GSMA Intelligence

The 5G FWA opportunity

Disrupting the broadband market

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GSMA Intelligence

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Published October 2021

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1 Introduction

5G fixed wireless access (FWA) is now a commercial reality in developed and developing countries around the world. While FWA solutions have been around for more than two decades, the massive performance improvements enabled by 5G and the use of mmWave spectrum (enabling speeds that are over 10× that of 4G) make 5G FWA a competitive solution compared to the predominant technologies in the fixed broadband market.

This report forms part of a research series that reviews the implications and costs associated with deploying 5G FWA services in several regions around the world.

The analysis looks at the cost effectiveness of meeting growing demand for fixed broadband services, comparing the use of wireline technologies with the deployment of 5G FWA enabled by mid-band and mmWave spectrum. The aim is to determine under what conditions 5G FWA can be a cost-effective deployment strategy in typical urban, suburban and rural areas in different global regions. In some circumstances, wireline technologies will be more cost effective than FWA. In others, FWA will provide the greatest cost savings.

We focus on three deployment scenarios that reflect situations in the market, such as mobile operators targeting fixed broadband users in underserved markets or areas with a limited number of fixed broadband alternatives, and service providers complementing their fibre offerings or replacing legacy copper-based solutions.

We have developed a unique total cost of ownership (TCO) model that considers a range of demand- and supply-side factors to determine the conditions where FWA deployments could provide cost savings compared to the main wireline alternatives available in the fixed broadband market: full fibre, copper and coaxial cable-based solutions. The findings will be published over five additional reports looking at the alternative deployment scenarios.

In this first report, we look at the different fixed broadband technologies available in the market, providing context for the research that follows. First, we delve into the make-up of the fixed broadband market. We then provide an overview of recent developments in 5G FWA networks. Finally, we describe the key cost drivers of each technology as well as the TCO model used to inform our findings.

The results of this unique modelling exercise will drive a better understanding of the conditions that enable FWA solutions to provide a cost-effective way to meet customer demand for improved fixed broadband performance.

2 Fixed broadband technologies: a changing mix

The fixed broadband market has been growing in most parts of the world. For instance, in OECD countries the market grew by 21 million connections in 2020.[1] This has been driven by the shift of more activities online and rising requirements in terms of performance. Video streaming has been one of the most popular and data-intensive use cases, accounting for 58% of global internet traffic in 2020[2] and 80%[3] when considered together with social networking and gaming accounts. The Covid-19 pandemic has only strengthened the growth in data consumption and has shifted consumer patterns, with home broadband now regularly used for work. This has brought to the fore the importance of robust, high-speed fixed broadband infrastructure and the need to deploy it in a timely and cost-efficient manner, in developed and developing countries. The result is continuously growing demand for fixed broadband services and a shift to newer, faster technologies.

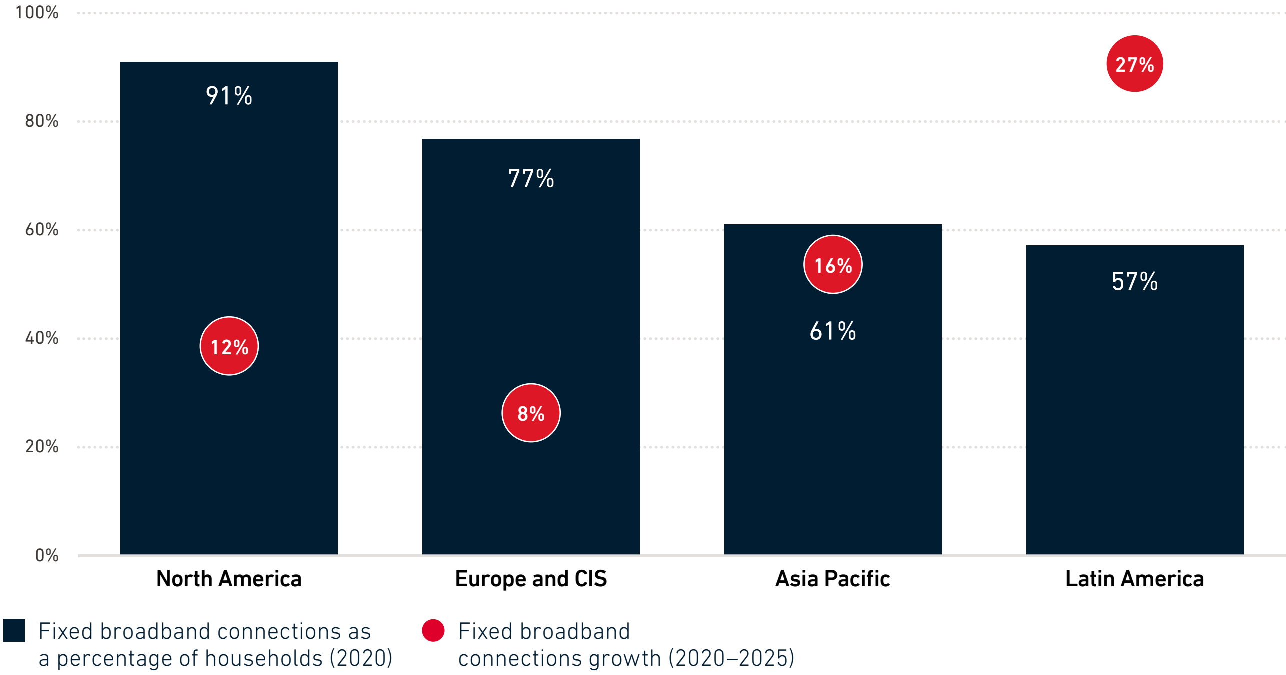
1 oecd.org/digital/broadband/broadband-statistics-update.htm
2 Source: Sandvine
3 Ibid.

Figure 1 provides an overview of fixed broadband penetration and connections growth in selected markets by region. Several developed countries have already reached market saturation (90–100% penetration), with the pandemic providing an additional boost. In these markets, 5G FWA can be beneficial in upgrading legacy infrastructure in underserved markets, reducing the digital divide, and/or providing an alternative in markets or areas with a limited number of fixed broadband offerings.

In developing markets, penetration is on average around a third of that for developed markets, so there are significant opportunities for growth and to reduce the digital divide. Particular markets where we expect penetration to rise significantly over the next five years include Indonesia (from 25% to 33% of households), Brazil (from 67% to 81%), Argentina (from 81% to 91%) and Chile (from 69% to 75%).

Figure 1

Fixed broadband connections as a percentage of households and connections growth in selected countries by region

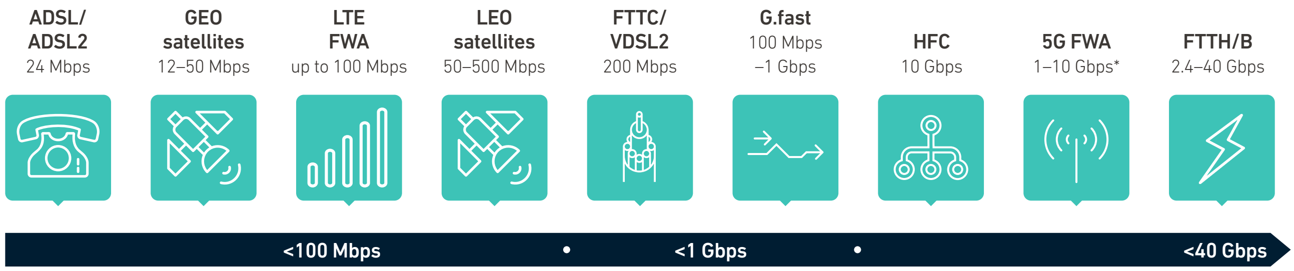


Note: based on a sample of 36 countries representing 62% of the global population
Source: GSMA Intelligence

Figure 2 shows the main types of fixed broadband technologies in use around the world, with each providing different download speeds. The fastest wireline technologies available on the market rely on optical fibre and differ in terms of the last mile to the customer premises: copper (VDSL, G.fast), coaxial cable (HFC) and optical fibre (FTTH). Wireless technologies include terrestrial (FWA) and satellite solutions.

Figure 2

Fixed broadband technologies and average download speeds

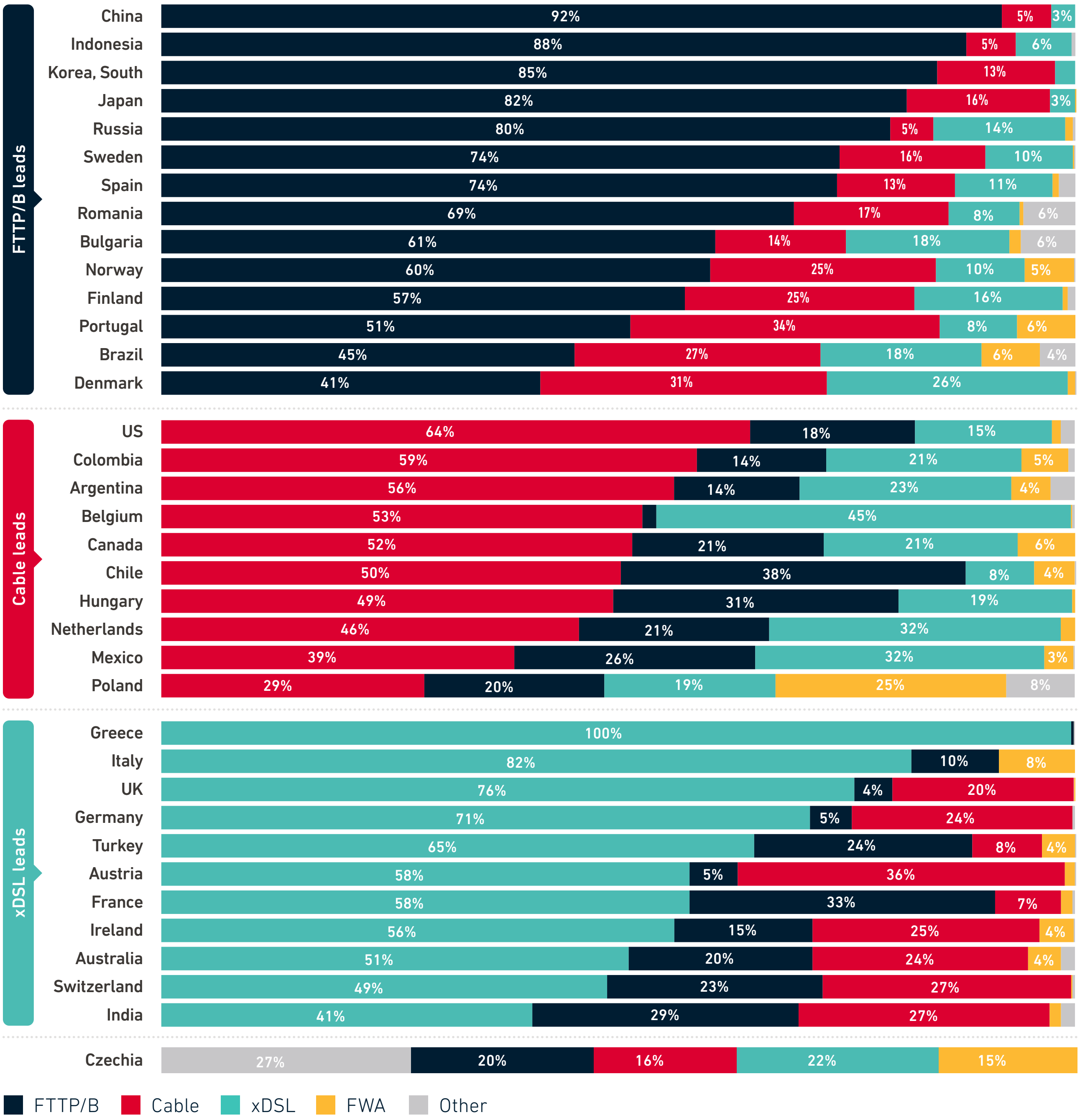


*Depends on spectrum band used and cell-site density
Source: GSMA Intelligence

The share of connections by technology varies significantly between countries, as shown in Figure 3. FTTH solutions dominate in Asia Pacific countries such as China and Indonesia, as well as some European countries as Sweden and Spain. Cable solutions are at the forefront in the US and several Latin American markets. Countries with a majority share of xDSL connections, such as Italy, Turkey and Australia, are starting to see the rise of FWA, as are countries where cable and FTTH solutions lead, such as Brazil, Portugal and Colombia.

Figure 3

Fixed broadband connections by technology as a percentage of total fixed broadband connections (as of the end of 2020)



Fixed broadband connections include residential and business.
Source: GSMA Intelligence

In OECD countries, DSL subscribers have fallen by 21% over the past five years, while fibre, cable and FWA subscribers grew (by 93%, 26% and 64%, respectively).[4] This shift away from DSL-based solutions is expected to continue, to the benefit of fibre, cable and FWA. Over the next five years, 5G FWA connections are expected to grow to more than 70 million,[5] due to a combination of new subscribers in greenfield areas (mainly in developing markets) and subscribers migrating from xDSL, cable and FTTH solutions (mainly in developed markets).

4 Source: OECD
5 See ericsson.com/en/mobility-report/dataforecasts/fwa-outlook

3 FWA grows in popularity, again

While FWA solutions have been used since the late 1990s, they have seen renewed interest as a key use case for 5G networks. 5G FWA solutions provide increases in speeds in the order of over 10× compared to 4G FWA, due to a range of technological improvements:

- **Unified standard.** While FWA was previously developed and deployed using LTE and other proprietary technologies that limited scalability, 5G provides a unified solution and standard.
- **Spectral efficiency.** Compared to LTE, the 5G NR standard provides significant improvements in spectral efficiency by increasing the amount of data that can be carried per unit of spectrum (Hz), due to several improvements in signalling and CPE technology that 5G helps support:
  - antenna gains and beamforming techniques
  - massive MIMO
  - sound reference signal (SRS) beam selection, which allows CPE to switch between beams to optimise signal reception.
- **Advanced features.** 5G supports more advanced features designed to boost performance by improving the capabilities of existing massive MIMO technology and beamforming, and driving improvements in coverage.
- **CPE innovation and model diversity.** The availability of 5G CPE models is continuing to grow, pushing down prices. There are more than 56 5G CPE models available in the market as of 2021 from over 30 different vendors.[6] These models can be installed both indoors and outdoors, can be self-mounted by customers and can support 5G bands including 26–28 GHz (mmWave). High-power CPE units that improve range and performance are also available.

6 Source: GSA

- **New spectrum in the mmWave bands.** mmWave spectrum provides greater bandwidth to support lower latency and higher (gigabit) speeds. In the US, the use of mmWave spectrum in FWA networks was first adopted by Verizon in 2018. While the majority of current 5G FWA deployments focus on the 3.5–3.8 GHz bands, mmWave spectrum is being used as a capacity and performance booster to complement coverage provided by lower bands by several operators around the world, including TIM and Fastweb in Italy, US Cellular and Verizon in the US, and NBN and Telstra in Australia. 5G FWA services are currently being launched worldwide. As of September 2021, 65 operators offer 5G FWA services, while another 19 have announced plans to launch. Across both 4G and 5G, 500 operators worldwide offer FWA services.

Figure 4

Live and planned 5G FWA networks (Q3 2021)

Note: Live or planned status assigned where at least one operator in the market has launched or plans to launch.
Source: GSMA Intelligence

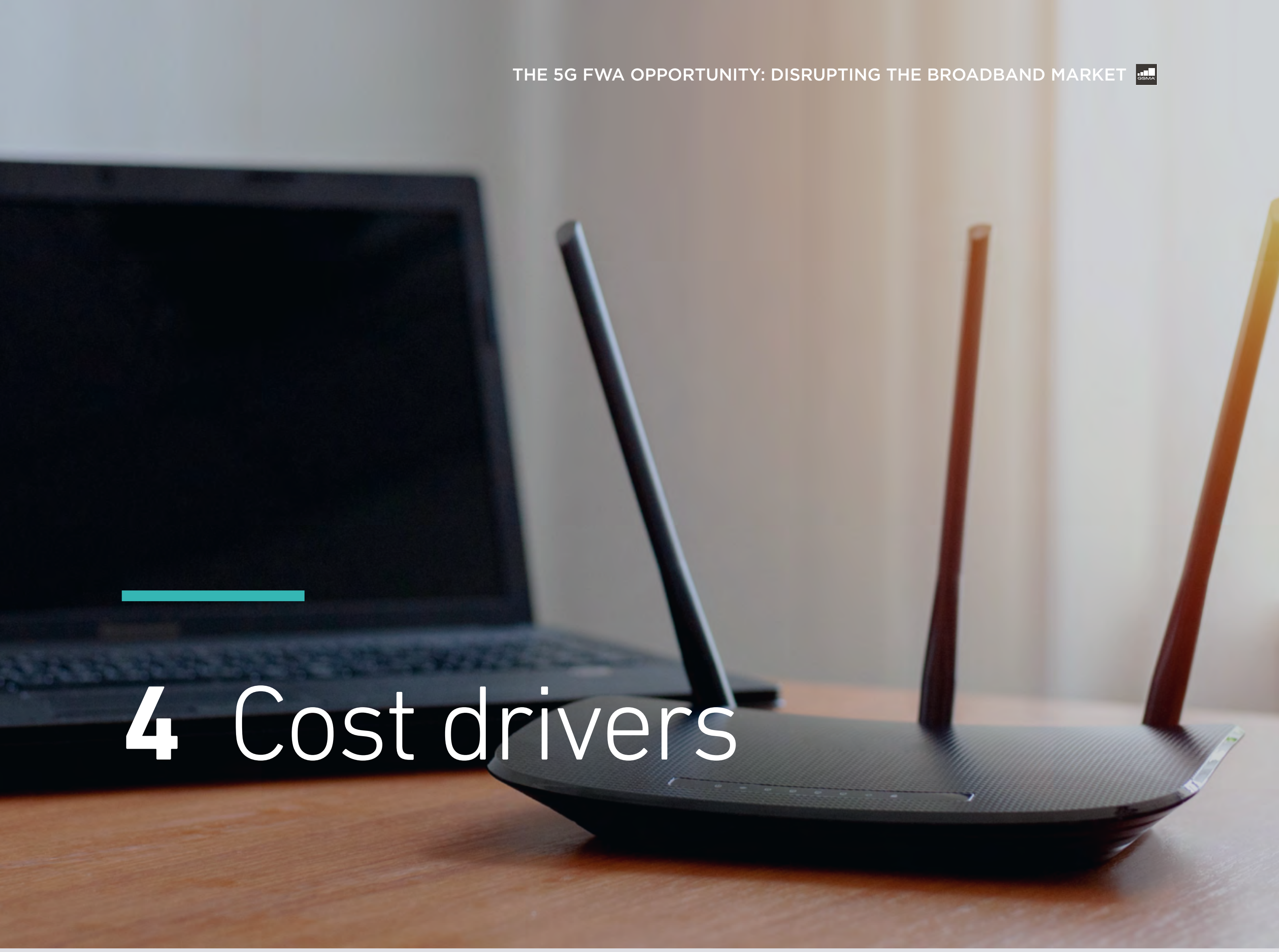
In developing countries, where fixed broadband penetration is low, FWA is being used to drive first-time broadband adoption. Globe in the Philippines – the first operator in Southeast Asia to launch a commercial 5G FWA service – provides a relevant example. Its proposition, targeted at the country's growing urban middle class, aims to build on Globe's 4G FWA success by offering download speeds of up to 100 Mbps and a data allocation of 2 TB. With the operator's 5G FWA plans priced with an average premium of 60% on its 4G FWA plans, there is a significant incremental revenue opportunity.

In developed markets, some mobile operators without existing fixed infrastructure are using 5G FWA to challenge DSL, fibre or cable competitors. The clearest opportunity is in markets where a significant number of households rely on xDSL broadband products with low speeds; 5G FWA can be positioned as a performance improver, particularly in terms of download speeds. For instance, in the UK, Three's 5G FWA product offers average download speeds of 100 Mbps – a significant improvement on the average broadband speed in the UK (64 Mbps[7]). In Italy, DSL fell from more than 80% of total fixed broadband connections in 2016 to below 30% in 2021, while FWA solutions have seen strong growth to the point of challenging FTTH in terms of connections (1.61 million versus 2.11 million respectively).[8] In the US, US Cellular has recently highlighted the importance of 5G FWA in bridging the digital divide. The operator has hit a 5G FWA extended-range milestone using mmWave spectrum, reaching multi-gigabit speeds at a range of 7 kilometres.

7 UK Home Broadband Performance, Ofcom, May 2020
8 AGCOM Osservatorio delle Comunicazioni, N2 2021

5G FWA is also being used by operators looking to expand into new areas to complement their FTTH networks, or by mobile-only operators aiming to challenge cable and FTTH broadband providers. Verizon's Fios FTTH service, for example, is available to around 15 million US households (12% of the total). To expand its fixed broadband footprint outside Fios coverage areas, the operator plans to use 5G mmWave FWA, citing an addressable market of 30 million households – double its current FTTH footprint. The service, marketed as 5G Home, will move Verizon into direct competition with cable providers, which account for 60% of fixed broadband connections in the US.
In high-ARPU markets, 5G FWA can be targeted at cost-conscious subscribers. The US provides another example here: T-Mobile began rolling out its 5G Home Internet offering earlier in 2021, with a view to cover 10 million premises (8% of US households) by 2024 in underserved areas and lower-income neighbourhoods in urban and suburban areas.

5G FWA is also being used as a complementary strategy for incumbent operators looking to migrate existing fixed broadband subscribers from copper-based networks. In Estonia, Telia is trialling 5G FWA with the intention of using the technology as part of its plan to replace copper access lines. Similarly, FWA is part of Telkom South Africa's planned technology mix to replace its copper network.



4 Cost drivers

To explore the deployment strategies available, we are publishing a series of reports that analyse the conditions where 5G FWA solutions can be a cost-effective alternative to wireline technologies, according to three scenarios:

- **Scenario 1 –** An operator with existing 5G services in the area deploys 5G FWA solutions with mmWave spectrum but with limited sub-6 GHz spectrum available.
- **Scenario 2 –** An operator with existing 5G services in the area deploys 5G FWA solutions with mmWave spectrum and a significant amount of sub-6 GHz spectrum.
- **Scenario 3 –** An ISP deploys a greenfield 5G FWA network.

These scenarios are representative of the approaches operators can adopt when looking at fixed broadband deployment.

The first two scenarios are relevant to mobile-only operators looking to service new markets, or converged operators aiming to upgrade their networks or complement them to gain market share. Sub-6 GHz assignments per operator vary widely; some operators will not have enough sub-6 GHz spectrum to service both fixed and mobile broadband users, so might use spare mmWave spectrum to provide 5G FWA more effectively. Other operators may have more sub-6 GHz spectrum to cater for 5G FWA; this would change their TCO picture. An example would be an operator that has rolled out 5G but has a limited or no fixed broadband offering. A further example would be a converged operator with a 5G offering, looking to provide better performance in underserved areas or an alternative service in urban and suburban areas with limited connectivity options.

The third scenario is relevant to ISPs that are looking to expand their networks or switch off their copper networks, and are considering different options, including acquiring spectrum to offer 5G FWA services.

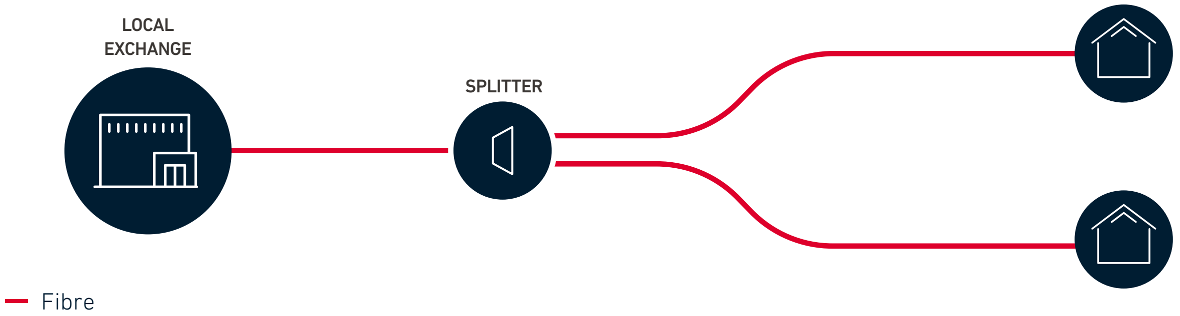
Our TCO model estimates deployment costs over the next 10 years in typical urban, suburban and rural areas in different regions. The model considers the main cost items and drivers of the technologies as set out below.

Fibre-to-the-home (FTTH GPON)

With FTTH, an optical fibre point-to-multipoint network brings fibre directly to the customer premises. The main costs are related to civil works and related government permissions, which depend on whether the fibre cables are placed underground or overground and whether they are owned or rented by the communication service provider (CSP). Deploying fibre solutions can be time-consuming in some areas, creating an opportunity cost. Optical splitters (unpowered) are used to serve several subscribers (typically up to 32) and are connected from the local exchange. Each subscriber is provided with the relevant equipment and connected to the fibre network via in-building wiring.

Figure 5

FTTH



Main cost items	Drivers
Civil works (underground/overground, own/rented)	Local terrain characteristics, local regulations
Fibre cable	Total length to reach all premises
GPON splitters and split ratio (1:x)	Number of premises served
Equipment at the local exchange	Number of premises served
Last drop to customer premises (including CPE and ONT)	Number of subscribers, availability of infrastructure at customer premises

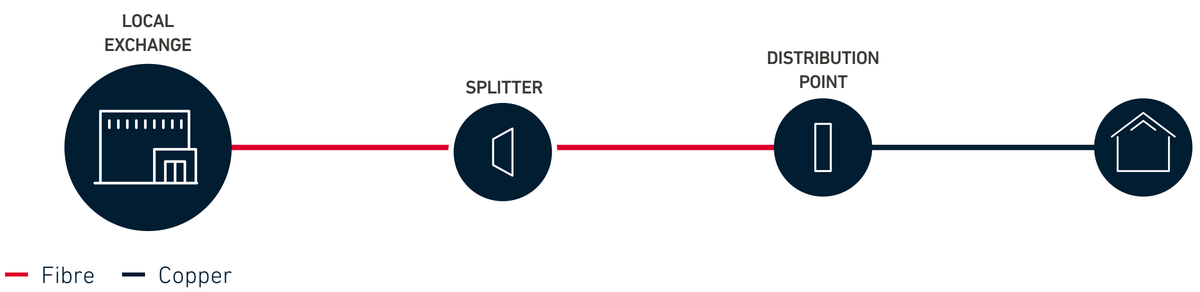
Source: GSMA Intelligence

DSL (FTTdp G.fast)

G.fast uses a fibre connection to a distribution point, generally close to the customer premises (less than 250 metres), while the last stretch is served by copper. The length of the copper sub-loop determines the performance experienced by the customer, so G.fast distributed point units or DPUs (actively powered or reverse-powered) feature a maximum copper range, which depends on the performance targeted by the network. The number of premises served also determines the number of DPUs deployed (typically 16 ports per DPU).

Figure 6

FTTdp G.fast



Main cost items	Drivers
G.fast DPUs	Coverage (range of copper sub-loop) and capacity (number of ports)
Fibre cable and infrastructure	Local terrain characteristics, local regulations, distance to DPUs to be served, number of premises to be served
Customer premises equipment (CPE)	Number of subscribers

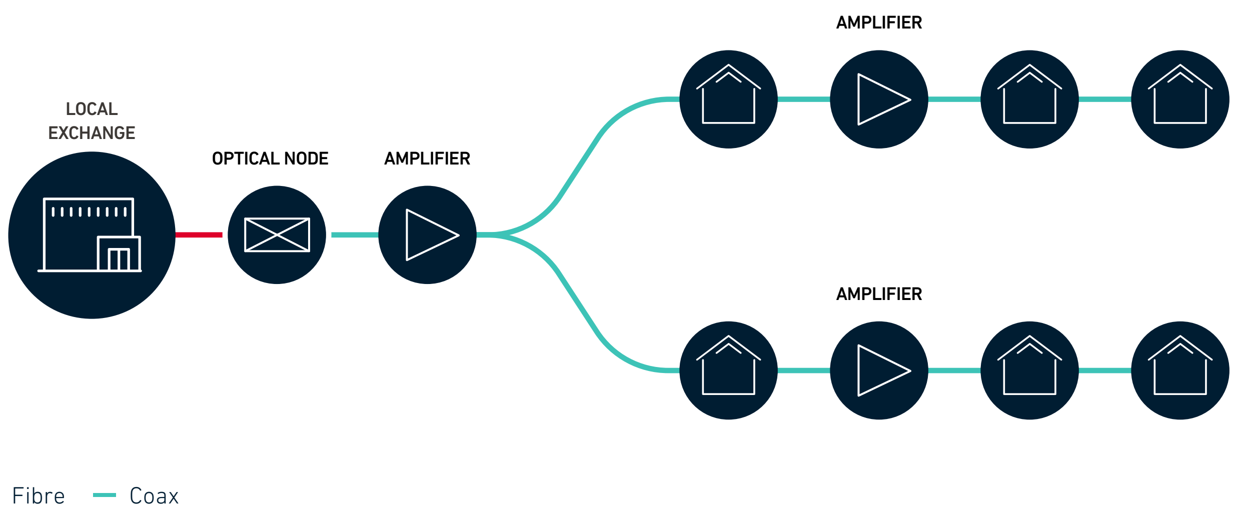
Source: GSMA Intelligence

Cable (hybrid fibre-coaxial – HFC)

HFC uses fibre to an optical node and then serves the premises with a coaxial cable network topology. Similarly to FTTH GPON, the main cost item is related to civil works, which will depend on the coaxial cable topology and fibre topology. Line amplifiers (powered) are used to amplify the signal, which deteriorates the longer the coaxial cable length. Splitters and taps are used to serve multiple premises. Each subscriber is provided with the relevant equipment (cable modem) and is connected via in-building wiring.

Figure 7

Hybrid fibre-coaxial



Main cost items	Drivers
Civil works (underground/overground, own/ rented)	Local terrain characteristics and local regulations
Coaxial cable	Total length to reach all premises
Active equipment (amplifiers, splitters, taps, optical nodes)	Depending on coaxial cable length and number of premises served
Fibre cable and infrastructure	Local terrain characteristics, local regulations, distance to optical nodes to be served, number of premises to be served
Last drop to customer premises (including CPE)	Number of subscribers, availability of infrastructure at customer premises

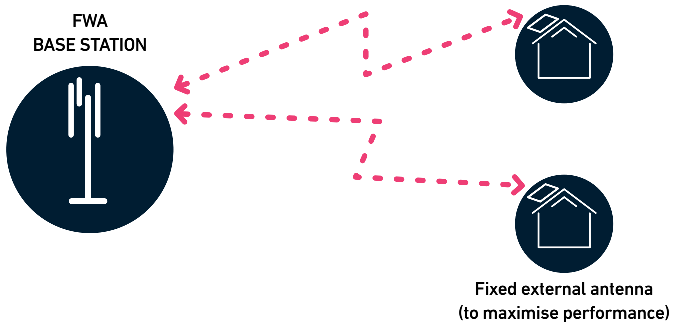
Source: GSMA Intelligence

5G FWA

5G FWA provides broadband access to subscribers wirelessly using a 5G network. The main cost drivers are related to coverage needs (if there is no existing 5G network), depending on the propagation characteristics of the area and the spectrum bands used; and capacity needs, according to network load at the peak hour and bandwidth availability. Subscribers are provided with the relevant equipment and may need an outdoor unit to enhance performance.

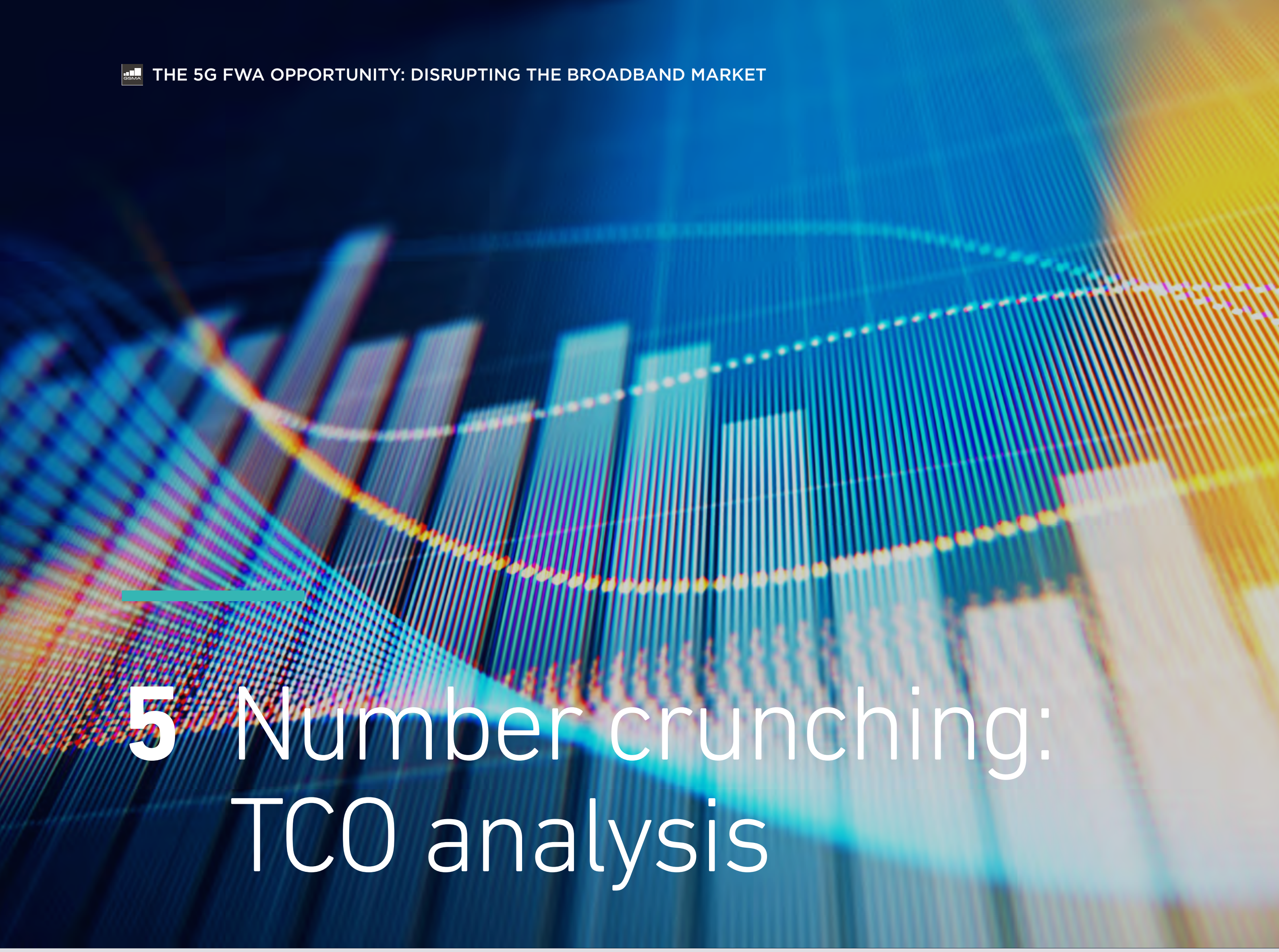
Figure 8

5G FWA



Main cost items	Drivers
Passive infrastructure (tower, shelter)	Fixed cost depending on coverage and capacity needs
Active infrastructure (including gNodeB, baseband, backhaul and software fees)	Fixed cost depending on spectrum band used and coverage and capacity needs
Customer premises equipment (CPE)	Number of subscribers, use of outdoor units

Source: GSMA Intelligence



5 Number crunching: TCO analysis

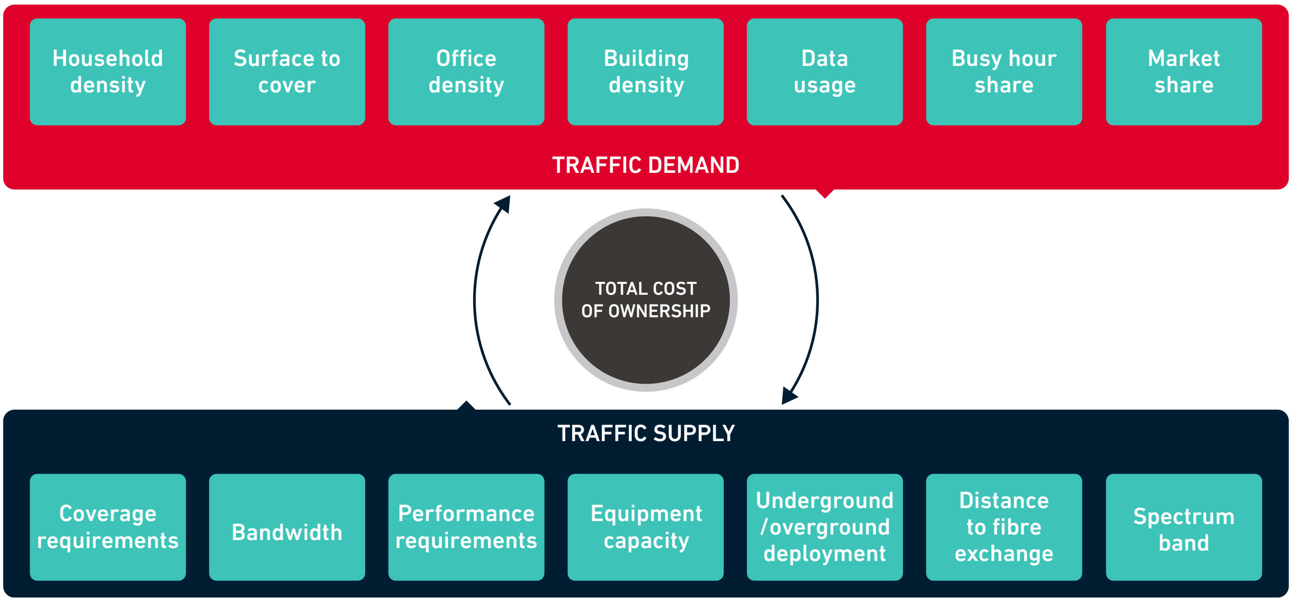
To reflect all the cost drivers and contextualise them in terms of real demand and supply situations, we have developed a unique TCO model. Below we present the key demand- and supply-side factors that our model leverages to determine the dimensioning of the network. Once the network is dimensioned, assumptions on unit costs and asset lifespans allow us to determine the total cost of ownership for each technology.

Figure 9

TCO model overview

TRAFFIC DEMAND

- Population and surface area give the population density of the area, which determines each geo-type (urban, suburban, rural) and household density.
- Household, office and building density (depending on the surface area to cover) together determine the number of premises to be passed by the network.
- The CSP market share determines the number of subscribers, which drives the number of last drops needed by the network as well as the CPE.
- Data usage and share of traffic at busy hour determine the traffic that needs to be supported by the network. Traffic patterns are also determined by an assumption on the downlink (DL) share of total traffic.



Source: GSMA Intelligence

TRAFFIC SUPPLY

- We set a minimum performance requirement of at least 100 Mbps downlink and 20 Mbps uplink (UL) everywhere. We assume FTTH GPON and HFC meet these requirements by their nature, whereas G.fast and 5G FWA are dimensioned accordingly.
- Spectrum band and bandwidth availability drive the coverage requirements and unit capacity for 5G FWA. We assume that the CSP will adopt a hybrid sub-6 GHz plus mmWave (26–28 GHz) deployment strategy. mmWave bands offer huge bandwidth availability but travel relatively short distances compared to the signals of lower frequency bands, so we expect CSPs to use sub-6 GHz bands to provide for contiguous coverage, and mmWave bands to be deployed on existing sites to fill capacity gaps in the network whenever traffic demand exceeds network capacity.
- The deployment mode (underground or overground) alongside road density determine the length of civil works needed to deploy wireline infrastructure as well as fibre and coax cable lengths. This is determined by regulatory factors (city planning) as well as the availability of ducts or poles that can be shared.
- The extent of existing infrastructure (for instance, whether customer premises are already wired with coaxial cable, copper or fibre) can drive significant deployment cost savings.
- The equipment capacity, such as the number of ports in a G.fast DPU or the split ratio for GPON splitters, determines (alongside the number of premises to be served) the equipment needed to cover the area.
- The distance to the fibre exchange determines the additional length of the fibre route needed to connect G.fast and HFC.

In the research that follows, we will publish our findings for each of the deployment scenarios. We examine the conditions where 5G FWA can be a cost-effective solution to deliver broadband speeds of at least 100 Mbps over the next 10 years for all types of operator, including:

- converged operators looking to upgrade underserved markets or looking to challenge concentrated markets
- mobile-only operators looking to enter new markets with agility
- ISPs looking to complement their fibre networks and penetrate new markets.

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