NORTH AMERICA: BROADBAND INVESTMENT GUIDEBOOK

HOW TO FORMULATE YOUR BEST BROADBAND INVESTMENT STRATEGY

WORLD BROADBAND ASSOCIATION

This guidebook helps stakeholders examine investment in broadband infrastructure, focusing on North America. It provides insight into the key metrics stakeholders must consider, the ways they can make broadband infrastructure investment more viable, as well as potential financing and business models for broadband infrastructure deployment.

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INTRODUCTION

This guidebook is a follow-up to the earlier World Broadband Association (WBBA) document "Broadband Investment Guidebook: How to formulate your best broadband investment strategy." In line with the original guidebook, this document provides guidance and advice to all stakeholders considering investment in broadband infrastructure, this time with a particular focus on North America. The guidebook provides actionable insights related to broadband investment to stakeholders in North America including the investment community, operators, and government and regulatory authorities. In addition, it can offer insight to these groups of stakeholders in other regions trying to understand the lessons they can learn from the North America region. Members of the WBBA can discuss the topics raised in this guidebook with other companies that are part of the organization, for instance, at the WBBA's own events. For stakeholders involved in broadband infrastructure investment in North America, membership of the WBBA offers the opportunity to share experiences with the wider industry and highlight opportunities as well as challenges. The guidebook comprises the following sections:

- An overview of the key trends in broadband investment in North America
- An analysis of the key supply, demand, and profit metrics for broadband investment in North America
- An analysis of the challenges to broadband investment and how to improve the viability of broadband infrastructure development in North America
- An analysis of the different funding models that are being and have been used to enhance broadband infrastructure and broadband demand in North America
- An analysis of the business models for broadband infrastructure in North America
- Key takeaways for stakeholders in other regions based on developments in North America

EXECUTIVE SUMMARY

- Cable has a high market share in North America, and operators must weigh up several factors when deciding whether to upgrade their DOCSIS networks or switch to fiber to the premises (FTTP). Fiber investment in North America is at high levels, and investment in next-generation Passive Optical Network (PON) technologies, particularly XGS-PON, is at higher levels than in Europe. Fixed wireless access (FWA) has grown strongly in the US market. Nevertheless, the inherent capacity limitations of cellular technologies mean that operators must consider the extent to which cellular network upgrades will be necessary to support growing traffic levels.
- FTTP costs per home passed and connection costs are generally on the high side in North America in comparison with many European markets, but there are other countries that have at least comparable rollout costs. It is therefore somewhat surprising there has not been more purely commercial investment in FTTP broadband infrastructure, particularly when some of the other metrics related to the viability of broadband infrastructure rollout, such as ARPUs, are favorable.
- There are many opportunities for all stakeholders to improve the viability of investment in broadband infrastructure in North America. Operators could look to enhance the attractiveness of their retail offers by maximizing the speed benefits that XGS-PON rollouts provide or by providing an optimal customer experience through a focus on Wi-Fi. On the supply side, stakeholders need to be aware of the importance of having a trained fiber workforce to reduce deployment costs and speed up time to market. Innovative deployment techniques, such as the use of preconnectorized fiber or tools to ensure FWA receivers can be installed by subscribers, also have a role to play.
- In the US the experience of the Affordable Connectivity Program shows there is high demand for government subsidies of retail broadband plans. This increases the appeal to regulators of analyzing whether to mandate the availability of low-cost retail broadband plans aimed at lower-income households. Bidders for funding from the Broadband Equity Access and Deployment (BEAD) program in the US must be careful to consider the various trade-offs involved in the scoring criteria. More generally, government programs for broadband supply and demand should work in harmony. There is little point in subsidizing the availability of good-quality broadband infrastructure if subscription take-up remains low.

- The US broadband market looks increasingly unusual given the low levels of wholesale broadband access in the market. All stakeholders should consider whether offering wholesale access should form part of their broadband infrastructure investment plan. Wholesale access offers the opportunity to increase overall subscription take-up rates. This may be particularly important for fiber investors in the US, where fiber operators will need to attract more cable churners than in other markets. The high market share of cable operators also means many US telcos have fewer existing broadband subscribers to migrate to new fiber infrastructure, and this too increases the importance of offering wholesale access.

HOW TO USE THIS GUIDEBOOK

All stakeholders, whether from operators, governments, regulators, or the financial community, can deepen their understanding of broadband infrastructure investment by consulting this guidebook. It lays out the options for these different stakeholders that are looking to make a success of investment in broadband infrastructure. Its aim is to provide food for thought and help stakeholders understand which of the various options, for instance, for financing broadband rollouts, is most appropriate to their particular circumstances.

For those just embarking on considering investment in broadband infrastructure the guidebook provides useful input on the basic metrics that will determine the business case (see ***The key metrics stakeholders must consider when investing in broadband infrastructure in North America***). For more seasoned investors, the guidebook provides comparisons of how these key metrics such as cost per premises passed can vary between and within countries.

The guidebook will also assist stakeholders that are wrestling with questions of how to improve the business case for investing in broadband infrastructure. It discusses measures that can help stakeholders come up with new innovations for their rollouts.

Those considering how to finance a broadband infrastructure rollout can use the guidebook to look at all the different options available and discover which mechanisms have been chosen and why in different cases (see ***Broadband financing model choices***). Public authorities can analyze which financing mechanisms have been chosen by their peers and assess which option provides the best fit for their circumstances.

The guidebook can also serve as a source of inspiration for stakeholders that are considering which business model—for instance, a vertically integrated model with wholesale access or a wholesale-only model—to choose for their broadband infrastructure rollout. The section ***Broadband business model choices*** can help stakeholders decide which model will work best for them and why.

BROADBAND INVESTMENT: AREAS OF FOCUS IN NORTH AMERICA

In order to set the context for discussing broadband investment in North America, it is important to analyze how the market stands today. In North America cable broadband coverage is very high: for example, US regulator the FCC reports coverage of around 83% of residences in the US at end-2023. Partly thanks to this very high coverage, cable broadband is very important in North America and accounted for 59% of total fixed broadband subscriptions in the US at end-2023 and 45% in Canada. FTTP coverage in the US is somewhat lower than cable coverage, and according to Omdia research stood at around 49% of total country premises at the start of 2023; at this point FTTP represented 23% of total broadband subscriptions. FWA is another increasingly important technology in the US broadband landscape. The FCC puts coverage at 42% of residences at the end of 2023, which represents significant growth from the 26% one year earlier. It should be noted that these figures refer to coverage with download/upload speeds of at least 100/20Mbps. As discussed later in this section, FWA has enjoyed strong growth in subscription market share in the US broadband market in recent years.

CABLE OPERATOR NETWORK UPGRADES: FTTP AND DOCSIS 4.0

As noted, cable broadband has high coverage and a high subscription market share in North America. The decisions taken by cable operators will therefore have very significant ramifications for the North American broadband market as a whole. One area of focus for cable operators is whether to continue upgrading their coaxial networks or switch to an FTTP-focused network strategy. Some cable operators, with Altice in its tristate footprint of New York, New Jersey, and Connecticut a prominent example, are overbuilding their coaxial networks with FTTP, although the trend is so far more prevalent in Europe than in North America. This FTTP upgrade strategy offers a number of potential benefits. In the first instance the opex associated with running FTTP networks will be lower than for running DOCSIS cable networks, for instance, because of lower energy consumption and potentially lower fault rates. Unlike with DOCSIS technologies there is a clear roadmap for future capacity increases on PON FTTP networks. Cable operators could deploy 25G Gigabit Passive Optical Network (GPON) or 50G GPON with a choice of multiple vendors, and there will be further future PON technologies that offer even higher capacities. This technology roadmap offers certainty to cable operators that upgrade to FTTP. As discussed in ***Broadband business model choices,*** FTTP networks also offer greater flexibility in supporting wholesale access, which might be attractive for some cable operators. The challenge with overbuilding cable networks with FTTP is that this will be a costly and capex-intensive exercise. Most of the cost of rolling out FTTP is in the last few hundred meters of the deployment. However, cable networks still use coaxial cable for the last portion of the network. This means that upgrading such cable networks to full FTTP is unlikely to offer a significant saving over deploying a greenfield FTTP network.

For other cable operators, notably the two largest cable players, Comcast and Charter, the focus is on upgrading their existing coaxial network footprint to DOCSIS 4.0. On a high level, DOCSIS 4.0 promises maximum downstream shared capacity of 10Gbps and maximum upstream shared capacity of 6Gbps. However, Comcast and Charter are pursuing different DOCSIS 4.0 network upgrade strategies. Charter is using the Extended Spectrum DOCSIS (ESD) version of DOCSIS 4.0, which delivers higher bandwidths by using additional frequencies. Comcast is rolling out the Full Duplex (FDX) variant of the technology, which delivers higher bandwidths by allowing frequencies to be shared for downstream and upstream transmission. FDX could allow operators to offer symmetrical multigigabit speed plans.

In comparison with overbuilding the cable network with FTTP, the advantage of a DOCSIS 4.0 upgrade strategy is that it will be less expensive in terms of both cost per premises passed and cost per premises connected. Comcast has previously quoted costs per premises passed of less than $200 for moving to a mid-split architecture (in terms of the frequencies used for upstream transmission), digitalizing its nodes, and upgrading to DOCSIS 4.0 using FDX. Connection costs for DOCSIS 4.0 should be limited to around $50 for a new DOCSIS 4.0 modem.

Operators could also choose to develop a hybrid approach whereby as nodes are digitalized and remote physical-layer (PHY) devices installed (alongside an upgrade to DOCSIS 4.0 and a move to a Distributed Access Architecture), remote optical line terminals (OLTs) could also be installed at the node location. Subscribers, such as high-value business customers, could then be connected to FTTP on demand. This might allow cable operators to incrementally upgrade subscribers to FTTP over a longer period of time and thereby avoid the significant spike in capex that might be associated with a project to fully overbuild the cable network with FTTP and then quickly decommission the cable network.

In the more immediate future, as cable operators consider their strategic options a further possibility is to deploy so-called DOCSIS 3.1+ / DOCSIS 3.1 enhanced or extended. The promise of this technology is it would allow cable operators to deliver symmetrical gigabit services. This approach would involve deploying DOCSIS 4.0 modems or updated DOCSIS 3.1 modems alongside a software upgrade to existing DOCSIS 3.1 cable modem termination systems (CMTS). The cable network will need to support so called mid or high splits where more bandwidth is dedicated to the upstream. This technology will also allow five OFDMA blocks to be bonded in the downstream (compared with two in initial DOCSIS 3.1 deployments) and two OFDMA blocks in the upstream. The approach has support from chipset vendors such as MaxLinear. This approach could offer bandwidth upgrades very quickly and cost-efficiently because, for example, there would be no need to implement such an upgrade alongside a move to

a Distributed Access Architecture and/or a virtual CMTS rollout. However, the DOCSIS 3.1+ / DOCSIS 3.1 enhanced or extended approach would not offer as much capacity as an upgrade to DOCSIS 4.0 and would be less competitive with the speeds that FTTP operators can offer. Under optimal conditions, for instance, where there are no QAM-based video services (which is not yet close to a reality for many cablecos), cable operators could offer service tiers of 8Gbps on the downstream and around 1Gbps on the upstream with a high-split frequency allocation.

FTTP INVESTMENT: EXISTING OPERATORS AND NEW ALTNETS

Investment in FTTP has grown strongly over recent years in the US, and this is reflected by the fact that fiber represented 23% of total broadband subscriptions at end-2023, strong growth from its 16% share at end-2020. Much of this investment has come from established players such as Frontier and AT&T. These investments have focused on upgrading operators' legacy copper footprints to FTTP. In addition, incumbents have sought to expand their legacy footprints and build FTTP in areas in which they previously had no coverage.

Such expansion has also on occasion involved bringing in third parties, notably private equity firms, to help fund the FTTP coverage expansion. One example of this is AT&T's Gigapower joint venture with Blackrock Alternatives as part of which the latter has made an initial commitment of $650m for its clients. The Gigapower rollout, announced in December 2022, covers areas outside the operator's traditional 21-state footprint. The Gigapower joint venture will offer wholesale access to several retail service providers including AT&T. Another example of sizable investment by private equity firms in US fiber assets is Apollo Global Management's investment in the assets of Lumen Technologies to create Brightspeed, whose footprint spans more than 20 states. Brightspeed has also received $500m funding from Mubadala, the sovereign wealth fund of Abu Dhabi, which has become a minority shareholder. A similar deal in which private equity acquired the assets of a legacy telco was WaveDivision Capital's 2019 acquisition of Frontier Communications' assets in the northwest of the US: the resulting company was named Ziply Fiber. The idea is for Ziply Fiber to cover up to 85% of the legacy footprint with FTTP over time.

FTTP TECHNOLOGY CHOICE: XGS-PON ROLLOUTS ARE INCREASINGLY THE NORM

It is also worth noting that the migration to XGS-PON FTTP networks is already quite advanced in North America compared with, for example, Europe. One prominent example of this is AT&T, which announced in January 2022 that more than 5.2 million premises could access its 2Gbps and 5Gbps speed tiers thanks to its XGS-PON rollout, and by March 2022 the figure had increased to 7 million premises. In all of its new rollout areas AT&T deploys only XGS-PON.

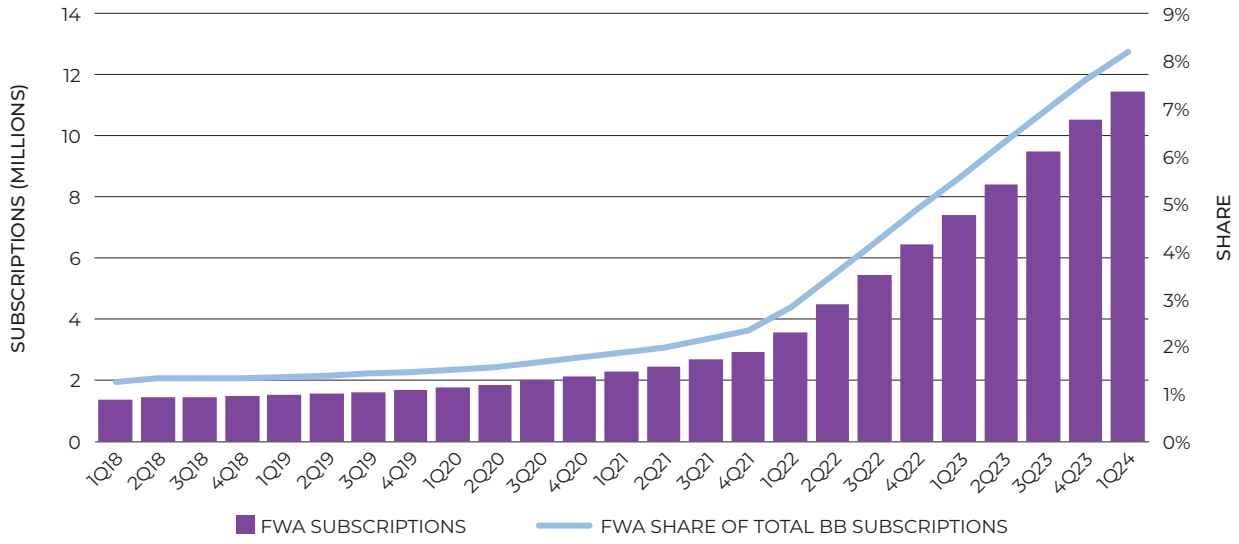
Rollouts of XGS-PON have been more rapid in North America than elsewhere because fiber operators can potentially gain a significant advantage in terms of maximum download and upload speeds over the cable competitors that predominate in the region. As mentioned, where it has rolled out XGS-PON AT&T offers symmetrical 5Gbps plans. This compares well with maximum 2Gbps symmetrical speeds for Comcast's retail plans in the areas where it has already upgraded its network to support DOCSIS 4.0.

In addition, by deploying XGS-PON, FTTP operators can avoid deploying GPON optical network terminals (ONTs) today then having to engage in a costly swap-out of these devices for XGS-PON replacements after a few years. Fixed broadband ARPUs in North America are also higher than elsewhere, and this makes it more viable for fiber operators to absorb the higher costs of XGS-PON ONTs.

FIXED WIRELESS ACCESS: SUBSCRIPTION GROWTH CONTINUES

The panorama of the US fixed broadband market has also changed over the last few years because of the rapid growth in FWA subscriptions (see **Figure 1**). In some cases, such as for Verizon, incumbent fixed-line operators have sought to expand their coverage by rolling out FWA. Verizon offers FWA using mmWave spectrum as well as C-band spectrum in the 3.5GHz band. In addition, mobile network operator (MNO) T-Mobile has entered the FWA market with a rollout that focuses on using spectrum in the 2.6GHz band.

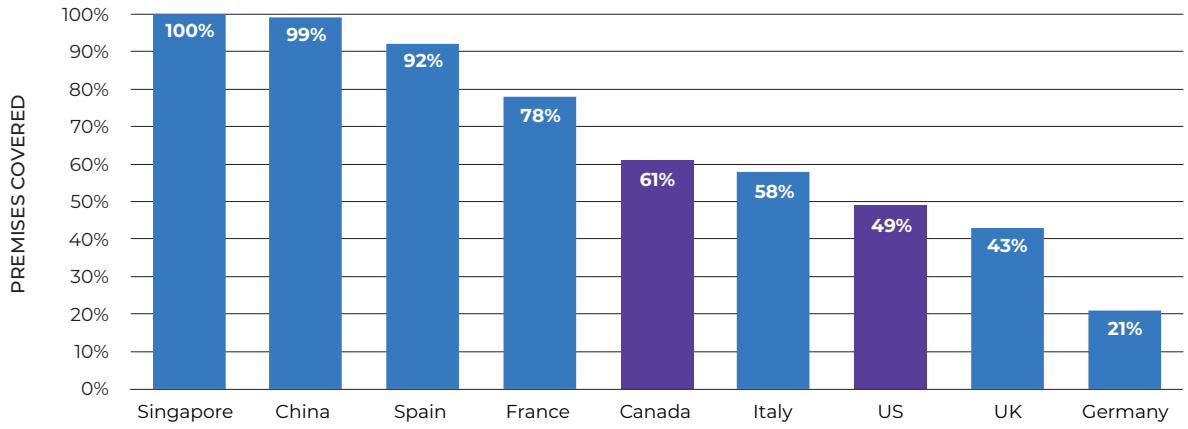
FIGURE 1: US, FWA SUBSCRIPTIONS AND FWA SUBSCRIPTIONS AS SHARE OF TOTAL BROADBAND SUBSCRIPTIONS, 1Q18–1Q24



SOURCE: OMDIA

There are several reasons why FWA has made more of an impact in the US than in most European or developed Asian markets. In the first instance, fixed broadband ARPUs in the US are higher than in Europe, which gives more opportunities for newer entrants to compete on price and develop a profitable business. In addition, FTTP coverage in the US is lower than in some European countries, which potentially makes it easier for lower-speed FWA to attract new subscribers. For example, Omdia's *Fiber Development Index: 2023*[1] estimates that the US had FTTP coverage of 49% of total premises at the start of 2023. In Europe leading countries such as Spain and Portugal had 92%, and France had 78% (see **Figure 2**).

FIGURE 2: SELECTED COUNTRIES, FTTP COVERAGE OF TOTAL COUNTRY PREMISES, JANUARY 1, 2023



SOURCE: OMDIA FIBER DEVELOPMENT INDEX: 2023

In Europe there has also been a very considerable amount of investment in new fiber operator rollouts, which has not been matched to the same extent in the US even though there have still been some sizable altnet fiber rollouts. This means that in Europe cheap wholesale FTTP access has been widely available, and this has encouraged MNOs to use these offers rather than roll out

[1]Each year, Omdia produces the Fiber Development Index, which benchmarks fiber development, including fiber coverage, household/business/mobile cell site fiber penetration, advanced wavelength-division multiplexing (WDM) investment, and broadband median download and upload speeds, latency, and jitter, across 93 territories. For more information see https://omdia.tech.informa.com/om032629/fiber-development-index-2023

FWA on a massive scale. There are signs that this scenario is beginning to be replicated in the US . One example is T-Mobile's April 2024 acquisition of FTTP operator Lumos alongside private equity fund EQT. Lumos currently covers around 320,000 premises with FTTP, and the objective is to increase this figure to 3.5 million by the end of 2028. As part of the acquisition T-Mobile will hold a 50% equity stake in the joint venture. T-Mobile will also acquire all of Lumos' existing fiber customers, and the operator will transition to a wholesale-only business model.

SATELLITE BROADBAND OPTIONS ARE INCREASING

Satellite broadband is also an important technology for the North American fixed broadband market. One indication of this is that Hughesnet had 978,000 subscriptions at the end of March 2023, and a high proportion of these are in the US. Moreover, Starlink, which launched services in the early part of 2021, has now exceeded more than 3 million subscriptions globally.

Operators Hughesnet and Viasat offer satellite broadband based on geostationary orbits (GEO). These satellites are in high orbit, and only about three are needed to provide global coverage. Starlink uses low Earth orbit (LEO) satellites, which are individually much cheaper, but many more of them (several thousand in total) are required to establish global coverage. In practice LEO-based satellite broadband can provide much improved latency of 25–60ms because of the lower orbit used by these satellites compared with GEO alternatives. Speeds with LEO-based satellite broadband are also likely to be higher than for GEO-based satellite broadband. Starlink itself notes that users typically experience download speeds of 25–220Mbps, with a majority of users experiencing speeds over 100Mbps, and that upload speeds are typically 5–20Mbps.

UPGRADES TO THE LATEST WI-FI TECHNOLOGIES

Many US and Canadian operators have developed retail broadband plans that place a heavy emphasis on the quality of in-home Wi-Fi. Part of this focus involves early upgrades to the latest Wi-Fi technology generations. For example, cable operator Comcast has said that it will begin to deploy Wi-Fi 7 in the second half of 2024, and fellow cableco Charter has said that Wi-Fi 7 routers and gateways will likely be available to its subscribers in 2024. In addition, Verizon has already launched a Wi-Fi 7 router targeted at enterprise customers. The move to offer the latest Wi-Fi hardware is logical because access speeds in the US broadband market are already very high, so there is a need for in-home network speeds to keep pace. Wi-Fi 7 shipments are expected to grow strongly over the next few years, and Omdia estimates that globally, Wi-Fi 7 customer premises equipment (CPE) will account for around 14% of total CPE shipped by operators (across the different access technologies) in 2025.

THE GROWTH OF ARTIFICIAL INTELLIGENCE IN NORTH AMERICA

Use of artificial intelligence (AI), for instance, for generative AI services, has recently grown sharply in North America. This is significant because an AI request is estimated to require 10× the elaboration needs of a traditional web search. As a result of these trends there will be a growing need for high-speed data center networks to properly connect the compute elaboration of GPUs and CPUs, although it should be noted that such traffic will not impinge on the broadband access network.

Investors in broadband infrastructure in the North America region could also be users of AI services. AI could be useful during the fiber network planning and design phases. For example, AI algorithms could use visual evidence from street surveys to determine the material, such as asphalt, that has been used for construction in the area. This can then help determine the potential costs of a fiber deployment in this zone.

HUGE GOVERNMENT FUNDING FOR BROADBAND INFRASTRUCTURE ROLLOUTS AND SUBSIDIES FOR RETAIL BROADBAND PLANS

Investment in FTTP is also set to enter a new phase as huge amounts of government funding for broadband rollout become available. The basic rationale for such funding is to ensure high-quality broadband access is available to all. This is important because with better broadband,

households will have better education, health, and economic prospects. Businesses will also enjoy the benefits of better access to digital tools.

The range of government funding programs is highlighted in **Table 1**, which shows that approximately $100bn of funding is being provided for broadband infrastructure rollout, the largest single program being the BEAD program. This funding is available for players of different sizes, and smaller operators can benefit from such funds. There are significant opportunities for smaller internet service providers (ISPs) to benefit, and the number of such operators is large: according to the FCC, there were 2,201 ISPs active in the residential broadband market at the end of 2021. These government funding programs could also lead to a growth in new broadband entrants and so could lead to a further increase in the number of operators in the US market. It is also worth noting that this level of government funding is very sizable in comparison with the total public funding that has been provided for broadband infrastructure rollout in Europe. By way of example, in the UK, which has a population around a fifth of that of the US, government funding for broadband infrastructure rollout has included the previous £2.54bn Superfast Broadband (SFBB) program and the ongoing £5bn Project Gigabit program, a total funding amount of around $9.7bn.

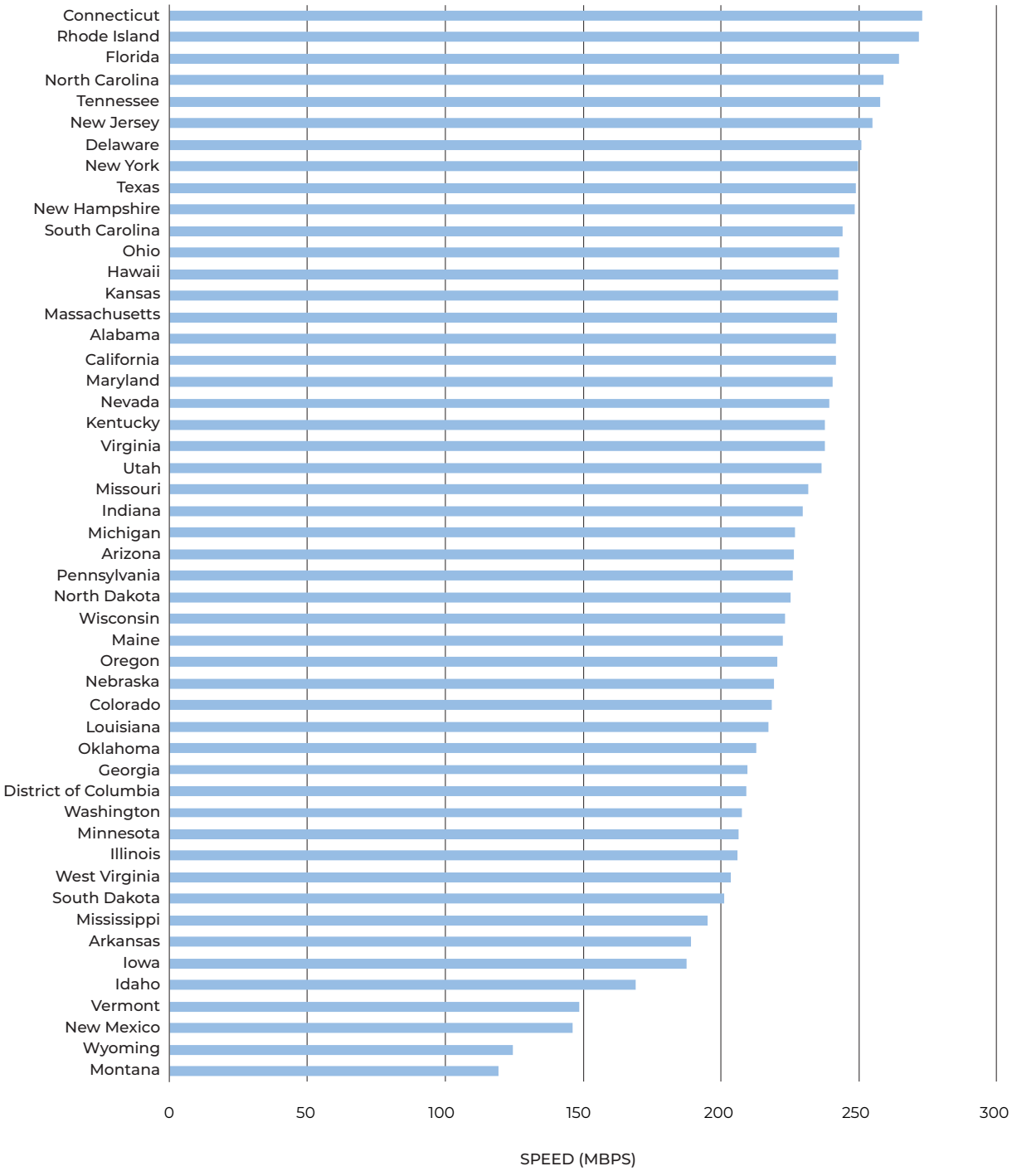
TABLE 1: SUMMARY OF WI-FI GENERATION CHARACTERISTICS

PROGRAM	FEDERAL AGENCY	GOVERNMENT FUNDING LEVEL	STATE INVOLVEMENT	TIMING OF FUNDING RELEASE
RDOF	FCC	Up to $20.4bn	None	From 2020, program funding over 10 years
Middle Mile Program	NTIA	$1bn	Eligible applicant	Awarded summer 2023
Tribal Broadband Connectivity	NTIA	Up to $3bn	None	2021, round 2 began in 2023
BEAD	NTIA	$42.5bn	Recipient	2023–25
CPF	Treasury	$10bn	Recipient	2022–23
ARPA	Treasury	$20bn	Recipient	Recipients must obligate funds by end-2024
Reconnect Round 4	USDA	$1.8bn	Eligible applicant	2023

SOURCE: NOKIA

There are several reasons for this increase in government funding in the US. In more rural areas of the US, costs per premises passed for FTTP rollout can be much higher than in urban areas, which means there may be no case for a purely commercially driven broadband infrastructure rollout. There is also an awareness that FTTP coverage in the US is significantly below that in many other developed countries. These factors together mean that there are a significant number of people in the country that are either unserved or underserved by existing broadband infrastructure, which means there is a risk of an in-country digital divide developing. It should also be noted that there are sizable differences in broadband performance across different states in the US, which reflects factors such as the size of the rural population. **Figure 3** uses Ookla Speedtest data to show median fixed broadband download speeds by state in June 2024.

FIGURE 3: MEDIAN FIXED BROADBAND DOWNLOAD SPEEDS BY US STATE, JUNE 2024



SOURCE: OOKLA SPEEDTEST

FCC data from 2023 shows that unserved broadband households, defined as households that lack access to broadband with download/upload speeds of 25/3Mbps, totaled 7.2 million locations from a total of 115 million broadband serviceable locations across the country. There are also sizable numbers of underserved locations that can only access broadband speeds of 25/3Mbps to less than 100/20Mbps. Sources have stated that the total number of unserved or underserved locations is around 11.8 million.

BEAD program funds are available for broadband infrastructure rollout to unserved areas, defined as those where 80% of locations have download speeds of less than 25Mbps, upload speeds of less than 3Mbps, and latency of more than 100ms. In addition BEAD program funds are available for underserved areas, defined as those where 80% of locations have download speeds of less than 100Mbps, upload speeds of less than 20Mbps, and latency of more than 100ms. States must first commit to projects serving all unserved locations within a jurisdiction and then prioritize the provision of broadband to underserved locations.

Most funding for BEAD projects is likely to be allocated to FTTP rollouts, although the use of other technologies is permitted under the BEAD program. The authorities managing the BEAD funding process in each state must set an Extremely High Cost Per Location Threshold and can decline to select a proposal above this threshold using FTTP if an alternative, less costly technology can be used, provided that such a proposal can meet the prioritization and scoring requirements of the BEAD program. Another area where states have flexibility is that they are able to decide on the scoring criteria that will determine the winning bidder for each project.

A further consideration of which bidders for BEAD funding must be aware is that they only need to provide cash flow projections for three years after the project build has been finished. In reality the payback period for projects might be longer than this.

In order to maximize the benefits of the available government funds, it is important that stakeholders have accurate information and maps on the availability and actual performance of broadband at a very granular level. With this information funds can then be targeted to those areas where the requirement is greatest. For more information on the importance of accurate mapping of broadband availability and broadband quality see *Improving the viability of investment in broadband infrastructure*.

In addition to government funding for broadband infrastructure rollouts, funding has also been provided for the subsidy of retail broadband plans as part of the Affordable Connectivity Program. As part of the scheme lower-income households have been provided with discounts of up to $30 on internet service including fixed broadband access. For eligible households, discounts of up to $100 for the purchase of laptops, desktops, or tablets have also been available. The program stopped accepting new applications in February 2024, and its last fully funded month was April 2024. A measure of the huge impact of the program is that more than 23 million households have used the subsidies since it started. The impact of the program is discussed in more detail in *Broadband financing models*.

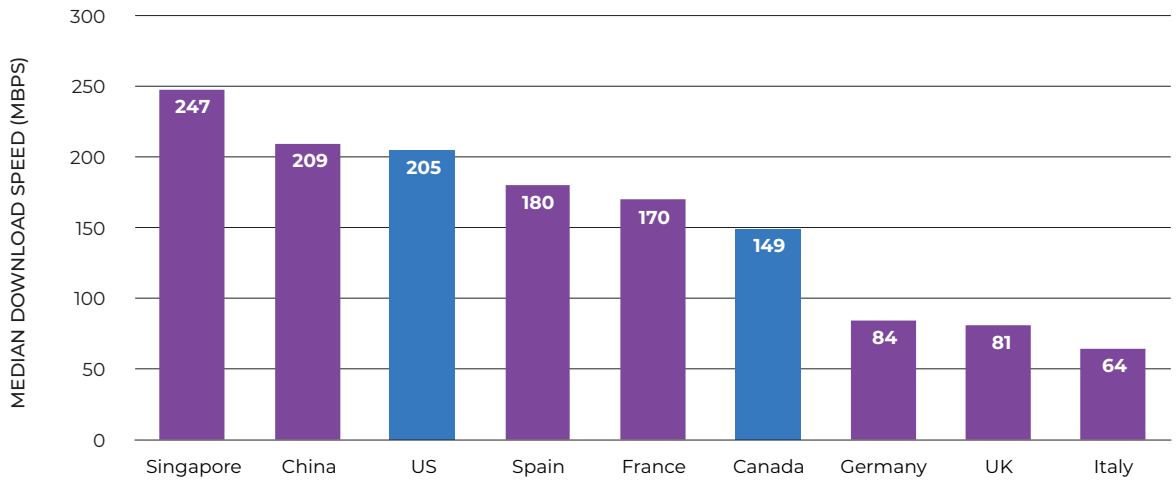
INVESTMENT IN IMPROVING THE WIDER CUSTOMER BROADBAND EXPERIENCE

US operators have been leading the way in placing a greater focus on a broader concept of broadband customer experience that extends beyond merely offering higher access speeds with the latest access technologies. This means that operators have placed more emphasis on the performance of home Wi-Fi and on additional services associated with Wi-Fi such as parental controls and connected-home cybersecurity. This greater focus on the broader customer experience in the US market is logical given the fact that access speeds are already high and that operators such as Comcast have already had success in boosting ARPUs with propositions such as xFi.

OVERALL SUMMARY OF THE MARKET

There are certainly areas for improvement in North America in terms of overall broadband availability, quality, and uptake. However, at the same time we should also note that there are plenty of positive aspects to broadband markets in the region. For example, broadband speeds are generally high, and given the high market share of cable operators in the US and Canada this reflects to a significant extent the performance of DOCSIS networks. For example, according to Omdia's ***Fiber Development Index: 2023***, which uses data from Ookla Speedtest, median download speeds in the US were 205Mbps and in Canada were 149Mbps. This meant that the US ranked 6th of the 93 countries included in the index, and Canada ranked 15th.

FIGURE 4: OMDIA FIBER DEVELOPMENT INDEX, MEDIAN DOWNLOAD SPEED BY SELECTED COUNTRY



SOURCE: OOKLA SPEEDTEST GLOBAL INDEX DATA, JUNE 2023

In addition, in some respects usage of broadband in the North America region is impressive, for instance, in terms of high traffic levels and high usage of online video. Residential and enterprise broadband penetration is also high and still growing. In light of this, the US and Canada score well in terms of the broadband component of the WBBA's Broadband and Cloud Development Index. The US and Canada perform better than most Western European countries, although they are behind a few countries in Asia.[2]

At the same time, there are certainly areas where there is room for improvement. One aspect of this is broadband affordability, although in recent years measures such as the Affordable Connectivity Program have been put in place to deal at least temporarily with this challenge. FTTP coverage is also lagging in North America in comparison with coverage in a sizable number of developed economies, although significant government funding is set to change this situation over the next few years.

[2]For more information see https://worldbroadbandassociation.com/wp-content/uploads/2023/10/WBBA-Broadband-Cloud-Development-Index_V5.pdf

THE KEY METRICS STAKEHOLDERS MUST CONSIDER WHEN INVESTING IN BROADBAND INFRASTRUCTURE IN NORTH AMERICA

ANALYZING THE CONSEQUENCES OF THE FIXED BROADBAND TECHNOLOGY MIX

One key consideration for all stakeholders is that the broadband technology mix is very different in North America than in other developed markets. In the first instance the market share of cable broadband in North America is higher than elsewhere. For example, Omdia data shows that at the end of 2023 in the US, cable broadband accounted for 59% of all broadband subscriptions; the equivalent figure in Canada was 45%, and it was only 15% across Europe as a whole. The greater market share of cable makes it rather more difficult to justify investments in FTTP for telcos because they will have fewer existing customers, for instance, on copper networks, that they can migrate to FTTP in order to monetize the network. In North America it is arguably more challenging for altnets without an existing subscription base to invest in fiber than it was in Europe some years ago because a higher proportion of existing subscriptions are on decent-quality cable networks in North America than in Europe, where lower-speed DSL was more prevalent. As a result investors considering the value of investing in FTTP infrastructure in the US must closely study trends from different markets to understand how cable broadband subscriber satisfaction and cable broadband network performance are evolving, because attracting cable churners will often be an extremely important part of the fiber rollout business case. In addition, the preponderance of cable broadband means that stakeholders need to be aware that there are more constraints on increasing upload speeds in North America than elsewhere.

FWA also has a growing share of broadband subscriptions in the US. According to Omdia data the figure stood at 8% at the end of 2023, which represents strong growth from 2% at the end of 2021. Investors in broadband infrastructure need to understand the potential for FWA to attract churners from other technologies in a mature broadband market. To this end it is important for those interested in investing in broadband infrastructure to understand customer satisfaction metrics such as Net Promotor Scores as well as broadband churn rates. In addition, those interested in investing in broadband infrastructure need to understand the reasons why broadband churners have churned.

BROADBAND INFRASTRUCTURE ROLLOUT: COSTS PER PREMISES PASSED AND CONNECTED

FTTP costs per premises passed in urban areas are quite high in the US compared with those in other developed economies, but there are some countries where such costs are higher than in the US.

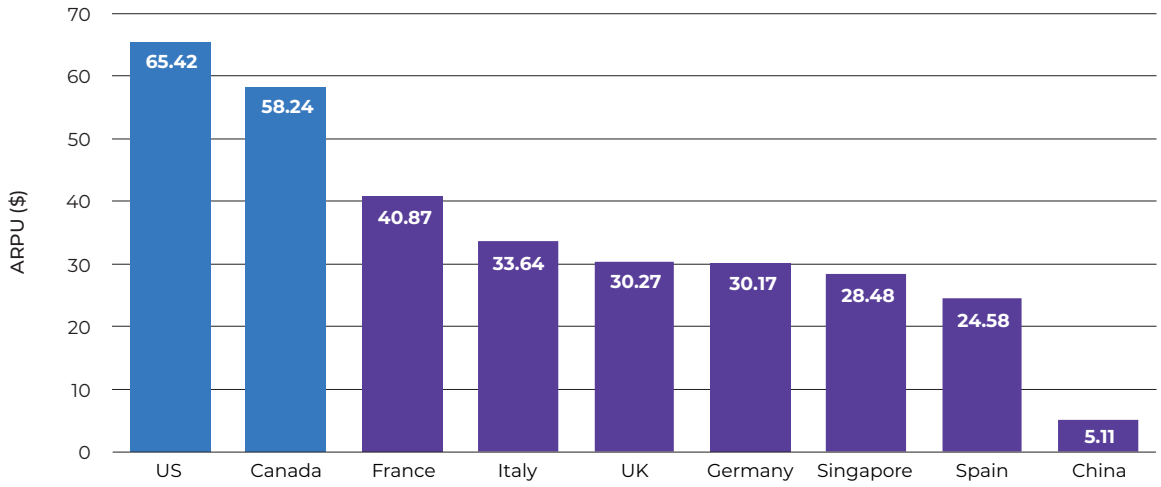
FTTP connection costs in the US are certainly at the high end of the range for developed countries. For instance, in 2022 Consolidated Communications put its connection costs at $700. This likely reflects the fact that many properties in suburban areas will be single-dwelling units with large front lawns, and this increases the amount of fiber that needs to be rolled out to connect the property.

Overall though, while FTTP rollout costs are quite high in the US, the lesson from other markets is that costs at this level need not prohibit rollouts and have not done so elsewhere.

BROADBAND ARPUs: HIGH ARPUs MAKE FOR A FAVORABLE BUSINESS CASE FOR FTTP ROLLOUT

Retail broadband ARPUs in North America are considerably higher than in most European countries. Even when the higher income levels in North America are taken into account, retail broadband prices are still high (see **Figure 5**). The fact that ARPUs are higher in North America has important consequences for broadband infrastructure investment.

FIGURE 5: SELECTED COUNTRIES, FIXED BROADBAND ARPU, 1Q24



SOURCE: OMDIA

The high retail broadband ARPUs might make it viable for operators to focus on offering lower retail prices in order to attract subscribers, and even with such lower prices rollouts could still be profitable. Higher retail ARPUs might make it more viable to still generate decent ARPUs even with a wholesale-only business model based on passive wholesale access, for example. Policymakers also need to be aware of the fact that broadband ARPUs in the US are higher than elsewhere. Higher retail prices can put some constraints on broadband take-up, and this has been recognized with the Affordable Connectivity Program.

IMPROVING THE VIABILITY OF INVESTMENT IN BROADBAND INFRASTRUCTURE

INVESTMENT IN TRAINING PROGRAMS FOR THE FIBER WORKFORCE

One constraint on the rollout and adoption of fiber broadband is a lack of personnel to perform the necessary tasks. If many operators are rolling out fiber concurrently, for instance, because they have received government funds for broadband rollout at the same time, this has the potential to push up deployment costs or cause delays in rollouts because there are insufficient labor resources. In addition, subscriber adoption of fiber broadband could also be limited if there are too few technicians to perform installations. With long waiting times for fiber installations, potential subscribers may prefer to keep using their existing broadband plans.

Measures have already been put in place to improve training for fiber technicians. In 2021 the Fiber Broadband Association launched a training program for fiber technicians. The importance of such training programs is demonstrated by the fact that the Fiber Broadband Association estimates that 205,000 fiber technicians will be needed in the US over the coming five years.

To a large extent companies have historically relied on unstructured on-the-job training, and there has been a lack of standardized training. As a result of these challenges, the Fiber Broadband Association launched the OpTIC Path course and certification program. By the end of the course, enrollees will have learned to install, test, and troubleshoot elements of FTTP networks.

More broadly, US states must also ensure that they have a workforce development plan as part of the BEAD program. Such a workforce development plan goes beyond the need to ensure there is sufficient labor for fiber and wireless rollout and also includes developing a diverse, equitable, and skilled labor force and ensuring that investment in training gives opportunities in the longer term for socioeconomic benefits.

INNOVATIVE DEPLOYMENT TECHNIQUES

Another way in which the viability of investment in broadband infrastructure in the US can be improved is through the use of innovative deployment techniques. Such techniques have the potential to reduce both costs per premises passed and costs per premises connected.

Operators in the US use preconnectorized fiber for FTTP deployments. This is important because it can avoid the need for fiber splicing and in this way can reduce the time for fiber deployment in both the build and the subscription installation phases. Preconnectorized fiber use can also limit the need for skilled splicing engineers. As a result of these factors, FTTP costs per premises passed and connected can be lowered. There are also lessons here for operators outside of North America, where the use of preconnectorized fiber is less common. Operators in North America have been happy to use preconnectorized fiber, and performance and reliability concerns have not stopped such deployments.

Innovative deployment techniques are also important for FWA rollouts in the US. One important consideration for FWA is whether subscribers can self-install their own FWA receivers and thereby avoid an engineer installation. This can then reduce connection costs when subscribers sign up for an FWA service.

Major FWA operators in North America offer self-installation. T-Mobile offers self-installation for its FWA service, which uses spectrum in the sub-6GHz range. Verizon uses spectrum in the mmWave bands for some of its FWA rollouts. The use of spectrum in such high-frequency bands typically requires the use of outdoor FWA receivers. Nevertheless, Verizon notes it has developed many innovations to make sure mmWave FWA receivers are easy to install. Such innovations include an AR signal-finding app, self-orienting 5G antenna, a reversible cover to keep internal components facing the proper direction, and discrete mounting brackets with gecko tape. These innovations make it possible for customers to install the mmWave FWA receiver themselves in a window, although for wall mounting some tools may be required. Verizon also offers the option of an engineer installation for its mmWave FWA receiver.

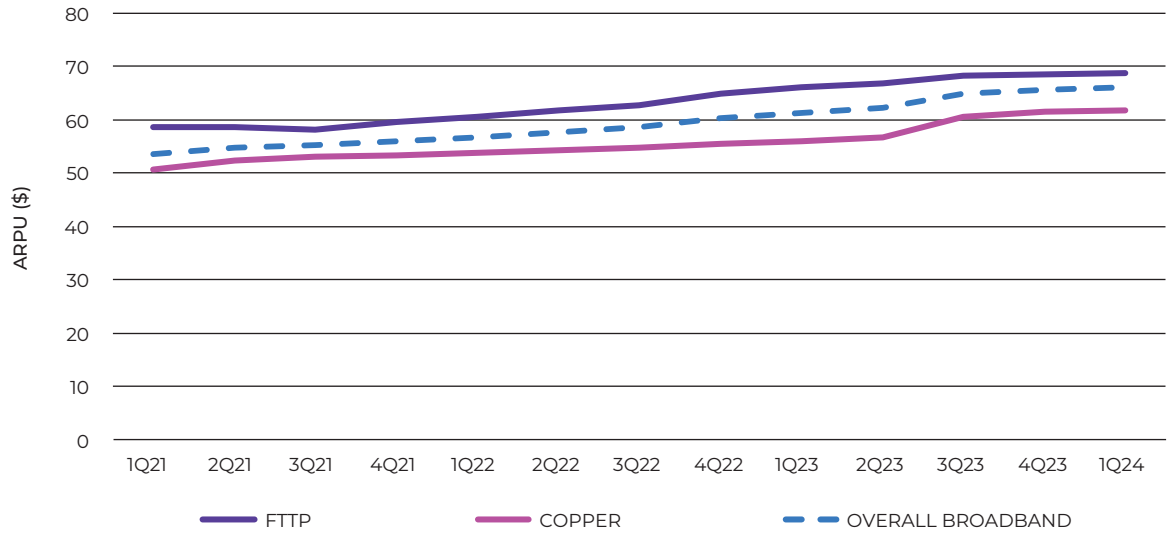
RETAIL BROADBAND OFFER INNOVATION

A further area for stakeholders to consider is whether there is scope for innovation in retail broadband tariffs. This is important both because it offers the possibility of increasing subscription take-up and of improving ARPUs, both of which improve the business case for broadband infrastructure investment.

US FTTP operator AT&T has had some success in increasing ARPUs (see **Figure 6**) with a focus on promoting the quality of its network with symmetrical gigabit and multigigabit access plans. In 1Q23 the operator noted that the ARPU of new FTTP customers was about $70. By way of comparison, the retail price of the operator's 300Mbps plan is $55 per month, and its 500Mbps plan costs $65 per month. This indicates there are significant numbers of customers subscribing to the company's 1Gbps, 2Gbps, or 5Gbps plans. Frontier in the US is another similar example. The operator noted that activation of new plans with gigabit or faster speeds was more than 55% of the total in May 2023, a 10 percentage points increase since January 2023. Google Fiber

is also looking to differentiate itself by offering the highest speeds in the market and has previously announced it will launch 20Gbps speeds enabled by the rollout of 25G PON.

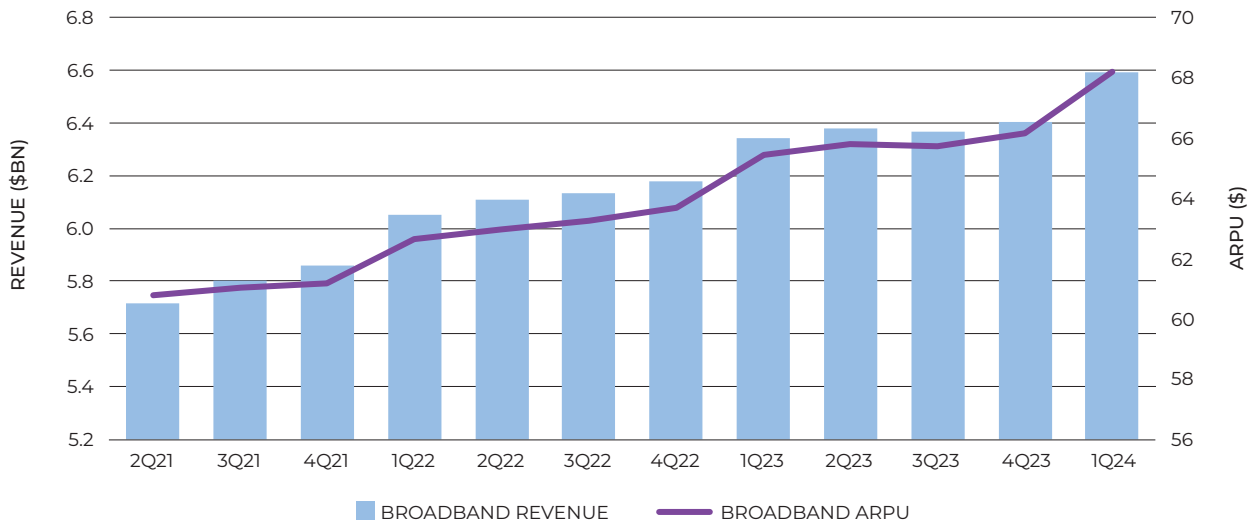
FIGURE 6: AT&T MONTHLY BROADBAND ARPU BY CONNECTION TYPE, 1Q21–1Q24



SOURCE: AT&T

Operators can also look to services associated with Wi-Fi such as connected-home cybersecurity, parental controls, and Wi-Fi management software as ways to improve customer experience and the overall attractiveness of their retail broadband offers. It is noteworthy that US operators have generally been quicker to develop these kinds of experience-centric offers than operators in other regions, and there are certainly examples of operators that have had success with such propositions. Comcast's xFi Wi-Fi-centric offering has played a role in helping the company achieve impressive ARPU growth (see **Figure 7**). One policy that operators can adopt is to introduce new services associated with home Wi-Fi such as connected-home cybersecurity and to initially charge a separate fee for them to establish their value in the minds of consumers. Monthly modem rental fees are common in the North American market. This means that operators could add these new services to their own gateways free of charge and then later increase the gateway rental fee in order to boost ARPUs.

FIGURE 7: COMCAST FIXED BROADBAND REVENUE AND ARPU, 2Q21–1Q24



SOURCE: OMDIA

ACCURATE MAPPING OF BROADBAND AVAILABILITY AND BROADBAND QUALITY

In order to improve the viability of investment in broadband infrastructure, all stakeholders need accurate data on current broadband availability and quality levels. For example, if local public authorities do not have accurate information on broadband availability, they may not be in a position to bid for federal funding. In the US decisions on whether to provide federal funding are made based on FCC Form 447 broadband mapping data. This data is based on self-reported data from operators at census-block level. However, if the operators report that one location within the census block is covered with download or upload speeds of 200kbps, this means that the entire census block is counted as being covered.

There are real-world examples of local public authorities benefiting from more accurate data on broadband availability. The NTIA Broadband Infrastructure Program, which has total funding of $288m, is focused on the rollout of broadband infrastructure in areas without broadband, in particular rural locations. The Acadiana Planning Commission in Louisiana successfully bid for funding through this program thanks to its use of more granular broadband availability data. The FCC data described above indicated that in some cases an entire parish within the Acadiana region was covered with speeds of 25–50Mbps. More accurate information based on data collected from end users about their actual broadband speeds showed that this was not the case. As a result of this more accurate information the Acadiana Planning Commission was able to receive $30m of funding to improve broadband availability.[3]

The importance of good-quality information on existing broadband availability and quality levels also goes well beyond showing that areas qualify for government funding programs. Commercial investment in FTTP will partly be determined by the quality of existing broadband. If investors have geographically accurate data on exactly which areas already have access to high-speed broadband from one or more providers, they will be in a much better position to develop a financially viable rollout. Information on the broadband speeds subscribers are receiving in potential rollout areas can also be an important input to deployment decisions.

BROADBAND FINANCING MODEL CHOICES

PUBLIC FINANCING OF RETAIL BROADBAND PLANS

The Affordable Connectivity Program was launched at the end of 2021 and succeeded the Emergency Broadband Benefit Program, which launched in May 2021. The initial Emergency Broadband Benefit Program included discounts of up to $50 per month on retail broadband plans for eligible households and up to $75 per month for households on Tribal lands. These discounts could be used for either fixed or mobile internet access plans. In addition, the Emergency Broadband Benefit Program offered a one-time discount of up to $100 for the purchase of devices such as laptops or tablets to access the internet. Many of these measures were carried forward into the Affordable Connectivity Program, although the discount on retail broadband plans for eligible households was reduced to $30. The Affordable Connectivity Program's last full month of providing funding was April 2024. The program ended even though participating operators wanted to see it continue and despite various proposals from members of Congress to in some way continue it. It is possible that in the future the program may be reintroduced in some form.

The rationale for the launch of these programs was to help households that were facing difficulties in paying for internet access during the COVID-19 pandemic. Internet access was seen as particularly important in that period, for instance, because of the need for home schooling. In addition, funding for such programs was part of a wider government spending stimulus during the pandemic and reflected concerns about the opening up of a digital divide within the country. In some respects then, the launch of these programs was driven by very specific one-off circumstances. Nevertheless, as the FCC notes, it was also clear from soon

[3]For more information see www.ookla.com/resources/casestudies/how-the-acadiana-planning-commission-won-30m-in-broadband-funding

after the launch of the Emergency Broadband Benefit Program that demand for the retail broadband plan subsidies would outlast the pandemic, which highlights the deeper issues of broadband affordability and the risk of an in-country digital divide. It is also clear that there is a broader trend toward governments providing subsidies for retail broadband plans and that this is often with the aim of promoting take-up of next-generation access technologies. In this way some governments have acknowledged that merely providing funding to drive improved coverage of next-generation broadband networks may not be sufficient to ensure the ultimate desired outcome of subscribers receiving such high-speed access.

RESULTS AND LESSONS LEARNED FROM THE AFFORDABLE CONNECTIVITY PROGRAM

It is noteworthy that the discounts available under the Affordable Connectivity Program have been very widely used. When the program stopped accepting new applicants in February 2024, 23.3 million households had enrolled, of which 22.9 million were in non-Tribal areas. The total number of enrolled households was equal to more than one in every six US households. It is also important to note the split of enrolments between fixed and mobile plans. At the end of 2023, 9.9 million households were using the retail broadband plan subsidy for their home wired broadband connection (defined as DSL, cable, or fiber), and approximately 0.2 million were using it for a fixed wireless or satellite connection. Compare this with the 12 million households using the subsidy for mobile.

One concern arising from the ending of the Affordable Connectivity Program is that it might make investments in improved broadband infrastructure through programs such as BEAD more challenging for investors. Without the subsidies for retail broadband plans, it might be more difficult to attract the necessary number of subscriptions on the new infrastructure to justify the private investment component for programs such as BEAD, or if such infrastructure is built and then subscription take-up is low, the relevant operator could face financial difficulties. A clear lesson is that there must be joined-up thinking in terms of supply-side measures to improve broadband infrastructure availability and demand-side measures to ensure take-up of broadband access.

A further challenge arising from the cessation of retail broadband subsidy programs after they have seen significant uptake is the impact on operators that are part of the scheme. In some cases operators have millions of subscribers that are receiving subsidies as part of the Affordable Connectivity Program. Some subscribers will have been aware that the program was ending and are likely to have continued their subscriptions, but others may now struggle to afford the price of internet access.

Evidence is starting to emerge of the impact of the ending of the Affordable Connectivity Program. For example, Comcast, the largest broadband operator in the US by subscription numbers, reported a loss of 120,000 broadband subscriptions in 2Q24. Nevertheless, this was only equivalent to 0.4% of the operator's total broadband subscription base, and moreover, the company had generally been losing broadband subscriptions over the preceding 18 months or so, although not to the same extent. However, Comcast also notes that it expects to see the bulk of the impact from the ending of the Affordable Connectivity Program in 3Q24.

It is also worth noting that some observers have expressed concerns about the wider economic impact of the ending of the Affordable Connectivity Program. Concerns have been expressed that if lower-income households no longer have home broadband then this will entail lost financial benefits for them and mean less online shopping and fewer telehealth appointments. In July 2024 the Benton Institute for Broadband & Society nonprofit organization put the value of these losses at over $2bn annually.[4] Other analysis has also concluded that the benefits of

[4]See www.benton.org/blog/how-end-affordable-connectivity-program-hurting-low-income-households-and-us-economy

the program far outweigh its costs, for instance, because of the effect on employment, which provides an uplift to incomes for lower-income households as well as convenience benefits, for instance, because of the time saved by shopping online.[5]

In some cases operators had existing plans targeted at low-income subscribers before the launch of the Affordable Connectivity Program and have pledged to maintain or extend such offers. For example, Comcast has maintained its Internet Essentials offering, launched in 2011, which offers plans with download speeds of up to 50Mbps at prices starting from $9.99. Internet Essentials is open to recipients of funding from the Affordable Connectivity Program. In addition, the operator offers the Internet Essentials Plus offering with download speeds of 100Mbps at a monthly price of $29.99 for those who were enrolled in the Affordable Connectivity Program. These offers reflect the fact that even in the absence of government subsidies there is a strong case for offering affordable retail broadband plans that are open to lower-income households. If operators do not voluntarily offer such plans, there may be a case for regulators to mandate their availability and also require that they are sufficiently publicized to ensure that they see significant uptake among eligible households.

PUBLIC PRIVATE PARTNERSHIPS

This section of the guidebook outlines how the BEAD program works in more detail.

STATE-LEVEL DECISION-MAKING FOR BEAD

One important point to note is that individual states can choose how to operate their own individual overall approach, for instance, in terms of how much funding is allocated to FTTP versus alternative technologies or how winning bidders will be selected, which means there are likely to be differences across different states. This will introduce challenges for bidders looking to develop a consistent approach to bidding across the different states.

BEAD FUNDING CRITERIA: PRIMARY SCORING CATEGORIES

The next section of this guidebook examines the criteria that determine whether bidders will be successful in receiving funds as part of the BEAD program. There are three primary criteria for determining the recipients of BEAD funding, and these total 75% of all available points:

- BEAD outlay: the funding that bidders commit to provide for the broadband infrastructure rollout
- Affordability: commitments to ensure that the broadband plans provided as part of the infrastructure rollout are affordable to end users in the deployment area
- Labor standards and workforce readiness: areas related to the treatment of the workforce, for instance, in terms of relations with contractors

BEAD OUTLAY

In the first instance, BEAD outlay determines the efficiency with which the government funding will be used. Bidders can try to increase their score in this area by using more cost-effective construction techniques; partnering with players that already have infrastructure, such as middle-mile fiber, that can help reduce rollout costs; or increasing their level of match funding. The section below describes match funding requirements in more detail.

A key element of the BEAD bidding process is that it requires match funding, and government funding will not cover the full cost of rollout. The standard match funding requirement is 25% of the capital of the project, although the figure is as high as 40% in Wisconsin. However, at the same time, states do have the option to waive the match funding requirement or to lower it or offer tax breaks. As a result of this flexibility for states to make their own decisions, some states may be seen as more attractive by investors than others. In order to meet match funding requirements where these apply, bidders should be prepared to be flexible and creative, because such requirements can be met with either cash or in-kind contributions. Another option for bidders for BEAD funding is the possibility of using funds from other government programs to meet match funding requirements. If funds from these sources are not available

[5]See www.benton.org/publications/affordable-connectivity-program-benefits-outweigh-costs

or are insufficient to meet the match funding requirements, then bidders could also choose to use loans or seek equity investors. A further consideration is the amount of match funding to which bidders for BEAD funding should commit. Committing more than the minimum amount of match funding is more likely to result in a successful bid, and many Tier 1 operators are expected to commit to this higher level of funding. In addition, committing to only the minimum level of match funding introduces some risks because in the case of project cost overruns, the private entity will be responsible for 100% of the overrun.

AFFORDABILITY

In addition to BEAD outlay, another primary criterion used to decide BEAD awards is affordability. There is a requirement for bidders to document a middle-class affordability tier as well as an affordability program with low-cost broadband. The first of these two categories is defined as a commitment to provide the most affordable total price for a 1Gbps symmetrical offering in the deployment area. In practice this may mean that state authorities require information on the actual price that will be charged for such a plan. Though an affordability program is a requirement for those bidding for BEAD funding, it is not necessarily included in the scoring of bids. Where there is scoring for the affordability criterion it is significant but is less important than the BEAD outlay criterion.

LABOR STANDARDS AND WORKFORCE READINESS

The third primary criterion for determining the scoring for BEAD funding bids is labor standards and workforce readiness. Of the three primary scoring categories this is the one with the least weighting in scoring. Points are allocated for being in compliance with federal labor and employment laws. In terms of mandatory fair labor practices, states have significant discretion when it comes to the categories to be included. Areas that could be mandatory include local hiring efforts, the use of prevailing wages, and commitments to union neutrality. Workforce readiness criteria could include commitments to recruiting a diverse workforce and using apprenticeships as part of the workforce strategy. This category will require efforts from bidders to ensure that these criteria have been considered when contracts with suppliers are drawn up. Such contracts can be used to demonstrate to the state authorities responsible for BEAD funding that the bid meets the labor standards and workforce readiness requirements.

BEAD FUNDING CRITERIA: SECONDARY SCORING CATEGORIES

In addition there are a number of secondary scoring criteria when weighing up competing bidders for BEAD funding.

DEPLOYMENT SPEED

Bidders for BEAD funding must also be aware that there is a four-year deadline to complete network deployments. It might be the case that the state authorities responsible for allocating the funding choose to launch a large number of small procurements in order to make sure that bidders can meet this deadline. In turn this might lead to diseconomies of scale because there will be a larger number of smaller projects. Deployment speed is a secondary scoring criterion, although it must be included in all states' scoring criteria. Some states will award full marks for this category if a deployment is completed in three years; others award the higher scores for projects completed within shorter timeframes.

NETWORK SPEED AND NETWORK TECHNOLOGY CAPABILITIES

As noted FTTP is the preferred technology option for BEAD funding. However, for so-called nonpriority last-mile projects where FTTP is not being used, the characteristics of the broadband technology can have a scoring weighting. Considerations include broadband speeds, latencies, the usable lifetime of the broadband infrastructure, and the cost-efficiency of the broadband technology. Bidders will often need to consider the trade-offs involved in proposing to deploy a technology that offers higher speeds but is more expensive to deploy than alternatives.

OPEN ACCESS: BUSINESS MODEL REQUIREMENTS FOR BEAD FUNDING

One very important difference between the BEAD selection process and government funding of broadband infrastructure rollout in Europe is that in the US using an open access operating model is not a mandatory requirement. States can, however, include offering wholesale access as a nonmandatory but preferred requirement for bidding. In most cases where states have included open access as a scoring category, it accounts for less than 10% of the score. As a result of these different requirements, operators bidding for BEAD government funding may need to develop both retail and wholesale product offers as well as accompanying business plans, and this introduces significant extra complexity to the bidding process.

OTHER SECONDARY SCORING CRITERIA

Bidders that can demonstrate that they have performed outreach locally and to Tribal communities might also be allocated additional points in some states. In addition, bidders need to demonstrate they have considered the risk of extreme weather events having an impact on the resilience of their infrastructure project. Some states make the resilience of the infrastructure deployment a scoring criterion. Additional points might be awarded if a deployment consists of buried fiber, for example.

VENDOR REQUIREMENTS: BUILD AMERICA, BUY AMERICA

Build America, Buy America requirements with relation to the government funding of broadband infrastructure rollout focus on ensuring that the components of the network equipment are made in the US. Build America, Buy America provisions extend beyond equipment for telecoms networks and also include requirements for other areas where government money is being spent on infrastructure, such as roads and bridges. The aim of the policy is to create jobs, boost economic resilience, and empower local businesses. As part of the BEAD program, at least 55% of all components of fiber networks must be manufactured in the country.

In terms of the BEAD program, bidders and the vendors they intend to work with need to understand that there are certain waivers of the Build America, Buy America requirements. In the first instance, limited waivers apply for the procurement of non-optic-glass inputs. Another waiver applies to semiconductors, which in the main are still manufactured outside the US. However, there are no waivers for OLT and ONT equipment, although waivers do apply to other network electronics equipment in the form of routers, switches, optical amplifiers, and components of fixed wireless networks such as antennas. Waivers do not apply for cabinets and enclosures used for fiber networks, because though such equipment may be manufactured overseas, a significant proportion of the cost of the components of such equipment already comes from components manufactured in the US. Equipment for PONs, such as splitters and multiplexers, is largely manufactured outside the US, so waivers to Build America, Buy America requirements have been included for such equipment.

As the BEAD program continues, the WBBA will continue to track its impact and the lessons to be learned for different stakeholders. Stakeholders involved in investment in broadband infrastructure can learn more about the different financing models deployed in different territories from content, including case studies, published by the WBBA and by interacting with fellow WBBA members, for instance, at events organized by the association.

BROADBAND BUSINESS MODEL CHOICES

THE GENERAL ABSENCE OF WHOLESALE BROADBAND ACCESS IN THE US MAKES IT VERY DIFFERENT FROM EUROPEAN MARKETS

It is generally striking how little wholesale broadband access there is in the US. It is true that in many cases in Europe there are regulatory obligations on incumbent operators to offer wholesale access to their infrastructure. However, at the same time growing numbers of nonincumbents are voluntarily opening their networks to third parties in addition to offering retail access over their own infrastructure. Furthermore, in Europe there are also a number of sizable operators, such as OpenFiber in Italy, SIRO in Ireland, and CityFibre in the UK, whose business model is wholesale only. As part of this investment guidebook, it is worth highlighting some of the reasons why stakeholders should at least consider the value of offering wholesale access on FTTP networks in North America.

WHOLESALE ACCESS AS A MEANS OF INCREASING SUBSCRIPTION TAKE-UP

Achieving high FTTP take-up rates in North America may be more challenging than elsewhere, which makes offering wholesale access more attractive. The low market share of telcos versus cable operator competitors in many areas means that any telcos rolling out FTTP will have fewer existing customers to migrate to fiber. In addition, it may be harder for new FTTP altnets to attract subscribers than elsewhere because this would require more subscribers to churn from cable than from the lower-speed DSL that is more prevalent in other markets. In this environment, one option to boost subscription take-up rates would be to open the network up to multiple retail service providers; the resulting competition could help increase subscription numbers.

It is also worth noting that FTTP rollouts offer flexibility in their ability to support different kinds of wholesale access. For instance, FTTP deployments around the world offer different flavors of both passive and active wholesale access. However, the situation for DOCSIS cable networks is very different. Few players offer wholesale access over cable networks, and the technical options are very limited. This lack of flexibility in offering wholesale access might be one reason for cable operators to upgrade to FTTP. As with telcos, offering wholesale access could help cable operators increase their overall subscription take-up rates. In addition, offering wholesale access on FTTP might reduce the threat of new fiber entrants in cable operators' coverage areas because such potential new entrants might instead be more inclined to take wholesale access from the cable operator that has upgraded its network to FTTP.

For operators that have deployed FWA, wholesale access might also be an option. Over time as network-slicing solutions mature, it will be possible for operators to offer a slice of capacity that could be used by another operator for retail FWA services. Such an approach could again serve to increase overall FWA subscription take-up rates on the wireless infrastructure that operators have already deployed.

TAKING WHOLESALE FIBER ACCESS MAY BE AN ATTRACTIVE OPTION FOR LARGE PLAYERS IN THE US MARKET

One further reason why offering wholesale access on a voluntary basis could be attractive in the US is that there may be a number of sizable existing operators that might be interested in using wholesale access. In the first instance, wireline operators do not have nationwide footprints in the US, and these operators, whether telcos or cablecos, may be interested in taking wholesale fiber access outside of their traditional wireline footprints. Such operators could help the business case for wholesale-oriented fiber operators because they could play an important role in driving take-up thanks to their existing brands, retail propositions, and operations. Second, the US telecoms market is seeing an increasing amount of fixed-mobile convergence, for example, as cable operators such as Comcast enter the mobile market through MVNO agreements or as MNOs such as T-Mobile launch FWA. This trend could push more mobile

players to enter the fixed market, and taking wholesale fiber offers may be an attractive option since there may ultimately be questions about the ability of FWA to deal with increasing traffic.

HIGH RETAIL BROADBAND ARPUs COULD ALSO FAVOR THE DEVELOPMENT OF WHOLESALE-ORIENTED BUSINESS MODELS

The very high retail broadband ARPUs in the US market mean that with a wholesale-only business model, even one that only offers passive wholesale access, ARPUs are still likely to be reasonable in comparison with the costs of fiber network rollout. The very high retail broadband ARPUs in the US might also make it an attractive strategy to initially develop a vertically integrated model and attract the highest-ARPU customers to the operator's retail ISP, then later open the network up for wholesale access in order to try to maximize subscription take-up on the network.

ANCHOR TENANT MODELS MAY BE VIABLE IN THE US MARKET

It is also worth noting that some large players in the market (e.g., T-Mobile) could be attractive candidates for an anchor tenant model. In such a model the infrastructure owner signs an agreement with a single retail ISP or anchor tenant that offers exclusive access to the network at favorable terms for a set period. This model has advantages in incentivizing the retail ISP to quickly maximize its subscription take-up and could also be a way of attracting a large ISP or anchor tenant to the network, which may not be possible without such an offer of exclusive access.

SMALLER OPERATORS MAY FACE CHALLENGES IN ATTRACTING LARGER PLAYERS ONTO THEIR NETWORKS

Smaller operators, whether those that have traditionally operated vertically integrated and closed networks or those that are considering launching wholesale-only business models, need to be aware that scale matters if they wish to attract bigger players onto their networks. Bigger operators will generally not want to establish wholesale relationships with hundreds of smaller operators. In order to address this challenge, smaller players can try to increase their footprints or else participate in wholesale aggregation platforms where such entities exist. Wholesale aggregation platforms would mean that larger operators could gain access to the whole range of networks that are members of the platform rather than having to establish individual relationships with each network.

WHOLESALE ACCESS AS A MEANS OF INCREASING COMPETITION AND SUBSCRIBER CHOICE

If operators open up their networks for wholesale access, this has the potential to increase the number of retail service providers to which end customers can choose to subscribe. Competition between more retail service providers also has the potential to reduce retail broadband prices, which is already an area of focus for governments as can be seen by measures such as the Affordable Connectivity Program. In addition, competition between more retail service providers that are active on the same access network might encourage greater innovation at the service level. It should also be noted that some operators around the world have argued that imposing regulatory obligations on them to open their networks to wholesale access may discourage network build because it may impose constraints on the overall ARPUs and revenue such operators can expect to generate. Nevertheless, as discussed, there are a number of reasons why operators may find commercial motives to open their networks for wholesale access.

Stakeholders involved in investment in broadband infrastructure can learn more about the different business models deployed in different territories from content, including case studies, published by the WBBA and by interacting with fellow WBBA members, for instance, at events organized by the association.

KEY TAKEAWAYS FOR STAKEHOLDERS IN OTHER REGIONS BASED ON DEVELOPMENTS IN NORTH AMERICA

- Operators and governments in other markets should not underestimate the value of wireless broadband technologies such as FWA and satellite. In the US there is room for fixed wireless deployments to qualify for government funding, for example. The success of FWA in attracting subscribers should also be noted in different markets with similar conditions. If traffic growth continues to slow, the capacity limitations of FWA and satellite broadband might also become less important, making them more attractive for operators to deploy.
- Investors from outside North America should carefully examine investment opportunities for broadband infrastructure deployment in the US and Canada. In many ways rollouts in North America might be more appealing than those in Europe, for instance, because of the high achievable ARPUs in North America and the often more modest levels of broadband infrastructure competition.
- The level of government funding in the US for broadband infrastructure rollout as part of different programs such as BEAD is very high, higher than is seen in many other countries. There is room for governments in other countries to provide additional funding for broadband infrastructure deployment to ensure their citizens have broadband access comparable to that in other peer markets.
- There is the potential for governments in other countries to do more on the demand side to encourage broadband adoption. The Affordable Connectivity Program in the US has seen very widespread take-up of its subsidies for retail broadband plans. There may be a role for retail tariff subsidies in encouraging the adoption of next-generation broadband in other markets.
- There are lessons for operators in other markets from how operators in North America have been able to successfully offer innovative retail plans that have helped them boost broadband ARPUs. Multigigabit access plans have helped increase ARPUs in the US as have plans that focus on providing a better customer experience, for instance, through offering services associated with home Wi-Fi.

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