Fiber Development Index Analysis: 2021

A global index comparing fiber development on a country-by-country basis

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Executive summary

The Fiber Development Index (FDI) tracks and benchmarks fiber development across 81 countries. Fiber investment is vital to the quality delivery of all data services and therefore merits thorough contextual analysis. Unlike other fiber benchmarks that largely track coverage or household penetration, the FDI includes a wider set of metrics including business penetration, mobile cell site fiber penetration, fiber backbone investment, and overall average download and upload speed in addition to the standard fiber household coverage and household penetration.

Fiber investment is an essential metric for government institutions, network operators, and other stakeholders such as media companies and other interested parties to track. As a broadband access technology, optical fiber provides an optimized, highly sustainable, and future-proof quality service. This superior level of quality is essential for the development of future digital services and applications across all verticals including (but not limited to) entertainment, education, home working, corporate services, smart cities, and health. With increased efficiency stimulating greater innovation, high-speed broadband has been proven to drive not just consumer satisfaction but national economic indicators, with additional GDP growth of 0.25–1.5% for every 10% increase in household broadband penetration and a further 0.3% increase for every doubling of speed. Only by maximizing investment in next-generation access can countries optimize their growth potential, and fiber-optic technology is key to that investment, whether this is in the backhaul or access network.

Singapore once again leads the annual (2021) index with maximum scores in fiber-to-the-home (FTTH) penetration, mobile-station fiber penetration, fiber-to-the-premises (FTTP) coverage, and both download and upload speeds. It is closely followed by South Korea, the UAE, Qatar, and China, the last of which is currently the fastest developing of the top-ranking nations. All countries in the top five benefit from strong national broadband plans with ambitious targets around ultra-high-speed services, often backed by generous government grants or subsidies.

In the past, a number of otherwise highly developed countries that rank lower down in the fiber index (such as the US, Australia, and the UK) have tended to suffer from less clear or ambitious national plans, providing weaker incentives for operators to invest. To some extent, this was often linked to less favorable geographical and demographic conditions, which made government initiatives expensive and therefore likely to come up against significant political opposition. However, thanks in some part to the impact of the COVID-19 crisis, which demonstrated just how important broadband networks are, governments around the world are now strengthening their broadband targets and increasing their focus on and investments in fiber-based infrastructure.

This white paper has been sponsored by Huawei, with all analysis and conclusions independently arrived at by Omdia.

Key points and recommendations

- **It is critical that the digital divide is not focused solely on being connected or unconnected.** Broadband connectivity is now essential to everyday life. However, the quality of that connectivity is also vitally important. For many digital applications such as videoconferencing, gaming, and video streaming to work well, they need high-speed, low-latency, and highly reliable and consistent networks. Those individuals and businesses that have such access will have a significant advantage over those that do not.
- **Fiber is not just about high speed.** Concentrating only on speed makes the business case for investing in fiber access difficult to justify, especially as copper-based access technologies continue to improve their own speed capabilities. However, fiber also brings a range of other benefits to an operator, including higher overall quality of service (QoS), lower maintenance costs, lower energy costs, and smaller physical infrastructure requirements. All these characteristics need to be considered when fiber investment plans are being developed.
- **Governments must recognize the benefits to the wider society.** Investing in greater fiber development brings benefits not just to end users and network operators but to society as a whole. A 10% increase in broadband penetration can lead to 0.25–1.5% growth in GDP and 1.5% in labor productivity, while every doubling in speed can lead to a further 0.3% GDP growth. Therefore, investment in advanced broadband technologies such as all-fiber-optic networks will bring vital socioeconomic growth to a country.
- **Fiber is future-proof and more sustainable.** Beyond economic benefits, an all-fiber network is virtually future-proof and has significant environmental benefits over both xDSL and hybrid fiber coaxial (HFC) networks. In 2019, Telefónica (Spain) stated that its FTTH network was 85% more energy efficient than its old copper infrastructure. The operator said its FTTH initiative had saved 208GWh over three years, representing a reduction of 56,500 tons of CO2 emissions. As countries move to a greener future, fiber-optic-based communications must be part of that plan.
- **An end-to-end fiber network is fundamental to digital transformation.** Quality of experience (QoE) guarantees will rely on end-to-end optical networking. This has led to a major industry mind shift in flattening the metro to a single-hop optical access that will ensure guaranteed bandwidth, higher network resiliencies and reliability, and service-level agreement (SLA) assurance for vertical business services and home users.
- **Leading countries will start to extend the access network deep into the customer premises.** Enterprises increasingly rely on time-sensitive networks to optimize their performance. We will therefore see a push to implement fiber to the machine (FTTM) to connect machines and industry robots in order to utilize fiber's high-bandwidth, high-reliability, low-latency, anti-interference, and high-confidentiality features. Starting with the high-end segment of the market, we will also see fiber-to-the-room (FTTR) technology increasingly used in residential settings.
- **Governments should pass legislation to enable gigabit societies.** Governments should ensure that telecommunications infrastructure can be deployed in the most efficient manner by requiring all new developments and real estates to be equipped with in-building mini duct, fiber, in-building access points, or other physical infrastructure to accelerate deployment and reduce rollout cost.

- **To encourage greater fiber deployment all regulators must follow best-practice policies including the following:**
  - Facilitating deployment through municipality approvals, using existing resources (government buildings, streetlights, ducts, etc.), and sharing infrastructure and facilities
  - Introducing and enabling flexibility in partnership arrangements by, for example, allowing agreements between players: cofinancing, collaborative models, public-private partnerships, and innovative partnerships
  - Providing financial support through investment support, incentives, and subsidies (e.g., universal service funds)
  - Implementing regulatory flexibility, including the removal of outdated or nonessential regulation
  - Improving access to telecom facilities and physical infrastructure and improving procedures for right of way (ROW), accessing public infrastructure, and broadband mapping
  - Setting coverage and minimum speed targets through a national broadband plan or universal service obligation (USO)

Why fiber investment is so critical

The pandemic has accelerated the urgency for more significant infrastructure investment

The COVID-19 pandemic has brought fundamental changes to people's daily lives, shifting the way in which companies, governments, and social organizations carry out their operations. Even before the pandemic, the world was entering a new era in communications, underpinned by the next generation of fixed and mobile communication networks. The pandemic highlighted the importance of this evolution, accelerating the urgency around further infrastructure investment.

During the pandemic, a large proportion of the world's population have been confined to their homes for significant periods. Remote working has become the norm, and according to the World Economic Forum, more than 1.2 billion children in 186 countries have been affected by the closure of educational facilities. All other aspects of daily life such as shopping, socializing with friends and loved ones, receiving healthcare, and entertainment have also increasingly moved online.

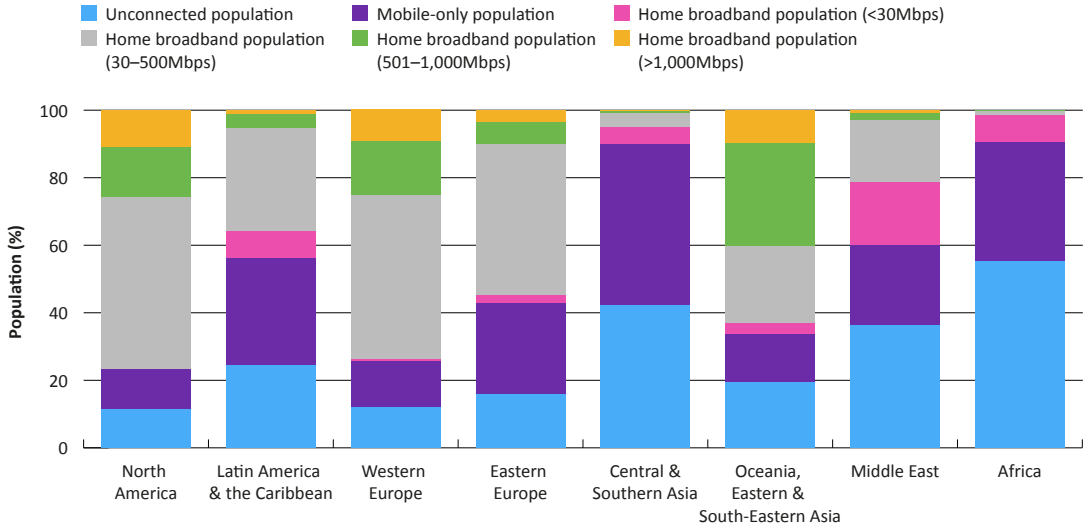
Although in some countries restrictions are now starting to ease, the impact of the pandemic will stretch far beyond the initial health and social crisis, with industry trends and people's behavior undergoing a marked and enduring change rather than a temporary spike. The world will increasingly rely on technology to manage this change. Unfortunately, this means that developed countries, which are already more technologically advanced, could pull even further ahead of their emerging market counterparts, driving wider and more profound social inequalities on a global scale.

Closing the true digital divide

Over the next five years, the percentage of the global population that remains unconnected will drop from 42% to 30%. However, by 2026 30% of the population will only be accessing the internet via a mobile device, meaning that in reality only 40% will have the luxury of fixed broadband at home.

However, this still does not tell the whole story. Even once they are connected to the fixed network, the type of service customers receive is far from equal, especially when we compare different geographies. For example, in Latin America (where 44% of the population will have access to fixed broadband services at home by 2026), only 5.3% will be on a connection delivering 500Mbps or more, and only 1% will have speeds of more than 1Gbps. In contrast, in North America the equivalent factors are 77%, 26%, and 11% respectively, and they are 66%, 40%, and 10% in Oceania, Eastern & South-Eastern Asia. At the other end of the spectrum, only 9% of the African population will have access to fixed broadband, with 84% of those users limited to speeds of less than 30Mbps **(see Figure 1)**.

Figure 1: Percentage of connected population by fixed broadband speed, by region, 2026



Source: Omdia

In summary, the percentage of ultrafast-speed households in developed regions such as North America and Oceania, Eastern & South-Eastern Asia is growing significantly faster than the overall number of connected households in emerging areas such as Africa. Going forward, the digital divide will, therefore, be less about the connected and the unconnected and more about the well served and the underserved, and the gap between them is growing at both country and regional levels.

Fiber benefits to the customer

If the socioeconomic development of countries is to be maximized, it is essential that governments of all nations accelerate their high-speed broadband investment and move toward a gigabit society. As fiber represents the most future-proof and environmentally sustainable telecom infrastructure, a full-fiber rollout must be considered as part of this roadmap.

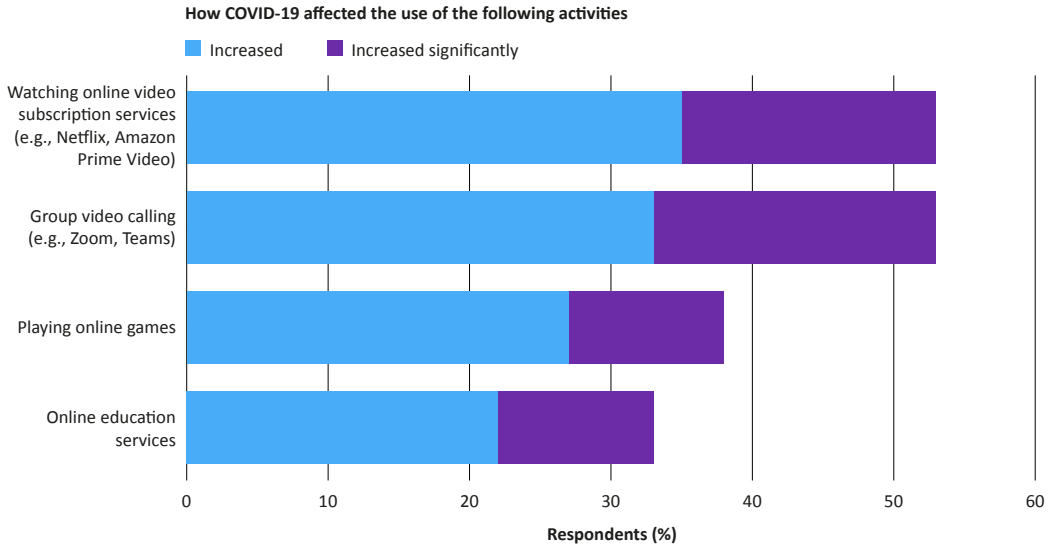
Meeting the new consumer demands

Even before the COVID-19 pandemic, broadband connectivity had become an essential element in many consumers' daily lives. The crisis served to

- Highlight just how reliant we had become upon internet connectivity
- Educate consumers on the importance of having a high-speed, reliable, consistent, and low-latency service

During the crisis whole families were confined to their homes for work, education, and entertainment, all of which were conducted online and often concurrently, pushing the home Wi-Fi and broadband connection to their limits. Based on Omdia's Digital Consumer Insights, **Figure 2** illustrates how the use of bandwidth-hungry and latency-dependent applications such as online video, video calling, and online gaming increased because of COVID-19.

Figure 2: Increase in consumer use of high-bandwidth applications during the COVID-19 crisis



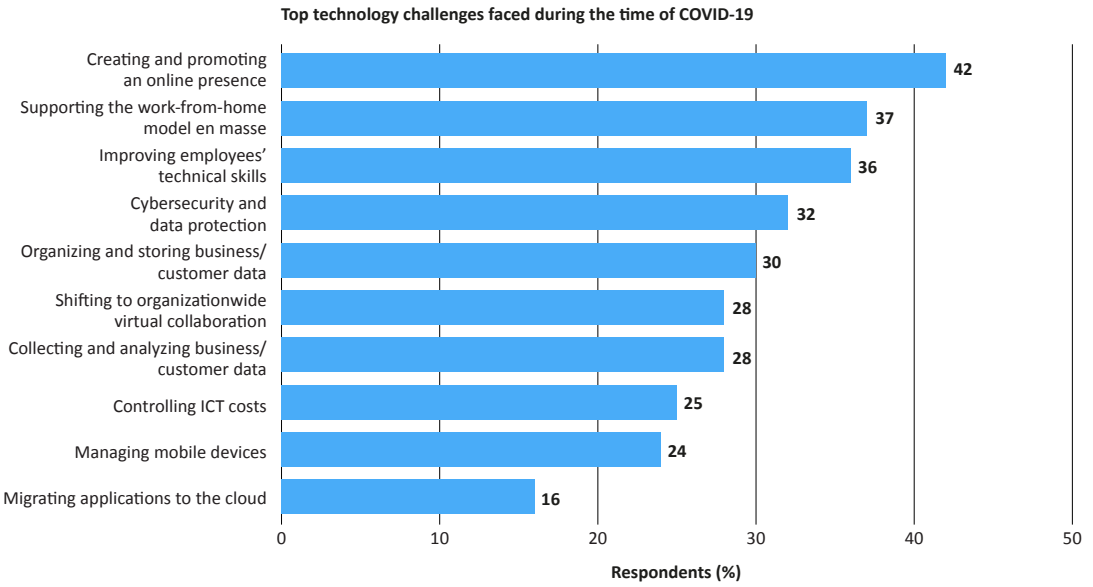
Note: n=3,157
Source: Omdia

These applications can place significant demands on the home Wi-Fi and broadband access network, especially when they are being streamed simultaneously. Basic 4K video streams can require bandwidths of at least 20Mbps, rising to 30Mbps for real 4K video and over 50Mbps for 4K ultra HD. Videoconferencing and online gaming do not require the same levels of bandwidth (typically in the 2Mbps and 5Mbps range respectively) but both need low latency to perform at a high quality. The recommended latency for online gaming, for example, is below 100ms, but ideally it should be in the 20–40ms range with less than 20ms preferred by serious gamers.

Meeting the new enterprise demands

COVID-19 restrictions and rapidly changing consumer behavior have had a significant impact on business sectors of all types. As within the consumer market, broadband connectivity has become an essential element for survival. As more enterprises digitize their business and move toward cloud-based applications and services, a fast, reliable, and stable broadband connection becomes critical. Although access cost will always be important to enterprises as they look to manage both their capital and operational expenses, most will take a wider view and see broadband as a productivity tool that can in its own right facilitate other business efficiencies (e.g., remote working, access to cloud applications, and more effective client communication).

Figure 3: Broadband connectivity will be critical to businesses as they emerge from the COVID-19 crisis



Note: n=877

Source: Omdia 2020/21 SoHo & SME Insights survey

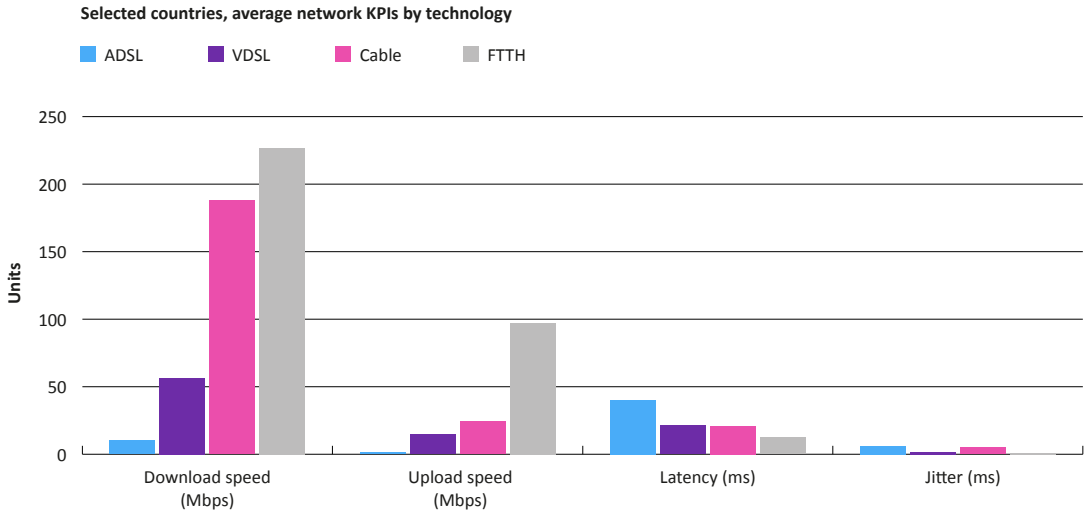
Businesses will therefore view other key performance indicators (KPIs) such as security, reliability, latency, quality of customer service / service flexibility, and of course, speed as equally important, if not more so in some cases.

Fiber is the only future-proof technology that meets such requirements

Fiber-based networks are recognized as providing sustainable and cost-efficient communications networks with high bandwidth, stability, reliability, and reduced latency. Based on real network data from Medux's report "Residential fixed broadband in Europe," **Figure 4** illustrates how fiber outperforms other technologies in all areas. Such QoS KPIs have a significant impact on application QoE. Web browsing, video streaming, gaming, and cloud services experiences may all be heavily affected depending on actual or average/median values and, most importantly, on the stability of those KPIs over time, especially during peak hours. Because an all-fiber-based network not only outperforms other technologies on all QoS metrics but also has superior network consistency properties, it is proven to offer the customer the best service QoE.

This overall enhanced customer experience has provided FTTH operators with a competitive advantage over other forms of broadband competitor in the form of superior Net Promoter Scores (NPS) and reduced customer churn. For example, in 2019, the Spanish operator MASMOVIL topped the network quality rankings with its FTTP network, enabling it to boast an NPS ahead of its competitors at that time. A second example is Bell Canada, which has highlighted that its churn rates are lower when customers are on a full-fiber (FTTH) network. On average, the company found that churn rates for fiber access subscribers are 30–35 basis points lower than those on fiber-to-the-node (FTTN) or digital subscriber line (DSL) networks.

Figure 4: FTTH networks provide a truly high-end experience



Source: Medux, Omdia

As with consumer services, fiber to the business (FTTBusiness) gives enterprises an optimal network performance ensuring a more reliable, stable, and faster service, providing a future-proof network to maximize operational efficiencies, as long as it can be provided at the right cost.

Fiber benefits to the operator

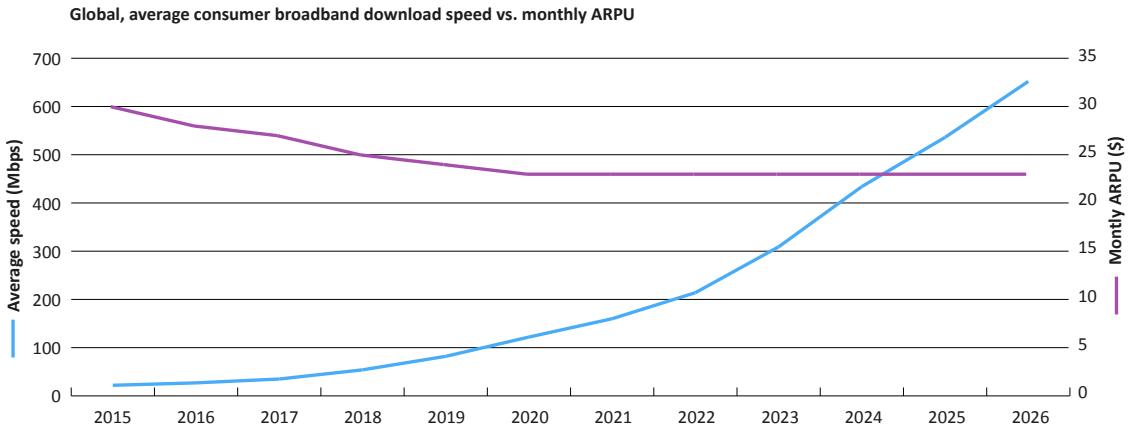
When one thinks of fiber, one naturally thinks of high speed. Indeed, a key element of fiber's claim to being "future-proof" is that its bandwidth capabilities are virtually unlimited. In terms of the business case for greater fiber rollout, therefore, the focus in the past has often been on speed and the search for "killer" applications that will justify speed upgrades by driving new revenue.

However, concentrating only on the downlink speed benefits has often made the business case for full-fiber rollout difficult to justify, especially as copper-based DSL technologies continued to improve, to the extent that speeds of 100Mbps plus were possible over existing infrastructure.

Overall, broadband service providers have struggled to grow ARPU on speed alone. **Figure 5** shows that because of continued market competition, average broadband speeds have been growing exponentially and will continue to do so over the forecast period, whereas average ARPU levels have remained relatively steady. Therefore, since service providers have had to invest in downlink speed to remain competitive, with no evidence that this will also grow revenue, most have opted to "sweat" their existing copper infrastructure for as long as possible.

What proponents of such business cases failed to realize, however, was that gaining almost infinite downlink speed upgrades is only one of the positive impacts of moving to a full-fiber network.

Figure 5: Broadband speeds have grown exponentially, while ARPUs remain flat



Source: Omdia

Full-fiber networks have several network benefits in addition to delivering a superior QoS experience and helping to accelerate socioeconomic growth. Full-fiber infrastructure is newer, made of more resilient material, and more passive than copper-based networks. These features mean that full-fiber networks need far less maintenance, and because they do not require as much active equipment in the field to power them, their energy consumption is lower, and there is less need for field maintenance.

In addition, optical-fiber cabling offers significantly higher bandwidth capacity at a fraction of the size and weight of copper wiring: it uses far less cabling and fewer racks and switches than copper-based networks, saving both physical space and money. Finally, the smaller size of the optical cables makes it possible to deploy them using a technique known as *microtrenching*, which is cheaper, quicker, and less environmentally destructive than traditional telecom network trenches.

Fiber benefits to society

It is now generally accepted that broadband investment positively affects economic growth and overall market competitiveness, because it is an enabler of more significant innovation and business efficiency. Global studies have tried to quantify this impact, three of which are summarized below:

- ITU analysis of more than 200 studies on broadband impact notes that a 10% increase in broadband penetration yields an increase in GDP ranging between 0.25% and 1.5% (ITU, 2016, "Working Together to Connect the World by 2020: Reinforcing Connectivity Initiatives for Universal and Affordable Access").
- OECD estimates that a 10% increase in broadband penetration can raise labor productivity by 1.5% (OECD, 2011, "National Broadband Plans," OECD Digital, Economy Papers, No. 181, OECD Publishing, p. 10).
- An EIB study asserts that a doubling of broadband speeds can result in 0.3% GDP growth (Bohlin et al., 2014, EIB Institute, "The economic impact of broadband speed: Comparing between higher and lower-income countries").

In summary, more significant investment in broadband infrastructure helps drive a country's GDP by optimizing its national broadband capabilities.

Fiber benefits to the environment

As already briefly mentioned, fiber has several inherent properties that make it more environmentally friendly than copper-based networks.

Full-fiber networks require much less active equipment in the field to power them, significantly reducing energy consumption. An optical distribution network (ODN) requires no electrical power. In addition, because fiber has significantly higher bandwidth capacity at a fraction of the size and weight of copper wiring, it requires significantly less power per bit. Typically, according to equipment vendor Huawei, for every 10,000 access connections that evolve from copper access to a FTTH Gigabit Passive Optical Network (GPON), the operator saves more than 1,500kWh of power.

In 2019, Telefónica (Spain) stated that its FTTH network was 85% more energy efficient than its old copper infrastructure. The operator said its FTTH initiative had saved 208GWh over three years, representing a reduction of 56,500 tons in CO2 emissions. A study launched in 2017 by Europacable, a European organization representing wire and cable producers, also concluded that fiber is 64% more energy efficient than DOCSIS cable technology. It found that performing at 50Mbps, fiber networks consume 56kWh per capita per year, compared with 88kWh for DOCSIS.

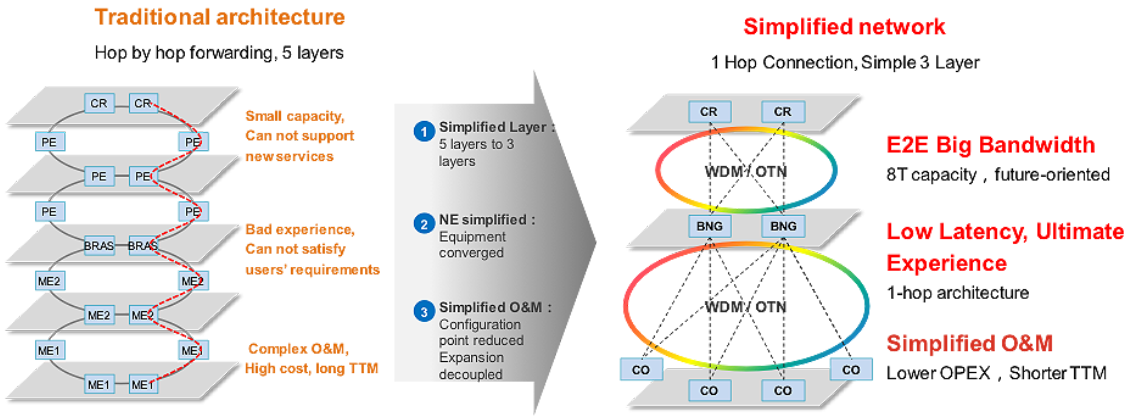
Moving toward a gigabit society with advanced fiber technology

Fiber access improves end-to-end optical networking

Passive Optical Network (PON) access networks are already supporting residential and nonresidential customers and applications today. Next-generation PON variants, such as 10G PON, are optimized to support future fixed-mobile convergence (FMC) needs because transport traffic (such as wireless backhaul) can be supported over the same PON infrastructure as end-user services. This approach saves fiber assets and operational costs, thereby achieving faster ROI. In addition, next-generation PON access networks will be future-proofed to support all enterprise services and smart city applications.

It is important to note that this future transport network will not be a dumb pipe that is fully dependent on IP capabilities but will rely on end-to-end optical networking to ensure guaranteed user experiences. This has led to a major industry mind shift in flattening the metro from the traditional five hops to a one-hop optical access (see **Figure 6**). An underlying optical network (wavelength-division multiplexing [WDM] and OTN) that flattens the metro and backbone network with all-optical ensures guaranteed bandwidth, higher network resiliencies and reliability, and SLA assurance for vertical business services and home users.

Figure 6: Moving to a flat optical network for optimized efficiency



Source: Huawei

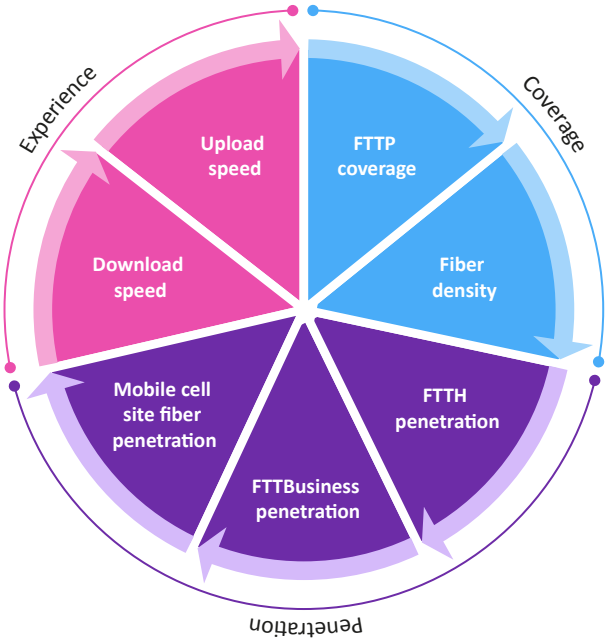
End-to-end IP-based packet networking is the basis for true FMC network construction and provides fast service-routing and switching capabilities. Network operators use IP ports to connect 5G radio access network (RAN) base stations (eNodeBs) with 10G or 25G interfaces to support 50G or 100G per ring and direct traffic to superfast heavy-duty core routers via cloud metro aggregations. For edge computing and latency-sensitive applications, many use-case service centers will be near the edge and used in cloud metro for quick response time. An excellent example of such a service is an edge-distributed content delivery network (CDN). Segment routing removes the need for resource reservation protocol traffic engineering. Moreover, the hardware and software of existing brownfield deployment routers require updates to support soft and hard slicing for many digital time-sensitive services. An all-optical network with smart protocols is a requirement for the gigabit society.

The FDI 2021: Key results

FDI 2021 methodology

Because of the importance of fiber investment and its impact on global development, Omdia has created a fiber benchmark called the Global Fiber Development Index. Unlike other benchmarks that only track a single development metric such as coverage or household penetration, the Global Fiber Development Index aims to capture all elements of fiber network investment, specifically fiber access, mobile fiber backhaul, core fiber backhaul, and overall fiber QoS, which is currently measured by overall average downlink and uplink speed (see **Figure 7**).

Figure 7: The Fiber Development Index



Source: Omdia

Only by optimizing each of these separate investment areas can a country optimize the overall broadband end-user experience, whether this is provided via a fixed or mobile access connection.

To quantify the level of investment in each segment, Omdia used a selection of metrics as outlined and defined in **Table 1**. Please note that some of these metrics or the way they are defined have changed slightly since FDI 2020, but data from the 2020 index has now been updated accordingly to make the two datasets directly comparable.

Table 1: Individual metrics used in the Fiber Development Index 2021			
Group	**Metric**	**Definition**	**Importance**
Coverage	**FTTP coverage**	The total number of residential and business premises covered by the optical-fiber network	Represents the current potential of the fiber access network. A limited coverage will mean that only a small selection of households and businesses can gain access to the full benefits of a fiber network.
	Fiber density	The total installed fiber length ratio to households, with a weighting factor to account for population density	Fiber throughout the network supports the necessary QoE and reliability that broadband services need. Thus, a higher quantity of fiber installed per household 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 penetration	The number of FTTBusiness subscriptions divided by the total number of business premises	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 if they are to optimize mobile-access performance. A high FTTSite penetration will therefore mean a more optimized mobile data network.
Experience	**Downlink speed**	The average end-user downlink speed	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.
	Uplink speed	The average end-user uplink speed	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.
Source: Omdia			© 2021 Omdia

Index ranking methodology

The index aims to combine the individual metrics outlined in **Table 1** of this report into a single benchmark measure following a four-step process.

Step 1: Data collection and analysis

For each metric, various datasets were used to gather as accurate information as possible for each country. Sources include

- National regulators
- National broadband operators
- Omdia's own databases and market forecasts

Where data does not yet exist for a metric in a particular country, estimates were made based on other relevant market information.

Step 2: Data normalization

The data for each metric was then normalized to offer the same unit of measurement and scale before a single, overall measure was generated. This is a vital step because many of the datasets can be expressed in different ways, perhaps as a percentage or some other metric such as Mbps or km per household. Normalizing the metrics transforms these different measures onto a standard scale, in this case 0–100.

Datasets expressed in a percentage were directly converted into a score out of 100. For other metrics, calculations were based on a reference measure, that is, the ideal goal, or using the top country as the reference if the objective is open ended. It is important to note that in such cases the goals or calculation methods are likely to change as markets develop over time.

Step 3: Weighting and index calculation

In each case, the metric and metric group (see **Table 2**) are weighted to apply differential levels of importance for the final index. In the case of the FDI, the weighting has been set as per **Table 2** to reflect the current importance of continued fiber rollout investment. However, this is expected to change over time as countries continue to develop and other metrics rise in importance.

Table 2: FDI, metric weightings, 2021

Group	Group weighting	Metric	Metric weighting within group
Coverage	40%	FTTP coverage	50%
		Fiber density	50%
Penetration	30%	FTTH penetration	33%
		FTTBusiness penetration	33%
		Mobile cell site fiber penetration	33%
Experience	30%	Downlink speed	50%
		Uplink speed	50%

Source: ISG F5G © 2021 Omdia

The final index measure was calculated as follows: the group score was created by summing the metrics in that group, multiplying these totals by their weightings, and then summing the group scores multiplied by their weightings.

Step 4: Sensitivity analysis

Finally, sensitivity analysis was carried out to investigate the robustness of the overall index result. To this end, different methods were used to calculate the individual metric scores and the global measure to estimate the general impact on the index results. Such an approach is essential because data sources can vary from country to country and can often change as their processes are reviewed or local definitions change.

2021 country grouping

The FDI covers 81 territories of varying sizes, demographic and geographical profiles, and levels of broadband development. Given these widely differing characteristics, it makes no sense to directly compare them: this would lead to unfair and unhelpful conclusions and recommendations.

To more realistically compare individual results of the FDI, Omdia has created three different country clusters:

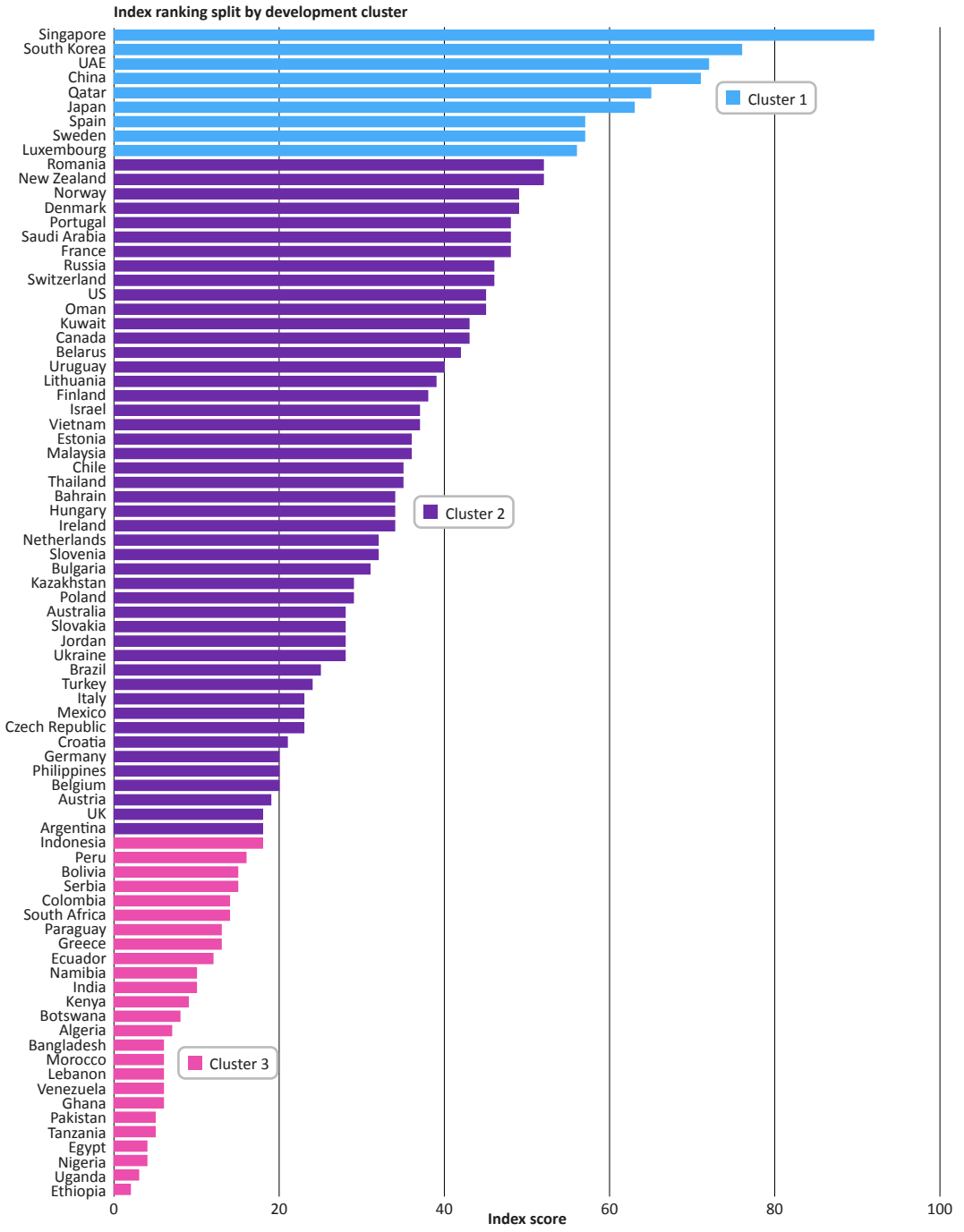
- Cluster 1: fiber-ready countries, which have a high level of fiber investment and are quickly moving to ultra-high-speed broadband services

- Cluster 2: broadband-ready countries, which have medium-to-high levels of broadband penetration but low levels of fiber investment
- Cluster 3: emerging broadband countries, which are still developing their fixed broadband networks

FDI 2021 ranking results

Singapore continues to lead the FDI in 2021, with an overall score of 92 out of 100. South Korea (76), United Arab Emirates (72), China (71), and Qatar (65) make up the rest of the top five countries.

Figure 8: Overall FDI 2021 results



Source: Omdia

The first European countries in the ranking are Spain and Sweden in seventh and eighth position respectively, each with a score of 57. They are closely followed by Luxembourg (56) and Romania (52). The US heads the Americas region with a score of 45, positioned 18th in the world overall.

Cluster 1 movers and shakers

The order of the top cluster 1 countries has not changed over the past 12 months. However, there have been changes to the individual scores, which if the same trend were to continue, could certainly see movement in future updates. The most notable changes affect South Korea (the only country in this group to witness a decrease), whose score has dropped slightly from 78 to 76 points, and China, whose score has increased by six points from 65 to 71.

Table 3: Cluster 1 results

Rank	Territory	Rank change 2020–21	FDI 2021 score
1	Singapore	→0	92
2	South Korea	→0	76
3	UAE	→0	72
4	China	→0	71
5	Qatar	→0	65
6	Japan	→0	63
7	Spain	→0	57
8	Sweden	→0	57
9	Luxembourg	→0	56

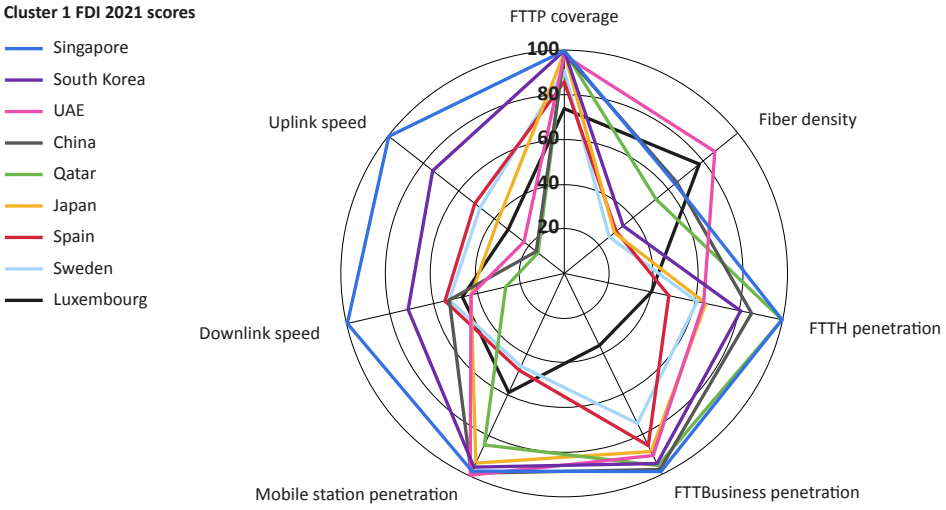
Source: ISG F5G © 2021 Omdia

The reason for the slight decrease in South Korea's score is that the average speeds have not accelerated there as fast as in other countries, although at the end of 2020 its average downlink and uplink speeds were still 216Mbps and 205Mbps respectively. This shows how quickly the top-ranked fiber countries are now accelerating their average broadband speeds.

China, on the other hand, has seen improvements in its ranking across all penetration-related metrics and a significant increase in its downlink speed. As discussed later in this report, a heavy focus is now being placed on speeds in China, and this is likely to see it move further up the FDI ranking.

Overall, cluster 1 countries show high scores in fiber coverage and mobile and FTTBusiness penetration (**Figure 9**). The two leading countries, Singapore and South Korea, also have high FTTH penetration, and Singapore in particular is now pushing ultrabroadband speeds and heading toward a gigabit society. China is rapidly catching up with these two countries in most areas but must continue to improve average broadband speeds, especially in the upstream direction. Countries lower down in this cluster (Spain, Sweden, and Luxembourg) show high levels of fiber coverage but must now focus on encouraging greater customer fiber penetration, which in turn will naturally start to increase other metrics such as average speeds.

Figure 9: Top cluster 1 countries are moving toward gigabit societies



Source: Omdia © 2021 Omdia

Cluster 2 movers and shakers

There has been far more movement in terms of the country rankings within the cluster 2 countries. Of the climbers, the Latin American countries Chile and Brazil have seen the biggest jumps, climbing 11 and 7 places respectively. This is largely due to significant increases in their FTTP coverage and FTTH penetration figures, which in turn have also led to improvements in average downlink and uplink speeds.

On the flip side, Canada, the Netherlands, and Ukraine dropped the most number of places (six, seven, and seven respectively). All three countries have reasonable fiber coverage (in the range of approximately 40–60% of premises covered), but growth in coverage has been slow over the past 12 months, and therefore increases in penetration and average speeds have also only grown marginally in comparison with other countries. This highlights the fact that relatively developed countries must keep the momentum up if they are to remain competitive on the global stage.

Table 4: Cluster 2 results

Rank	Territory	Rank change 2020–21	FDI 2021 score
10	Romania	→0	52
11	New Zealand	↑1	52
12	Norway	↓-1	49
13	Denmark	→0	49
14	Portugal	→0	48
15	Saudi Arabia	↑3	48
16	France	↑3	48
17	Russia	↓-1	46

Source: Omdia © 2020 Omdia

Table 4: Cluster 2 results (continued)

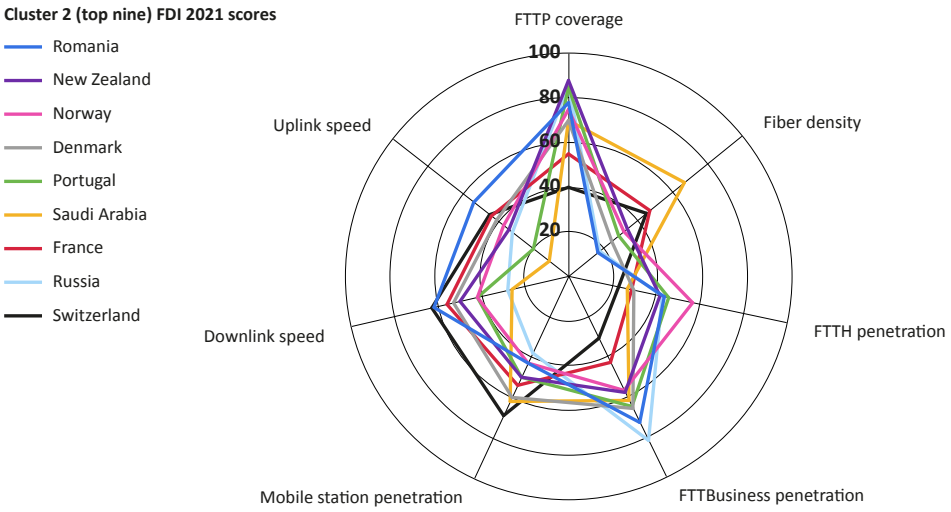
Rank	Territory	Rank change 2020–21	FDI 2021 score
18	Switzerland	↑2	46
19	US	↓-2	45
20	Oman	↑2	45
21	Kuwait	↑4	43
22	Canada	↓-7	43
23	Belarus	↑3	42
24	Uruguay	↓-1	40
25	Lithuania	↓-4	39

Source: Omdia © 2020 Omdia

Table 4: Cluster 2 results (continued)			
Rank	Territory	Rank change 2020–21	FDI 2021 score
26	Finland	↓-2	38
27	Israel	↑1	37
28	Vietnam	↑3	37
29	Estonia	↑1	36
30	Malaysia	↓-3	36
31	Chile	↑11	35
32	Thailand	↑2	35
33	Bahrain	↑3	34
34	Hungary	↑1	34
35	Ireland	↓-3	34
36	Netherlands	↓-7	32
37	Slovenia	↓-4	32
38	Bulgaria	↑2	31
39	Kazakhstan	↑4	29
40	Poland	↓-1	29
41	Australia	↓-3	28
42	Slovakia	↓-1	28
43	Jordan	↑4	28
44	Ukraine	↓-7	28
45	Brazil	↑7	25
46	Turkey	↓-2	24
47	Italy	↓-1	23
48	Mexico	→0	23
49	Czech Republic	↓-4	23
50	Croatia	↓-1	21
51	Germany	↓-1	20
52	Philippines	↑2	20
53	Belgium	↓-2	20
54	Austria	↑2	19
55	UK	↓-2	18
56	Argentina	↓-1	18
Source: Omdia			© 2021 Omdia

As illustrated in **Figure 10**, top-ranked cluster 2 countries are now starting to gain reasonable FTTP ratio metrics. The top five (Romania, New Zealand, Norway, Denmark, and Portugal) all have FTTP coverage ratios of 70–88%. However, FTTH penetration is still lagging, with Denmark, for example, only at 30% FTTH penetration.

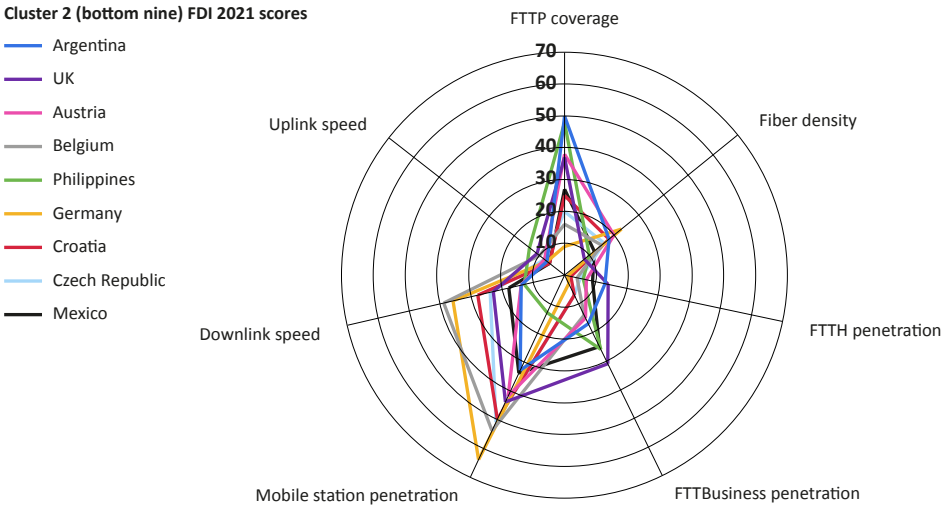
Figure 10: The top cluster 2 countries need to turn focus onto penetration



Source: Omdia

In the bottom-ranked cluster 2 countries (**Figure 11**), FTTP coverage tends to be lower, and it follows therefore that most other fiber metric scores are also low. Note that average downlink speeds for some of these countries might still be in the average-to-good range, since typically such countries have invested in advanced copper technology such as HFC and VDSL/G.fast. However, upstream speeds are low, and downlink speeds will be unable to grow much further without additional FTTP investment.

Figure 11: The bottom cluster 2 countries need to continue to focus on coverage



Source: Omdia

Cluster 3 movers and shakers

Bangladesh and Bolivia have made the biggest improvements of the cluster 3 countries, moving up eight and four places respectively on the previous FDI. Although it started at a very low base, Bangladesh has more than doubled both its FTTP coverage and FTTH penetration, pushing up its average speeds significantly over the past 12 months. Bolivia is at a different starting point from Bangladesh with over 35% FTTP coverage, but it has still managed to increase penetration, which again has pushed average broadband speeds up.

Of the countries that have witnessed significant drops in ranking (such as Greece and South Africa), all saw minimal increases in fiber development and thus only marginal increases in average speeds compared with other countries.

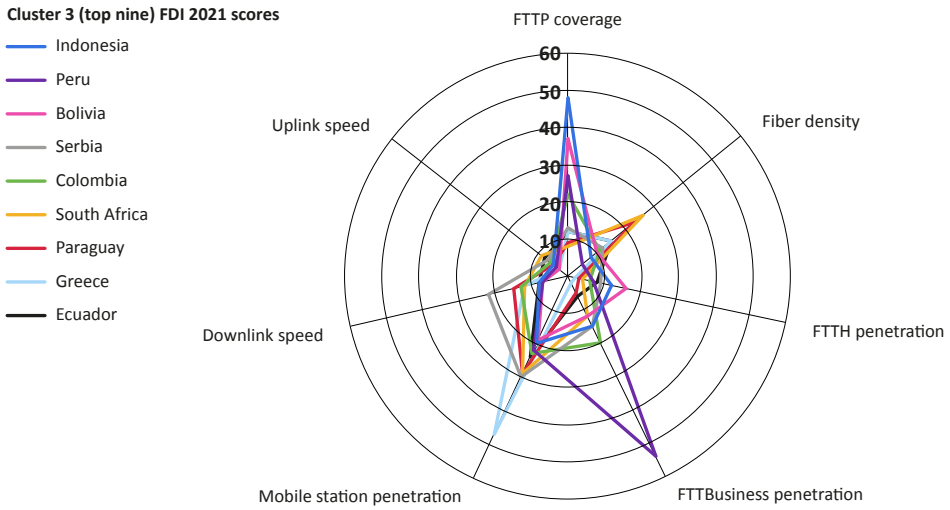
Table 5: Cluster 3 results

Rank	Territory	Rank change 2020–21	FDI 2021 score
57	Indonesia	→0	17
58	Peru	→0	16
59	Bolivia	↑4	15
60	Serbia	↑1	15
61	Colombia	↑1	14
62	South Africa	↓-3	14
63	Paraguay	↑1	13
64	Greece	↓-4	13
65	Ecuador	↑3	12
66	Namibia	↓-1	10
67	India	↓-1	10
68	Kenya	↓-1	9
69	Botswana	→0	8
70	Algeria	→0	7
71	Bangladesh	↑8	6
72	Morocco	↓-1	6
73	Lebanon	↓-1	6
74	Venezuela	→0	6
75	Ghana	↑1	6
76	Pakistan	↓-3	5
77	Tanzania	↓-2	5
78	Egypt	↓-1	4
79	Uganda	↑1	3
80	Nigeria	↓-2	3
81	Ethiopia	→0	2

Source: Omdia © 2021 Omdia

As in the 2020 FDI, cluster 3 countries tend to have spiky results because they have prioritized fiber investments in particular areas, for example, mobile station backhaul or FTTBusiness. However, it is encouraging to see that some of the leading cluster 3 countries now have relatively high FTTP coverage, illustrating their desire to move to the group of "fiber-first countries" (see **Figure 12**).

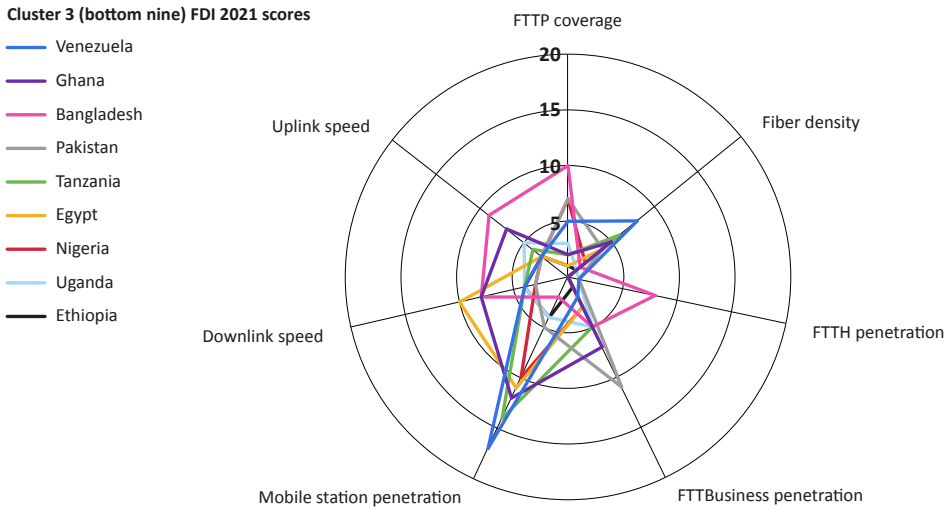
Figure 12: The top cluster 3 countries need to turn focus onto penetration



Source: Omdia © 2021 Omdia

The bottom cluster 3 countries (**Figure 13**) are only seeing very early stages of development and are largely prioritizing fiber deployment to mobile cell sites, which is typical in such countries. However, it is vital that these countries start to develop their own fiber-first roadmaps over time.

Figure 13: The bottom cluster 3 countries need to continue to focus on coverage



Source: Omdia © 2021 Omdia

Legislation best practice

Cluster 1

Singapore

National broadband plan and universal service obligations

Singapore is one of the most advanced telecom markets in the world and has led Omdia's FDI for the past two years. It achieved this status through well-targeted regulatory support and adopting an all-fiber broadband market very early on. The country is an interesting case: while publicly retaining their policy of encouraging infrastructure-based competition, the government and regulator have moved in the opposite direction, having established a single national fiber broadband network and limited nationwide 5G network deployments to two operators. The country has embarked on a less traditional model of having a state-commissioned and state-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 as well as pricing regulations. This approach has seen success, because all retail service providers rapidly migrated to FTTH, resulting in very high take-up of passive products and correspondingly high retail take-up of FTTH services. In addition, the decision to define a rollout schedule within the passive network operator's contract has been critical in ensuring timely deployment.

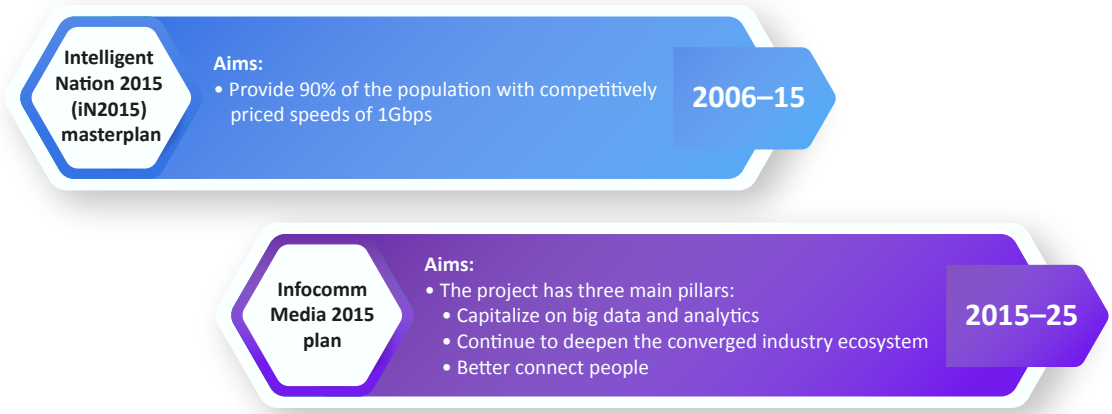
The government embarked on its Intelligent Nation 2015 (iN2015) master plan back in 2006. While most countries were still focused on improving basic broadband coverage, Singapore was already focused on providing 90% of the population with competitively priced broadband speeds of 1Gbps.

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 passive network operator ("NetCo"), an active network operator ("OpCo"), and the retail service providers, which 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 of September 2020, NetLink NBN connected more than 1.4 million homes and 27,600 nonresidential premises. A total of S$1bn ($743m) of government investment has been plowed into building and operating the FTTH network.

Since January 1, 2013, as part of the Infocomm Media Development Authority's (IMDA) 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. 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 universal service fund. Instead, the government co-funds the Next Generation Broadband Network.

The country has now completed its next-generation national broadband network FTTH (Next Gen NBN FTTH) project. Currently it is pushing to become the world's first "smart nation" under its Infocomm Media 2025 plan, which was introduced back in 2015 and builds on the iN2015 plan. The project has three main pillars: capitalize on big data and analytics, continue to deepen the converged industry ecosystem, and better connect people. The last of these is now complete.

Figure 14: Singapore's successive national telecom policies



Source: Omdia

Telecom facilities

In January 2021, the regulator proposed to update the country's telecom code. Under a draft updated Code of Practice for Competition in the Provision of Telecommunication and Media Services (the Code), the regulator proposed to make a number of changes to ensure the framework still effectively supports the market. The regulatory framework includes extensive provisions on sharing of passive infrastructure. Singapore does not define markets in the way EU member states do, but the IMDA does consider some operators to be dominant in certain markets. A licensee is classed as dominant if it is licensed to operate facilities used for the provision of telecom services that are difficult to replicate. These 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 proposed to extend the resource-sharing provision to services-based operations (SBO) licensees. The revised Code continues to retain the regulatory principle of promoting facilities-based competition for telecom markets but proposed that if a network element is more passive and comprises civil-based infrastructure, then a historic cost accounting / regulated asset base (HCA/RAB) pricing methodology should be adopted.

Ensuring the regulatory framework in the country is robust while effectively reflecting market conditions and requirements has been key to supporting successful fiber rollout programs. The infrastructure access requirements have boosted competition, and in particular, passive access to the PON is working well. However, it has also been critical that the regulator has recognized that passive-only remedies for FTTH are insufficient to enable FTTH competition everywhere, so both active wholesale remedies and passive remedies have been implemented.

Copper switch-off

As operators started to deliver services over fiber, IMDA proposed in 2019 to remove legacy services such as the unbundled network elements, unbundled network services, and colocation facilities from the schedule of regulated services, interconnection related services (IRS), and mandated wholesale services (MWS). The aim was to avoid overburdening operators and allow them to focus their efforts on rolling out fiber connectivity. Following an extensive review, the regulator finally decided in January 2021 that copper services had not significantly contributed to market development and there had been zero take-up of the legacy services over recent years, so it could withdraw the regulation of these services. In particular, it decided to withdraw the unbundled network elements—namely local loops, sub-loops, line sharing, distribution frame access, and internal wiring services—from the IRS and MWS schedules.

Spain

National broadband plan and universal service obligations

Spain is the leading European country in the FDI. It has successfully rolled out its national fiber network to 86% of homes, but with a greater geographical spread of communities than in countries such as Singapore, it still has challenges in improving rural connectivity.

Spain's current success is based partly on an ambitious "300×100" plan to deploy a high-speed fiber-based broadband network with speeds of 300Mbps to 100% of the nation during 2018–21. The government approved €525m ($626m) of funding for this four-year project. National FTTP coverage increased to 86% of households by the end of 2020. Fiber coverage has long been part of the country's plan, however: in February 2013, the Digital Agenda for Spain adopted the targets of the European Commission's Digital Agenda, but the government also set interim targets for 2015 of 50% FTTH coverage and 47% HFC coverage.

The country's Digital Agenda 2025 was introduced in July 2020 with the aim of improving rural connectivity and reducing the digital divide. The €140bn ($167bn) initiative aims to provide 100Mbps connectivity to 100% of the population by 2025. In December 2020, the government received public funding worth €4.3bn ($5.1bn) to expand the fiber-optic network infrastructure in rural areas. An estimated amount of €883m ($1,053m) is proposed in the 2021 budget. In addition to the public sector, the government expects contributions from the operators to roll out FTTH across the country.

One key aspect of Spain's success has been the focus on providing funding for rolling out very-high-speed networks to homes and businesses in rural and dispersed areas (called "white areas"). In November 2019, Spain's Ministry of Economy and Competitiveness (MINECO) approved €140m ($167m) of funding for the National Program of Extension of the Broadband of New Generation (PEBA-NGA), which is cofinanced by the European Regional Development Fund. The program aims to provide access to speeds of at least 100Mbps for 706,000 homes and businesses in white areas. This ultra-high-speed broadband is expected to provide connectivity to 91.24% of the population by 2021. In addition, the program intends to deploy networks that are capable of supporting services with uplink and downlink speeds of a minimum of 300Mbps, covering 95% of the households in each province. In November 2020, MINECO awarded the broadband provider Adamo funding worth €72m ($86m) to lay fiber-optic infrastructure, which will provide 1Gbps connectivity to 450,000 unserved households in the rural regions of 19 provinces. The provider intends to invest around €165m ($197m) in the rural fiber rollout with the aim of reducing the digital divide.

In February 2020 MINECO published a consultation on a proposal to revise its PEBA-NGA €400m ($477m) program for 2019–21. The ministry decided to expand ultrafast broadband networks in the gray areas and provide connectivity to 1.5 million additional residents. In July 2020, the council of ministers approved the proposal to grant €150m ($179m) for deploying FTTH networks in underserved regions under the PEBA-NGA program.

Telecom facilities

Spain has seen significant uptake of duct access that has helped to drive infrastructure-based competition in next-generation access (NGA) broadband. FTTH is being rolled out by alternative operators as well as the incumbent because of high-quality, low-cost duct access and the comparatively high number of multidwelling units in cities. There is also a range of active remedies in place in addition to passive obligations with associated QoS requirements including installation timescales and fault-resolution timescales. Some countries around the world, including Spain, have granted an exclusivity period to the first operator that builds fiber in a designated area to encourage fiber investments. Meanwhile no fiber wholesale obligation is required in subnational competitive areas (where at least three next-generation networking players are providing service in the area).

In Spain there is a focus on ensuring fiber network investment by reducing costs or other barriers to network deployment and encouraging infrastructure sharing, although in competitive areas regulation is reduced. This has been the case since at least 2009, when the regulator reviewed the market for wholesale broadband access and defined it for the first time as incorporating wholesale broadband access regardless of whether this used public switched telephone network (PSTN) or fiber-to-the-x (FTTx) technology (up to 30Mbps). The market was reviewed again in 2016, and since then the competition regulator the CNMC has differentiated obligations for copper and fiber networks based on their differing competitive pressures in various geographical areas. It also introduced a controversial new obligation requiring the incumbent, Telefónica, to provide its competitors with access to its FTTH network only across certain parts of the country where there are fewer than three competing fiber networks. In 2020 the regulator also placed an obligation on Telefónica to provide wholesale access to its physical infrastructure for the deployment of fiber networks. Unlike in Singapore, the bulk of next-generation network investment in Spain has been funded privately. Access to Telefónica's poles continues to present a bottleneck for the deployment of ultrafast access networks in areas away from urban centers because of their operational difficulties and high costs, but the operator is looking to address this.

Key to the high levels of FTTH coverage in Spain has been the low investment requirement in order to roll out FTTH, which has encouraged private investment in infrastructure. The cost to connect premises is far lower than in many other places around the world, and this has been achieved through extensive access to ducts at regulated prices to enable faster and cheaper deployment of high-speed networks. Maintaining a competitive market has pushed the incumbent to roll out fiber to compete with alternative telcos and cable operators.

China

National broadband plan and universal service obligations

China has been ambitious with its connectivity targets considering the size of the country and scale of the population. The country currently sits in fourth position in the FDI, having witnessed the highest increase in its FDI score of all the cluster 1 countries in the latest update.

The State Council launched its national broadband strategy Broadband China in 2013. Initially the increase in the ratio of FTTH users was slow. To push forward the fiber access network construction, therefore, in 2014 the Ministry of Industry and Information Technology (MIIT) and the Ministry of Housing and Urban-Rural Development (MHURD) made a joint announcement about the new national standards for fiber preinstallation and sharing with operators in new buildings, which created a clear requirement for fiber cabling and installation engineering and removed obstacles from property management organizations. According to the new standards, before new buildings receive a sales permit, the access fibers to every household and the rooms for communication device deployment must be completed and have passed the acceptance tests. All engineering costs should be covered by building developers. With strong support from government, the fiber access ratio among all broadband users increased significantly from 2015. By the end of 2020, 92% of home broadband users in China were using fiber access technologies.

Between 2016 and 2018, the MIIT and National Development and Reform Commission (NDRC) jointly led a three-year action plan for the construction of communications infrastructure with a budget of CNY1,200bn ($181bn). The plan aimed to support the development of high-speed fiber optics and the construction of advanced mobile broadband systems and global network facilities. To execute this plan, the government focused on 92 selected infrastructure projects, with a total investment budget of CNY902.2bn ($136.3bn). Prioritizing certain projects allowed the government to focus on the areas most in need.

In 2019 the MIIT proposed a “dual-gigabit acceleration, same speed for same network” plan to promote fixed broadband gigabit applications in order to keep pace with bandwidth-hungry services. This involves utilizing 10G PON technology to create a dual-gigabit broadband service that features both wired and wireless gigabit broadband.

There is currently no regulation imposing a broadband USO across the entire country. However, the MIIT supports the upgrade of fiber broadband in 130,000 administrative villages, including 43,000 poor villages. By November 2018, 96% of administrative villages had achieved optical-fiber access, and the country expanded broadband infrastructure to 94% of underserved villages, which was ahead of schedule according to the country’s broadband strategy, which required operators to expand broadband infrastructure to 98% of underserved villages by 2020.

In 2021, China has shifted its focus from broadening coverage of the fiber network to increasing the speed and improving the quality of broadband services. In March 2021 the MIIT released a plan to expand the gigabit network to cover 200 million people by the end of the year and 400 million by the end of 2023. The government also targets 10 million gigabit users by the end of 2021, a goal it is already well on its way to achieving. Additionally, the government has set a target that 5G should be available in all areas above the county level and in some key townships by the end of 2021.

Telecom facilities

Telecom towers, poles, ducts, base station equipment, and transmission lines must either be shared for existing facilities or co-constructed for new facilities in China. No duplicated construction of such infrastructure is allowed in any location unless prior approval is received from the provincial telecom regulators. Other types of telecom facilities (e.g., optical-fiber cables) must be shared to the extent that conditions permit.

Cluster 2

Chile

National broadband plan and universal service obligations

Chile has one of the most developed telecom markets and is one of the most connected countries in Latin America. It jumped 11 places in the FDI in the latest update, largely because of a significant increase in fiber coverage and household penetration, which in turn led to an almost doubling of average downlink speeds to 180Mbps.

A major challenge in Latin America is how to make the best use of the region's limited available resources in order to reduce the digital divide. However, an effective regime passed by the Chile's telecom regulator Subtel has encouraged competition in all market segments, while successful digital agenda measures from the government have enabled broadband connectivity in many rural areas.

Successive Chilean governments have had several digital strategies in place over the past few years. In May 2013, the government announced the start of the Imagine Chile Digital Agenda, a digital strategy built on five strategic pillars, one of which focuses on connectivity and digital inclusion to facilitate citizens' access to the internet and to information society services. The original plan was updated in November 2015 with the launch of a Digital Agenda 2020, which aimed to achieve, among other things, 90% broadband household coverage and 20% fiber coverage, the latter of which it has comfortably surpassed.

The key to fiber success in Chile has been a network that is operated by the private sector but that is funded by direct subsidies. In 2019 the government introduced several programs aimed at improving connectivity across the country, including the National Fiber Optic (FON) project and the Digital Matrix program. In May 2019 President Sebastián Piñera announced the FON project to deploy more than 10,000km of fiber-optic lines in 13 regions, including 202 nodes located in 186 districts. The initiative obtained a subsidy of CLP86bn ($110m), and the main objective of this project is to make Chile the digital hub of Latin America. The regulator awarded five of the six macrozones of the FON project to WOM in April 2020. This initiative, which will come into operation in 2022, aims to improve connectivity of more than 2.5 million inhabitants in 186 communes. In March 2020 the regional government announced its plans to allocate a subsidy of CLP6bn ($8m) to reduce the digital divide in the Tarapacá region in the extreme north of Chile. The initiative aims to deploy 1000km of fiber-optic cable and implement 41 Wi-Fi zones in 31 areas that allow users access to free internet services. Besides this, in 2019 the government announced a new Digital Matrix program, which aims to reduce the digital divide. These initiatives were reinforced during the pandemic to ensure progress did not slow down, and there is a commitment to connect the last 1,495 localities to the internet before 2025. Public and private sector are working together to achieve these challenging goals.

A USO for broadband in Chile does not exist. Instead, the country operates a Telecommunications Development Fund (FDT), which was founded in 1994 as a government tool to give marginal and isolated sectors of Chilean society access to telecom services (though it only came into effect in 2011). The FDT finances projects totally or partially, but these projects are managed by private entities. It chooses the candidates that best address its technical, service, and time requirements through public tenders. The fund is intended to improve the coverage of telecom services, particularly in rural areas and low-income urban areas. The FDT is funded by contributions annually assigned to it from the public sector budget, although it may also be open to other sources of financing. Subtel sets out an annual plan of projects to be subsidized based on specific requests it receives. It does so in cooperation with the municipalities, which advise it of the needs of each local community. Subtel receives requests until May each year, and

requests can come from operators, local or regional authorities, universities, NGOs, or other third parties. The program is evaluated by the council, which then assigns the approved projects by means of public tenders. By June 2019, two tenders for new fiber projects were planned to be launched: National Fiber Optic, 8,474 fiber-optic kilometers to cover 3.2 million inhabitants in 186 communities, and Tarapacá Fiber Optic, 1,000 fiber-optic kilometers to cover 230,000 inhabitants in seven communities.

Telecom facilities

In January 2020 the government announced its plan to remove 3,000km of disused aerial cables by March 2022. In August 2019 the president announced a new law to regulate the laying of aerial cables across the country. The law establishes that telecom companies are responsible for the installation, identification, modification, maintenance, arrangement, transfer, and removal of their aerial or underground cables. Disused aerial and underground cables classified as waste by municipalities must be removed by the responsible companies by March 2020, except in special circumstances. In cases of failure to remove the cables in time, companies were fined up to CLP50m ($0.06m). In 2018 a law came into force in Chile that guarantees residents of apartment blocks and other buildings the right to freely choose their telecom provider. The law put an end to the monopolistic practice of exclusivity contracts with real-estate companies for fixed-line telephony, broadband, and pay-TV services. A code of good practice was implemented to avoid conflict in existing buildings where a new operator plans to offer services.

Back in June 2012, Subtel issued a decree that sets out the rules for obtaining and operating a license as an intermediate operator that provides physical telecom infrastructure. These operators face an obligation to provide access in a nondiscriminatory way to all operators that request it, based on physical and technical availability. They cannot sign exclusive deals with any one operator. Every six months, they must inform Subtel of the actual degree of usage of their infrastructure compared to the maximum declared when the license was issued. Usage reporting is broken down by geographic region, type of service, type of infrastructure, and the specific operators provided with infrastructure access.

France

National broadband plan and universal service obligations

France is one of the leading Western European countries within cluster 2 and has seen significant improvements over 2020 in FTTP coverage, FTTH and FTTBusiness penetration, and both downlink and uplink speeds.

The country explicitly favors FTTH connections but accepts that currently other technologies must also be deployed to ensure nationwide high-speed coverage. Initial national broadband plan targets were less ambitious than the Digital Agenda for Europe's targets to deliver 30Mbps broadband capability by 2020, but the country successfully achieved its first broadband target of 50% NGA coverage by the end of 2017, and take-up rates of these services have continued to improve: by the end of 2020, 55% of households were covered by the FTTH network.

In February 2020 the government set out a more ambitious plan that aims to achieve 100% fiber coverage by 2025. However, setting coverage targets is only one part of the story. For these targets to be achieved, particularly in rural areas, sufficient funding needs to be made available. 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 rollout of

FTTP services. In September 2020, the government also announced a new stimulus package worth €240m ($264m) to extend the reach of fiber networks in rural areas. This follows a slowdown in the rollout of fiber due to the COVID-19 pandemic.

Broadband does not form part of the USO in France.

Telecom facilities

Facilities sharing is becoming an increasing focus for regulators as the desire for competition in next-generation network deployments grows. France has seen significant uptake of duct access, which has helped to drive infrastructure-based competition in NGA broadband.

The French regulator has concentrated on passive remedies such as nationwide duct access and has legislated for symmetric FTTH wholesale access to the final segment across the country and for vertical access obligations. Take-up of the duct access product has been high and has been one of the key reasons for extensive fiber deployment across the country. The priority for ARCEP has been infrastructure-based competition and ensuring the market conditions are conducive to encouraging private investment. Nonincumbent operators have been actively building FTTH networks in France using duct access and dark fiber and following a co-investment model, often with the incumbent. In general, there has been a preference for using sewer access, and because of the number of urban multidwelling units, rollout of FTTH has been prioritized. The regulator has applied geographic remedies based on population density and potential infrastructure competition, with regions split into very dense and less dense areas. The remedies were applied through legislation and are symmetric. While most deployments have been privately funded, FTTH rollout in more rural areas has been fulfilled through public initiative networks.

Orange is obligated to provide access to its civil engineering infrastructure and fiber-passive access. In its sixth cycle of market analysis (2021–23) concluded in December 2020, ARCEP designated Orange as the operator with significant market power and is working on implementing a symmetrical regulatory framework on all FTTH operators. The 2020 market analysis focused on regulating pro-investment to make fiber the new benchmark fixed infrastructure and on promoting competition in the B2B segment by deploying fiber network. Orange is obligated to provide access to the 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). Orange's civil engineering infrastructure is the main nationwide infrastructure and is in many cases the only infrastructure available at the local level for deploying a new fiber-optic local loop.

Copper switch-off

With several European countries gradually phasing out copper networks, the national regulator ARCEP has proposed guiding parameters in a draft consultation, such as a five-year notice period, availability of alternative operators, and the level of fiber coverage required before an operator can switch off its copper network. It will be important that this process is effectively managed so that no customer is left without alternative provisioning and to ensure operators are encouraged to deploy more fiber networks safe in the knowledge that they will not need to maintain and fund two coexisting networks indefinitely.

There is sometimes a reluctance by incumbents to commit to fiber infrastructure because of the high investment required coupled with a lack of awareness among customers of the benefits of migrating, so fiber deployment has been hampered for a few operators. Regulatory factors such as long notice periods for copper switch-off, associated wholesaling requirements for the shutdown of copper exchanges, and higher consumer switching costs have further contributed to delays in the transition process. On the other

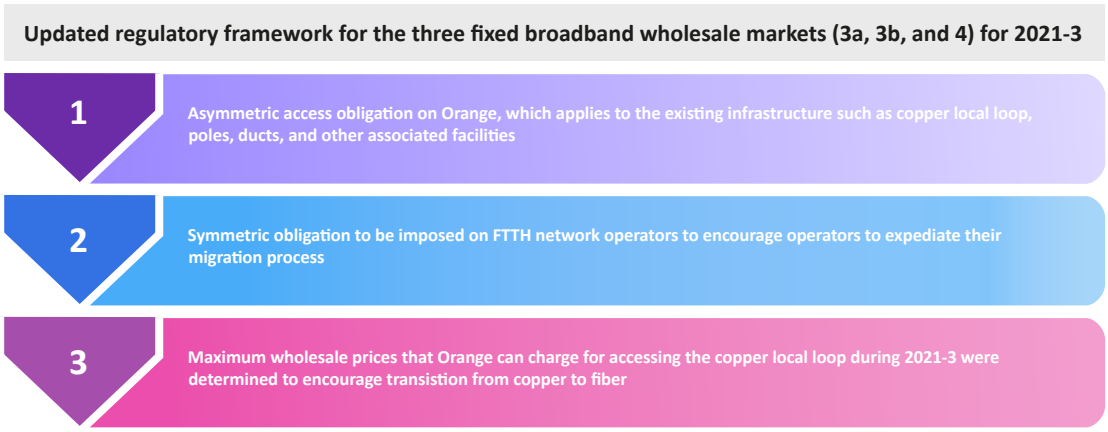
hand, rising demand for ultrafast broadband and several government initiatives have encouraged the shutdown of legacy networks in some places.

France has embarked on a number of regulatory updates to take account of the migration to fiber. In December 2020, ARCEP concluded its fixed market analysis and decided to adopt the updated regulatory framework for the three fixed broadband wholesale markets 3a, 3b, and 4 during 2021–23 and include regulations related to the transition from copper to fiber networks. The updates to the framework included the following:

- Asymmetric access obligation is to be imposed on the incumbent telco, Orange, to iron out the competition imbalances observed in the telecom market. The asymmetric access obligation applies to the existing infrastructure such as copper local loop, poles, ducts, and other associated facilities. ARCEP has decided not to lift this asymmetric regulation until more users have been migrated.
- Symmetric obligation is to be imposed on FTTH network operators to preserve fair competition in the new fiber market and encourage operators to expedite their migration process.
- Determine the maximum wholesale prices that Orange can charge for accessing the copper local loop during 2021–23. The wholesale price affects retail prices, which can significantly influence an end user's decision to either continue with legacy services or switch to a new network. If users switch to a new network, the legacy copper network can be retired.

Meanwhile, Orange has requested permission 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 to make it less financially attractive to use copper-based services and encourage migration to fiber. The decision was not finalized at the time of writing.

Figure 15: France's regulatory framework



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ARCEP has been actively involved in encouraging the migration from copper to fiber networks within 10 years. In line with the regulator's objective, Orange has already started trials for a seamless switch-off process and is planning to switch to the fiber network nationwide between 2023 and 2030. Under the agreement between Orange and the government, the operator decided to allocate €500m ($603m) for maintenance of the aging copper network during 2021 to ensure existing customers are not affected by falling quality levels while the focus shifts away from copper.

Cluster 3

Peru

National broadband plan and universal service obligations

Peru is a leader within the cluster 3 list of countries. It has a reasonable FTTP coverage of 27%, but penetration of FTTH is modest and average broadband speeds are still low.

In the last two years, the telecom regulator Osiptel and the Ministry of Transport and Communications (MTC) have introduced several innovative measures aimed at improving coverage. While overall broadband coverage has dramatically improved, the biggest challenge the country now faces is underutilization of its high-speed network. As part of the national broadband plan, in July 2016 Peru completed the deployment of a national fiber-optic backbone, the RDNFO, connecting 180 district capitals and aiming to reduce internet access costs by up to 80%. The total investment for the project, which involved laying 13,500km of fiber cable connecting 22 regional capitals and 180 district capitals, was $333m. By September 2018 ProInversion launched tenders to build 15 regional fiber broadband networks that will be integrated with the RDNFO. These projects add up to 21 regional broadband projects designed to reduce the digital divide. In March 2019 the MTC announced the activation of the first rural broadband project in the Lambayeque region. The project aims to connect more than 355 localities and 500 public institutions through the implementation of 650km of fiber cables. In May 2019 the MTC signed a financing contract with the Bandtel Consortium for the implementation of the Huanuco and Pasco regional broadband project. The MTC financed more than $148m for this project, which involves laying 2,257km of fiber cables. The project aims to benefit more than 300,000 people from 612 rural localities. Meanwhile, a regional project in Junin will benefit 249,000 inhabitants in 353 rural locations. In addition, a broadband project in the Lima region aims to benefit more than 191,000 inhabitants and 477 institutions through the implementation of 1,797km of fiber cables. The projects will be financed through the country's national telecom fund, Pronatel.

However, the aim of the RDNFO project was to help Peru increase its fixed broadband adoption rates to 50% of households by 2021 rather than purely to increase coverage, and so far the fiber backbone has been underutilized. The RDNFO has been held back because of excessively high pricing, service provider installation delays, lack of flexibility to install additional ports, infrastructure duplication from operators building their own fiber networks, and less than 20% of the capacity being used. The government is in the process of establishing how it can be utilized in future. Despite challenges with utilization, Osiptel has been proactive in already suggesting several options to improve commercial usage of the project, including modifying the backbone's price structure to bring it in line with current market conditions and providing more flexibility to access procedures. After two years of negotiation, Azteca, which manages the RDNFO, submitted a proposal requesting termination of its participation in the contract of the network project, but in June 2020 the MTC submitted a counterproposal to Azteca to try to mitigate the termination. It has suggested that through the use of its universal services fund (Pronatel), the government would take over the responsibility of handling the operation and maintenance of the backbone network for up to three years from the date of Azteca's withdrawal. This is still pending in the regulatory agenda, with a clear roadmap still in the planning stages.

Telecom facilities

The MTC published a draft rule to regulate the sharing of active infrastructure among the operators in November 2020. The ministry will set standards related to conditions, procedures, and requirements for the approval of infrastructure-sharing agreements. This initiative is expected to reduce the cost of investment and encourage wider network expansion, promote network development in underserved areas, and help reduce the environmental impact of installing antennas. In May 2021, the Peruvian ministry collaborated with the South Korean Ministry of Science and ICT (MSIT) and the Korea Information Society Development Institute (KISDI) to come up with an infrastructure-sharing model to reduce operational and maintenance costs in remote areas. The agreement aims to reduce the digital divide and improve the deployment of networks in rural areas of the country.

To encourage better connectivity in the rural regions, the MTC also proposed leasing antennas from the Community Communication Support Project and Community Communication Support Project Conglomerate in December 2020.

Major suppliers in the country are obligated to allow other public telecom service providers access to the physical or virtual colocation of their infrastructure and to their pipes under nondiscriminatory conditions and at reasonable rates. In addition, the incumbent, Telefónica, must offer access to its ducts at fair and reasonable prices. Since 2011 the Peruvian government has ruled that large infrastructure projects in the country must include ducts for the installation of fiber-optic cables.

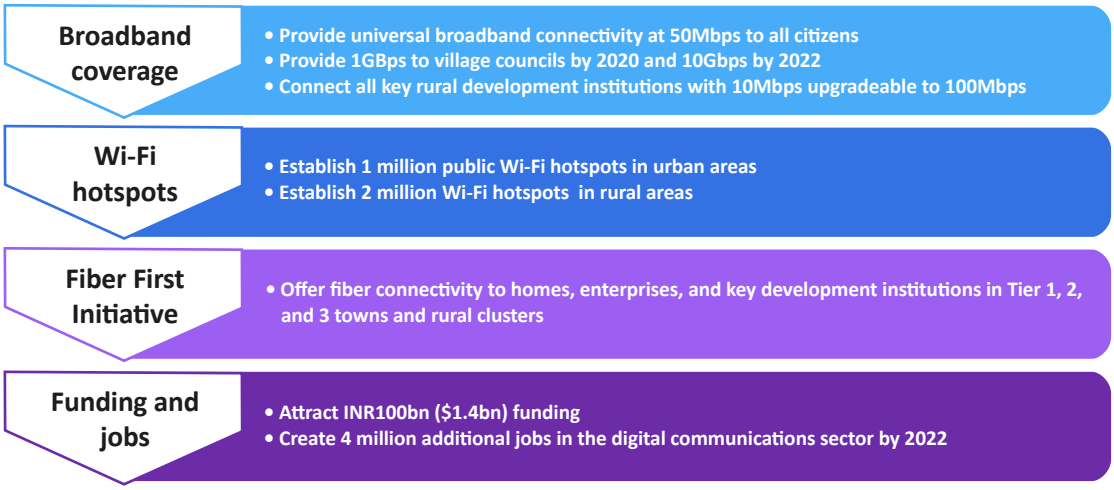
India

National broadband plan and universal service obligations

India is currently situated toward the bottom of the FDI but is one of the world's largest and fastest-growing telecom markets. On the broadband front, the government finalized its National Digital Communications Policy 2018 and renamed the Telecom Commission (part of the Department of Telecommunications) the Digital Communications Commission in September of that year. The policy seeks to attract $100bn in investment and extend connectivity to all areas by 2022. It aims to implement the following broadband initiatives, to be financed through a combination of universal service obligation fund (USOF) and public-private partnerships:

- Provide universal broadband connectivity at 50Mbps to all citizens
- Provide 1Gbps connectivity to village councils by 2020 and 10Gbps by 2022
- Connect all key rural development institutions with 10Mbps upgradable to 100Mbps
- Establish 1 million public Wi-Fi hotspots in urban areas
- Establish 2 million Wi-Fi hotspots in rural areas
- Fiber First Initiative to offer fiber connectivity to homes, enterprises, and key development institutions in Tier 1, 2, and 3 towns and rural clusters
- Facilitate connectivity to all uncovered areas
- Attract INR100bn ($1.4bn) and create 4 million additional jobs in the digital communications sector by 2022

Figure 16: India's broadband initiatives



Source: Omdia

By March 2020 the government reported that 14 universal service projects were underway.

In December 2019 the government launched the National Broadband Mission (NBM) with the following key objectives:

- Broadband connectivity to all villages by the end of 2022
- Investment of INR70tn ($944bn) including INR7tn from USOF
- Laying of 3 million kilometers of optical-fiber cable and increasing the tower density from 0.42 to 1.00 towers per 1,000 people by 2024
- Enabling universal and equal access to broadband services across India, mainly in rural and remote areas

In March 2019 the state-owned telco BSNL launched a new initiative with the support of the national regulator TRAI: Digital Gram Sewaks will deliver high-speed optical fiber internet to rural areas. The operator has partnered with local entrepreneurs in these areas to provide connections to homes using BSNL's network. The partnership works on a revenue share basis whereby local firms maintain the last mile of connectivity to customers. Through the initiative, customers are given speeds of up to 100Mbps along with various options for daily data downlink allowances ranging from 5GB to 50GB per day.

By January 2020, more than 146,717 village councils were connected by optical-fiber cable, and 132,993 village councils were service ready. The government also aims to offer last-mile connectivity through Wi-Fi or any other suitable technology to access broadband services. It aims to provide five access points (two access points at public places and three access points at government institutions such as schools and hospitals) per village council.

Telecom facilities

Sharing of passive infrastructures such as buildings, towers, dark fiber, duct space, and right of way is permitted (and mandated) for a set period of time for operators holding valid unified access service licenses (UASLs). The Unified License (UL) also allows for the provisioning of point-to-point bandwidth from one licensee's infrastructure (within the service area) to other licensed telecom service providers (TSPs) for their own use (resale not to be permitted). Sharing of switches by licensees for providing other licensed services is permitted. The regulator has prioritized updating the regulatory framework to advocate active as well as passive remedies. In March 2017, TRAI published recommendations on the proliferation of broadband through public Wi-Fi networks. As per the recommendation, it proposed to amend the terms of the TSP license to allow the sharing of active infrastructure, in line with the UL. In addition, it recommended that clarification should be provided on the sharing of active Wi-Fi infrastructure such as Wi-Fi routers, access points, and backhaul.

The regulator has been proactive in updating licensing conditions to ensure the country has the best chance of reaching good levels of fiber coverage. Currently, passive infrastructure such as dark fiber, towers, and duct space can be created and shared by Infrastructure Providers Category-I (IP-I) and TSPs, but active infrastructure creation and sharing is permitted for telecom licensees only. However, in March 2020, TRAI recommended that the IP-I registration holder should be given permission to own, establish, maintain, and work all infrastructure items, equipment, and systems that are required for establishing wireline access network, RAN, and transmission links. The scope of the IP-I Registration now covers right of way, optical fiber, feeder cable, antenna, duct space, base station, tower, in-building solution (IBS), distributed antenna system (DAS), and so on, so IP-I can share passive as well as active infrastructure.

Nigeria

Thanks to its historical lack of investment in fixed broadband infrastructure, Nigeria is near the bottom of the FDI. In 2013 Nigeria set out its previous National Broadband Plan, which aimed to improve coverage and penetration rates to 80% and 42% respectively by 2018. However, by 2018 broadband coverage was approximately 27%, far off the target. In 2020 most broadband accesses (over 99%) were still provided over mobile networks, and 4G coverage had risen to 37% of the population.

In March 2020, the government announced a new National Broadband Plan 2020 – 2025 with the aim of achieving 100% coverage of 10Mbps connectivity in rural areas and 100% 25Mbps connectivity in urban areas by 2025. There are interim targets of 10Mbps in urban areas and 5Mbps in rural areas by 2023 with a penetration target of 50% of eligible individuals by 2023 and 70% by 2025 (up from 30% in 2020).

The plan aims to improve digital literacy and gender equality for digital access and to improve affordability of devices and connections. Funding will come from coordinated government spending, and support will come from the Universal Service Provision Fund (USPF), Rural Broadband Initiative (RUBI), and National Information Technology Development Agency (NITDA) Fund for ICT development.

The plan stipulates a range of fiber targets, shown in **Table 6**.

Table 6: National Broadband Plan 2020 – 2025, fiber targets

Details	Indices	2025 target
Schools	Ensure fiber build such that institutions are within 5km of a fiber manhole or with a fixed connection	100% of tertiary institutions 50% of secondary schools 25% of primary schools
Health facilities	Ensure fiber build such that institutions are within 5km of a fiber manhole or with a fixed connection	Connecting one general or major hospital per local government area and federal medical centers
Local government	Build in state capitals and major cities	90% of (774) local government HQs (secretariat) connected by fiber 10% connected by satellite/fixed/other in remote areas
Fiber to towers	Percentage of towers connected	60% of towers connected
Fiber infrastructure	Open access shared fiber	Minimum 120,000km needed Nonoverlapping routes All major roads, federal and state Minimum of 90% of local government areas

Source: Omdia © 2020 Omdia

Infrastructure is at the core of any national broadband plan, and to overcome the challenges faced in Nigeria, the National Broadband Plan 2020 – 2025 set out the following recommendations with regard to optical fiber infrastructure:

- Create regulatory guidelines and establish a coordinating unit of the Nigerian Communications Commission to ensure nonduplication of fiber builds on the same routes by various operators.
- Enforce an open access model with pricing regulations on existing and new fiber builds.
- Coordinate ROW access across various entities to facilitate approved builds.

Best practices on fiber development and key tools to enable faster deployment

The COVID-19 pandemic has amplified the need for fast, reliable, and low-latency connectivity, so policymakers are increasingly pushing for countries to evolve toward becoming gigabit societies. In addition, as connectivity in more developed markets becomes increasingly ubiquitous, focus has been shifting away from competitive pricing and toward speed, reliability, and content bundling. Therefore, policymakers' conversations about the digital divide have also shifted from who has and has not been connected and onto higher speeds that support a better QoE. The public no longer needs to merely access basic internet browsing; instead broadband services must be capable of supporting a range of applications such as media streaming and video calling. Full-fiber (FTTH/B) networks are becoming the preferred solution for these purposes.

However, when looking to deploy fiber, operators face a number of challenges that require intervention from regulators and governments. These include adoption rates, switch-off of the copper network, resource duplication (which reduces ROI), ROW accessibility and approval, construction costs, lack of information and collaboration around construction, problems with access to physical infrastructure, and concerns about whether sufficient financial resources will be available to ensure full-fiber coverage. Streamlining and simplifying ROW approval processes is therefore critical. Promoting and facilitating sharing of infrastructure should also be a priority for regulators and governments, while encouraging or even mandating the rollout of fiber to new buildings could be another effective policy solution. A range of regulatory tools as well as demand-side and supply-side public policies are required to improve broadband affordability, adoption, coverage, and access.

Ubiquitous access to broadband is a crucial element in any country's digital agenda and national broadband plan. Accelerating digital infrastructure deployment and reducing the digital divide are therefore high up on most telecom policy agendas. Regulation and public policy have a key role to play in removing any barriers, and a better-connected world can only emerge if there is collaboration between governments, regulators, and operators to encourage investment. While governments and regulators can set clear connectivity targets and lower the financial and regulatory barriers to broadband access, private investment must also be fostered, and conditions for good levels of competition must be set.

There are a number of regulatory policies that are seen as best practice for encouraging the deployment of very-high-capacity networks:

- Facilitating deployment through municipality approvals, using existing resources (government buildings, streetlights, ducts, etc.) and sharing infrastructure/facilities
- Introducing flexibility in partnership arrangements such as allowing agreements between players / cofinancing / collaborative models / public-private partnerships / innovative partnerships
- Providing financial assistance through investment support, incentives, and subsidies, for example, universal service funds

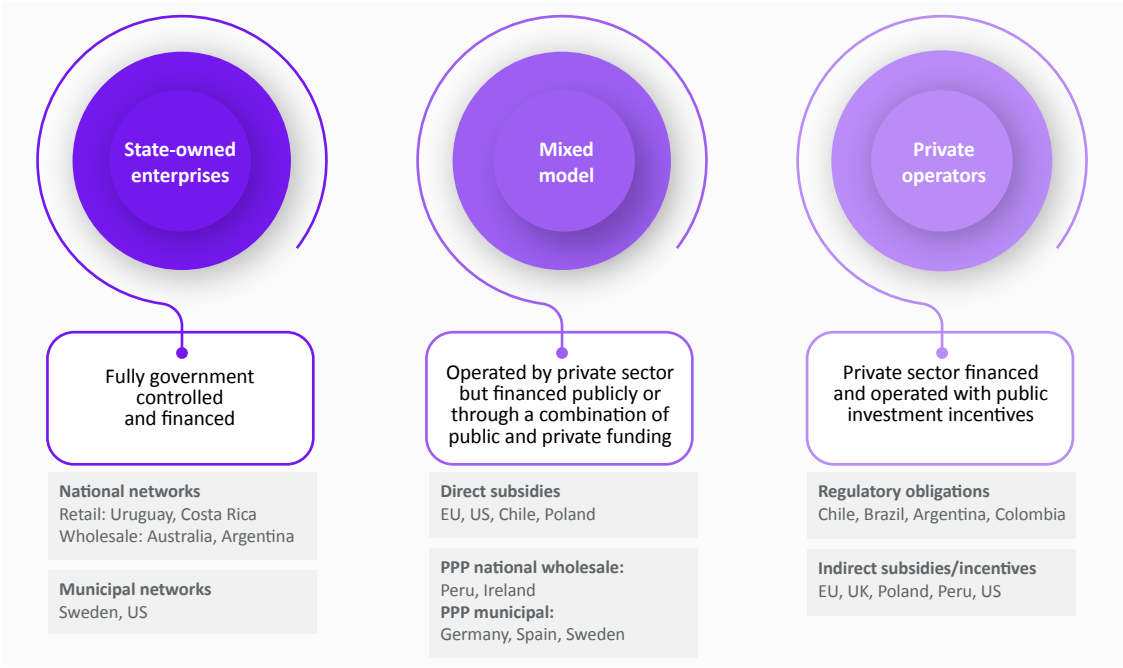
- Implementing regulatory flexibility including the removal of outdated or nonessential regulation
- Improving access to telecom facilities and physical infrastructure, improving procedures for rights of way and accessing public infrastructure, and broadband mapping
- Setting coverage or minimum speed targets through a national broadband plan or USO

Financing tools

The pandemic has highlighted the remaining holes in broadband maps and reinforced the need to close the digital divide and designate networks as critical infrastructure. So ubiquitous broadband access is a key element in any country's digital agenda. High-speed network rollout is commercially viable only in densely populated areas; therefore, nationwide deployment will require some form of government funding. The key challenge is ensuring widespread broadband rollout is funded and fiscally sustainable while still preserving private incentives to invest. This challenge will grow in the coming years when economically viable areas are covered but the gap in rural areas with scattered populations widens.

Various forms of financing are being used to ensure that these areas are not left behind: publicly built networks (e.g., Australia and Argentina), publicly built municipal networks (e.g., Sweden and Germany), public-private partnerships (e.g., Mexico and Peru), direct or indirect subsidies (e.g., the EU), physical resources access (i.e., ducts, poles, land access, e.g., Mexico and Sweden), and regulatory coverage or service obligations (e.g., Chile and Brazil). There is no single right answer, but at the very least, governments should certainly get more involved in guaranteeing broadband connectivity for all citizens. However, it is also crucial to adopt the most suitable investment model to reflect national circumstances. This does not necessarily involve a state-owned company that is controlled and financed by the government: public-private partnerships or private-led deployment with government incentives could be more appropriate in some cases. 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 17: Investment models



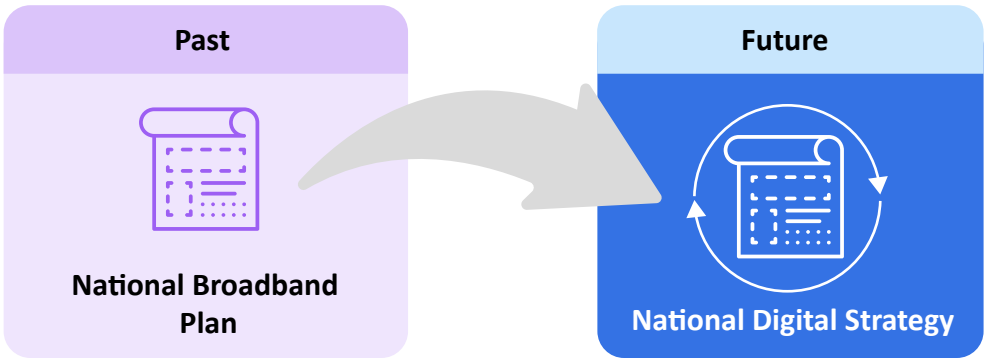
Source: Omdia

National broadband plan targets and universal service obligations

To varying degrees of detail, most countries around the world have outlined some form of national broadband plan. For the less economically developed nations, these plans should focus on improving broadband coverage before looking to expand high-speed networks such as fiber. Meanwhile, the more progressive countries should focus on developing national digital strategies. Developing comprehensive national digital strategies that ensure citizens can use connectivity in a transformative way to bring about innovation and growth, rather than focusing purely on broadband infrastructure deployment, will be crucial in building the case for fiber deployment and encouraging further investment.

National broadband plans aim to only guarantee infrastructure availability and deployment, and have proven not to be enough on their own: the targets of many countries have not been achieved, so gaps are widening. 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 and a strategy to get citizens to use it effectively. Combining these strategies to reflect each country's resources and capabilities maximizes the benefits of digital transformation for innovation, growth, and social prosperity. Within the best digital strategies, governments tend to still set coverage objectives in an effort to ensure that connectivity continues to improve. Leaders agree that unlocking the benefits of ongoing digital transformation means addressing the challenges this creates, particularly for jobs, skills, and trust. A few advanced countries have already defined their national digital strategy, but many more are expected to do so in the coming years.

Figure 18: Digital transformation is now high on the global digital agenda, so national broadband plans should be transformed into all-encompassing national digital strategies



Source: Omdia

There are many examples of governments around the world that have already moved from pure national broadband infrastructure deployment plans to comprehensive national digital strategies. For example, in 2017 the UK launched its national digital strategy, which looks at connectivity, digital skills and inclusion, development of digital sectors, helping businesses go digital, cybersecurity, digital government, and unlocking the power of data. Meanwhile, Singapore's Infocomm Media 2025 plan has three main pillars:

capitalize on big data and analytics, continue to deepen the converged industry ecosystem, and better connect people. The first phase, involving extending connectivity through the deployment of aboveground boxes and technologies from a heterogeneous network (HetNet), was completed at the end of 2015. The other two phases involve introducing real-time data collected through a mesh of sensors nationwide.

In addition to introducing a national broadband plan and digital strategy, many regulators look to implement a USO to ensure that basic telecom services are available at an affordable price to all households and businesses. For many countries, functional internet access has been included in USOs for some time. This has usually been defined as basic dial-up speeds, but as demand for greater data volumes increases and with improvements in average connection speeds, there is an argument to introduce a broadband USO, which better reflects today's technological capabilities. However, these are mostly in mature markets, and usually the broadband speed targets that have been adopted are fairly low, ranging from 1Mbps to a potential 30Mbps. Smaller countries seem to generally be ahead on this issue, 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. In Singapore, for example, an operator faces a USO to install fiber-optic connections on request. It is clear that regulators and policymakers cannot rely on market forces alone to deliver ubiquitous high-speed broadband without some kind of regulatory intervention, but USOs have not been universally proven to be the best means at achieving this goal. Rather than explicitly setting USOs to install fiber connections, many countries have instead been using universal service funds as a source of financing to support one-off investment projects to deploy higher-capacity networks.

Copper switch-off rules and regulating fiber services

As legacy copper networks become harder to maintain, operators around the world are starting to consider phasing them out, but this generally requires input from regulators. It is important to retire legacy copper networks so that incumbents do not encounter the unnecessary costs of running two parallel networks and can free up investment for further fiber deployment. Best practice for countries heavily reliant on copper demands that migration away from copper does not cause disruption for consumers. Therefore, some regulators have imposed minimum notice periods to minimize the effect on the market and ensure the transition is carried out under fair and competitive terms. This needs to be coupled with the removal of regulation on the incumbent's copper products in areas where full fiber is built and with 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, thereby building the case for more investment in underserved areas. Until the deployment of fiber has been sufficiently accelerated, it is better for regulators to continue not to regulate full-fiber services. In Spain, for example, fiber services offering speeds of more than 30Mbps have not been regulated, and full-fiber investment has been successfully stimulated, with fiber cables being rolled out not only by the incumbent but also by its rivals.

Infrastructure sharing

Facilities sharing is becoming an increasing focus for regulators as the desire for competition in next-generation network deployments grows. In markets where there is the perception of market failure through lack of attainment of national broadband plan objectives, regulatory intervention in infrastructure sharing can be beneficial. To encourage private investment in fiber infrastructure, barriers to entry and the cost of laying fiber need to be addressed, access to ducts and poles must be simplified, and a stable regulatory environment needs to be maintained. Comprehensive passive infrastructure regulation has had a significant impact on the deployment of next-generation networks.

Alternative operators generally attribute high importance to the presence of offers of passive infrastructure access. Regulatory approaches do vary, however. Those that have seen greatest success rely on a clear, simple, and certain regulatory framework and on an effective process to handle disputes that may arise. They also outline maximum timelines for repairs and installations. Transparency can be assured with the use of online broadband network maps. It is good practice for the role played by facilities sharing in a given country to vary according to the degree that competitive outcomes are supported by infrastructure-based competition and the level of intervention perceived to be necessary to achieve investment. 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 coordination of investment within the sector and with other infrastructure verticals. Meanwhile, asymmetric regulation remains a key tool of regulators in recognition of the ownership of bottleneck assets by incumbent service providers. Spain is a market with considerable asymmetric regulation, because only the incumbent Telefónica is subject to duct and pole access (DPA) obligations. DPA regulation can also be limited to certain use cases, such as allowing access to ducts to support FTTx deployments.

The early adoption of a facilities-sharing policy contributes to improved fiber connectivity availability. In countries with significant uptake of duct access, this has driven infrastructure-based competition in NGA broadband. Requiring incumbents to grant access to telegraph poles and underground tunnels to all alternative providers makes it quicker and easier for them to build their own full-fiber networks, which cuts the upfront costs associated with laying fiber cables by approximately 50% and acts as a considerable incentive for investment.

Access to other civil engineering and rights of way is 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.

Five-year forecast toward gigabit societies

Over the next five years, leading fiber countries such as China, Singapore, South Korea, and Sweden will gradually move toward becoming truly gigabit societies. Thanks to its ambitious strategy and government backing, China will already be very close to reaching an average downlink speed of 1Gbps, with other countries such as Singapore close behind.

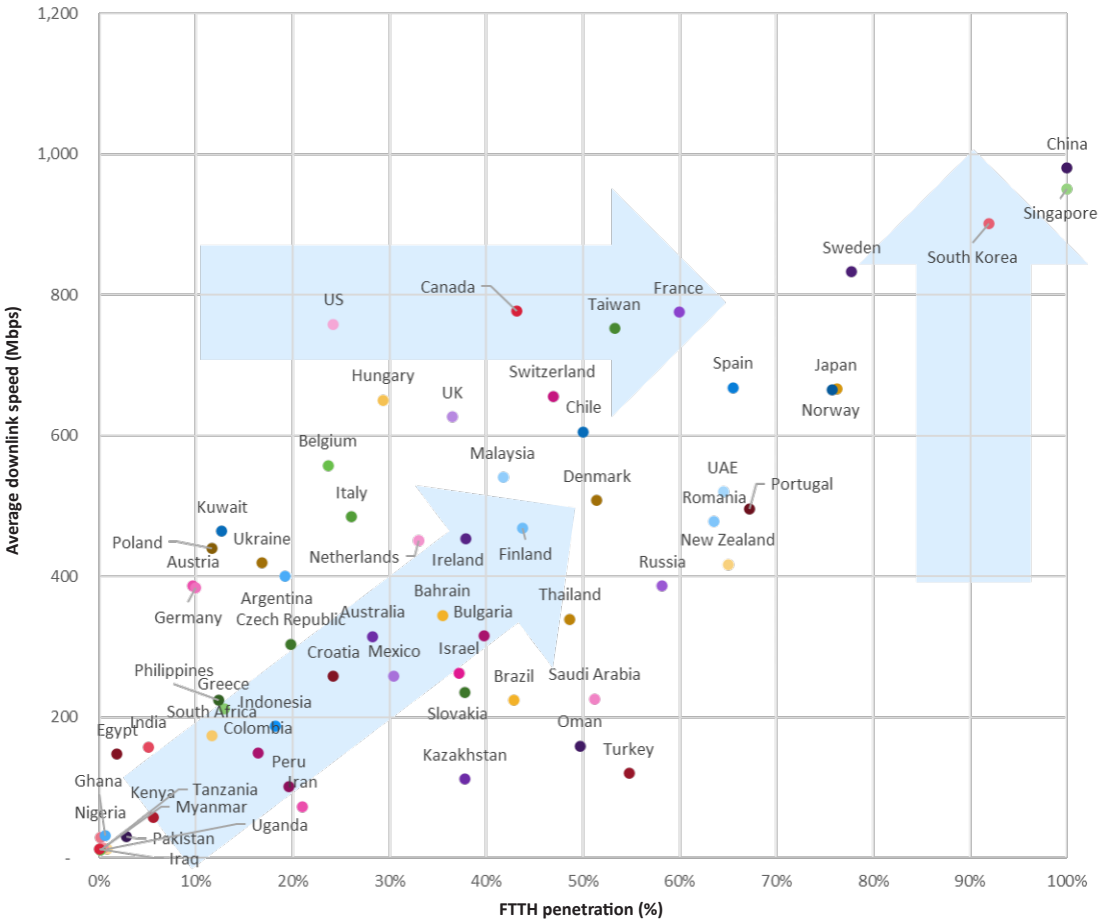
In such countries, advanced fiber PON networks will also be replacing the traditional Ethernet networks in the enterprise domain. The implementation of PON in the enterprise LAN will save the cost of cable and maintenance, because ODN is cheaper and maintenance free compared to traditional Ethernet networks comprising switches and copper cables.

We will also see fiber access further penetrate into the production systems of industrial enterprises, connecting machines (FTTM) and industrial robots. With the high-bandwidth, high-reliability, low-latency, anti-interference, and high-confidentiality features of fiber networks, time-sensitive networks can be established to implement industrial digital transformation.

Thanks to investments in advanced copper-based technologies such as G.fast and DOCSIS, many cluster 2 countries such as the UK, the US, France, and Canada will be reaching ultrafast average broadband speeds, in many cases more than 600Mbps, but as discussed earlier, to progress further and take advantage of the other characteristics of an all-fiber network, they must keep investing in fiber, especially in the more rural areas and deeper and deeper into the network, for example, FTTR and FTTM.

By 2026 emerging markets will be increasingly left behind, although some (such as India) are starting to develop more quickly. However, it is imperative that these countries continue moving toward a fiber-first network strategy.

Figure 19: Leading countries move toward becoming gigabit societies



Source: Omdia

Appendix

Methodology

The Fiber Development Index is based on metric data that has been gathered for each individual index factor. There are seven index factors in total: FTTH penetration, FTTBusiness penetration, mobile cell site fiber penetration, FTTP coverage, fiber density, upload speed, and download speed.

Where possible, independent country-level data sources (such as the national telecommunications regulatory authority) have been used. All data is for December 2020. Where data does not exist, Omdia has provided realistic estimations based on other factors such as leading service provider data or information.

All other research presented in this paper is based on Omdia's extensive research around broadband and optical fiber networks, including market trackers, in-depth market forecasts, and consumer and enterprise surveys.

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