wholesale broadband services were not regulated in Mexico until 2014. Since then, the IFT has found Telmex to be dominant in the market and obligated the operator to provide access to services over copper and fiber. However, in January 2020, the IFT issued guidelines for the deployment, access, and shared use of telecoms and broadcasting infrastructure. The guidelines aim to eliminate the asymmetric rule imposed on the dominant agents (Telmex and Telcel). With this move, the regulator imposes infrastructure-sharing obligations on all service providers, improving the landscape for fiber deployment.

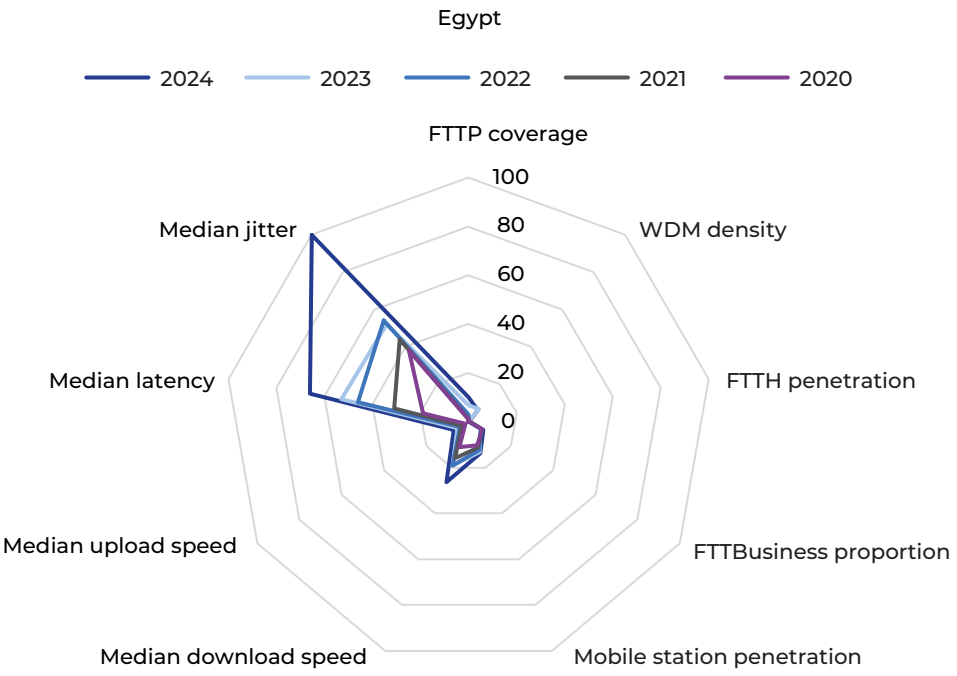
Over the past few years, many of the regulatory measures imposed on the operators with significant market power (SMP), such as interconnection rates and infrastructure-sharing obligations, have benefited consumers through an improvement in services and a drastic decline in prices. However, there is still a lack of proper connectivity in the remote and rural parts of the country, so the government should also ensure sufficient funds are allocated to the sector through its annual budgets.

Egypt: One of the regional leaders in fiber development to be further improved by substantial planned government and operator investment

Egypt is a Cluster 3 country ranking number 77 in FDI 2024. At the end of 2023, 40% of Egyptian households subscribed to a fixed broadband connection at home, but only 0.3% subscribed to a fiber connection. Historically, the incumbent Telecom Egypt, which holds 79% fixed broadband subscription market share, focused on upgrading its primarily copper network to VDSL and FTTSite.

However, the Egyptian government and telcos have intensified their efforts in the broadband market. The regulator, which is the National Telecoms Regulatory Authority (NTRA), and network operators are making substantial investments in fiber infrastructure to expand the fiber network across the country. The NTRA and Cairo Water Company have signed an agreement with Telecom Egypt to develop fiber-optic networks in collaboration with the necessary infrastructure of critical facilities. Moreover, in July 2024, Telecom Egypt announced a $500m investment plan, in collaboration with 4iG Group, to develop and operate wholesale FTTH and FTTS infrastructure in Egypt over the next ten years.

FIGURE 25: EGYPT, FDI METRIC RANKING



SOURCE: OMDIA

Nevertheless, Egypt is performing better than the rest of the African region, where nearly half (46%) of households continue to lack any broadband connection (compared with 22% of Egyptian households), and 43% of households rely on mobile broadband data to connect to the internet (compared with 38% in Egypt). Some of the key barriers to faster fiber adoption growth across the region are lengthy price plans and the relatively high cost of fiber broadband contracts.

In terms of fiber network rollouts, there have been many government-led initiatives in policy and regulation. Most African governments are increasingly adopting policies and strategies to promote broadband development as a catalyst for socioeconomic development. Thirty-seven of the 54 African countries had national digital development strategies (including national broadband plans) in 2022.

Key challenges slowing the implementation of national broadband plans in Africa include a lack of funds, unclear broadband implementation targets, and a lack of clear policies on broadband infrastructure deployment, particularly fiber. Therefore, African regulators should develop policies that are tailored to their countries' specific market conditions and make sure not to introduce rules and regulations that may be necessary for other markets. However, in the African market, context can hamper fiber development.

African governments should simplify the broadband network deployment process by adopting policies that eliminate unnecessary administrative requirements and procedures during network deployment. The policies should aim to reduce the bureaucracy in obtaining necessary approvals for broadband network deployment projects, including rights of way, ducts and poles, in-building wiring, and transportation of network equipment. Governments should also introduce new policies to accelerate FTTH deployments, such as a fiber pre-deployment policy that requires real-estate developers to include communication facilities in newly built residential areas and buildings. In addition, governments should adopt policies and regulatory frameworks to promote network sharing among service providers to reduce the cost of deploying networks.

Policy and regulation assessment

Key points:

- In 2019, the regulator, NTRA, issued a framework for service providers to move customers to high-speed internet with a minimum speed of 30Mbps. As a result of this framework, all operators were able to transition their customers to the new speed.
- Also in 2019, the Egyptian government launched a new national broadband plan to improve infrastructure in villages, known as the Decent Life (Hayah Karima) initiative. Under the plan, one of the Ministry of Communications and Information Technology's (MCIT) main goals was to install fiber-optic cables (in government buildings, hospitals, households, schools, etc.) over the course of three phases.
- Under Phase 1 (which was completed by the end of 2022), approximately £E60bn ($1.26bn) was invested to support fixed infrastructure.
- Phase 2 is currently being implemented to improve and speed up internet connections in developing villages with 50–70% poverty rates, with investments amounting to £E40bn ($0.84bn).
- In 2020, the government launched the Digital Egypt Strategy, which focused on broader digital transformation. This three-pillar initiative involves improving Egypt's digital infrastructure and the regulatory environment through transformation, capacity building, and innovation.
- In 2024, the government's strategy for a digital and sustainable society by 2030 included a plan to boost fiber-optic cable production by setting up 20 factories, connecting all government buildings to fiber, and establishing the country as a leading regional center for manufacturing fiber cables.

Egypt has one of the largest internet telecoms markets in Africa, dominated mostly by mobile services. However, in recent years, there has been progress in the deployment of fixed broadband services following several regulatory policies and government projects. Encouragingly, the country's telecoms regulator, the NTRA, and the government are taking several steps to improve broadband coverage and intensify competition in the market. The government announced a plan to replace 95% of all copper networks with fiber by the end of 2020. To encourage this, the country followed a "pull model" by incentivizing fiber deployment for incumbents and uptake by consumers. By 4Q19, the state-owned operator Telecom Egypt had already replaced 90% of its middle-mile copper network with fiber.

It is common practice for regulators to review the wholesale fixed broadband markets and assign access obligations to operators who exert significant market power. While the NTRA does not currently assign significant market power to the incumbent or obligate it to offer wholesale fixed-line services, this does not seem to have held the country back from making progress in its broadband deployment so far. However, such market analysis and subsequent regulation have been successful elsewhere in the world, so it should be an area for the regulator to consider in the future to ensure progress is not held back going forward. In the meantime, all wholesale fixed-line contracts are entered into through commercial negotiations, but the contracts must be approved by the NTRA. Meanwhile, in 2021, the regulator signed a memorandum of understanding (MoU) with the Egyptian Competition Authority (ECA) to develop a system to regulate free competition in the telecoms market. The NTRA has more recently continued to work with the ECA to address competition concerns specifically in closed compound residential developments.

Back in 2019, the NTRA issued a framework for service providers to move customers to high-speed internet with a minimum speed of 30Mbps. As a result of this framework, all operators were able to transition their customers to the new speed. Furthermore, the NTRA awarded Etisalat Misr and Vodafone Egypt licenses to encourage infrastructure competition and induce FTTH rollouts in closed compounds. In the same year, the government launched a new national broadband plan to improve infrastructure in villages, known as the Decent Life (Hayah Karima) initiative. Under the plan, one of the Ministry of Communications and Information Technology's (MCIT) main goals was to install fiber-optic cables (in government buildings, hospitals, households, schools, and so on) over the course of three phases. MCIT is currently implementing the Decent Life project's second phase, which aims to improve and speed up internet connections in developing villages with 50–70% poverty rates, with investments amounting to £E40bn ($0.84bn) to implement FTTH in urban areas. Under Phase 1 (which was completed by the end of 2022), approximately £E60bn ($1.26bn) was invested to support fixed infrastructure. Telecom Egypt installed fiber-optic cables to boost wired connection, with an investment of £E5.8bn ($0.12bn). It connected 1,436 villages, which covers 1 million homes and 14,000 government buildings, with FTTH. Telecom Egypt installed 301,744 fiber distribution hubs (FDH), providing coverage to 713,996 buildings. Additionally, it finished its FTTH project in approximately 390 villages (267 villages in 2023). The Decent Life (Hayah Karima) initiative has had a substantial impact on connectivity levels in the country. By January 2024, the initiative had benefited approximately 58 million people, most of whom reside in rural areas.

Another important development in the market occurred in 2020 when the Egyptian government shifted its focus toward a broader digital transformation under the Digital Egypt Strategy. This three-pillar initiative involves improving Egypt's digital infrastructure and the regulatory environment through transformation, capacity building, and innovation. On the broadband front, this includes increasing the number of government buildings connected with fiber from 5,300 to 35,000 by the end of 2022. Meanwhile, under the government's strategy for a digital and sustainable society by 2030, it released a plan in 2024 to boost fiber-optic cable production by setting up 20 factories, connecting all government buildings to fiber, and establishing the country as a leading regional center for manufacturing fiber cables. This plan should enable the country to more efficiently and cost-effectively roll out fiber connectivity.

WORLD BROADBAND ASSOCIATION

Join the World Broadband Association

We encourage your feedback and would welcome the chance to discuss with you how you can benefit from, and contribute to, the success of the WBBA. Please submit enquiries for free membership via *https://worldbroadbandassociation.com/*