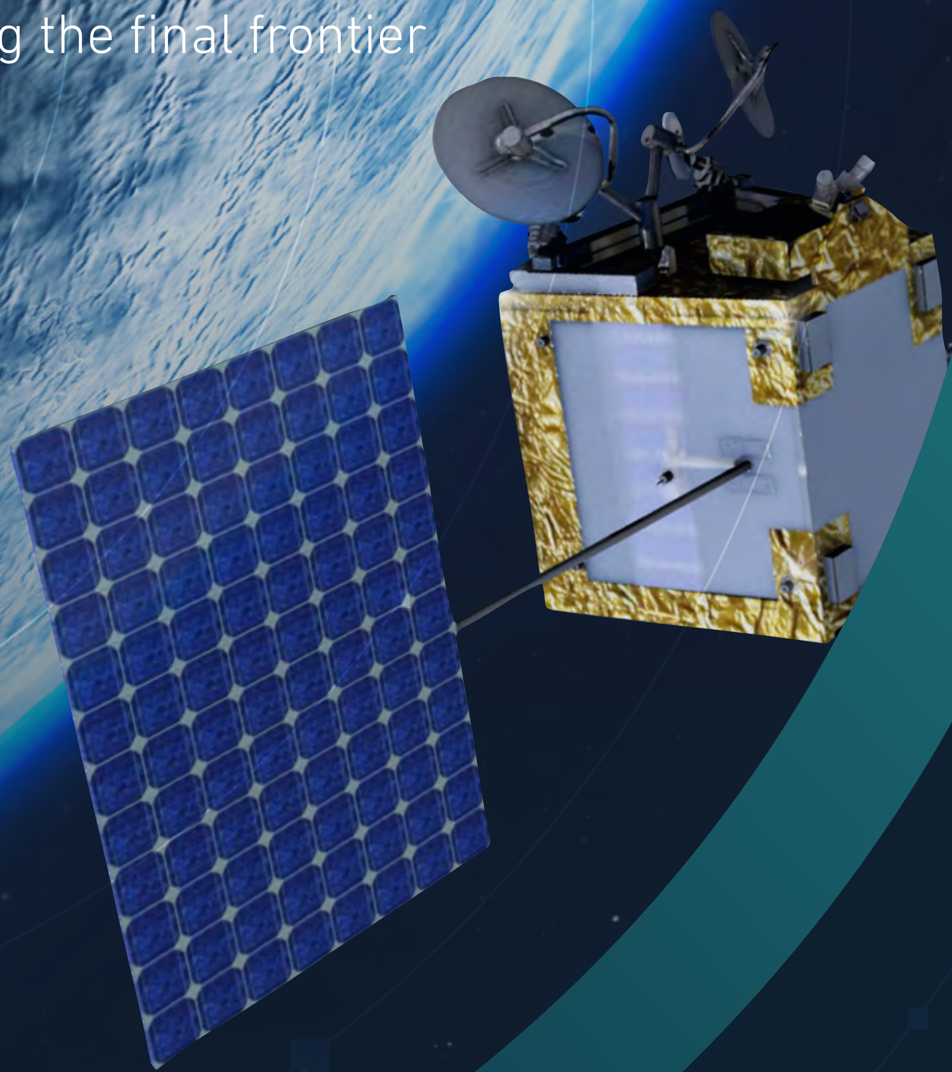
GSMA Intelligence

RADAR

Connectivity from the sky

Reinventing the final frontier



OneWeb Intellian SoftBank

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Published June 2021

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This report was conducted by GSMA Intelligence and supported by OneWeb, Intellian and SoftBank

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Executive summary

An economical means of bridging the digital divide

Satellite broadband continues to undergo a period of reinvention through the low Earth orbit (LEO) constellation model that re-emerged five years ago from OneWeb, SpaceX and a range of other participants. Momentum and industry traction have been underpinned by a reduced cost structure and higher performance capability relative to legacy geostationary satellites that operate at much higher altitudes. A separate mode of aerial connectivity called high-altitude platform stations (HAPS) is also in development, albeit at an earlier stage and further away from commercial deployment.

The reasons for the satellite and broader aerial connectivity push are clear: the size and persistence of the digital divide, and connectivity barriers for businesses operating in rural or remote areas. It can be easy to forget that on a global scale, mobile internet penetration is only 50%. This means around 3.7 billion people (or 3 billion adults) remain offline, most of whom reside in India, China, Africa and a handful of populous lower-income Asian countries such as Pakistan and Indonesia. We estimate 25% of this unconnected population – approximately 780 million people – live outside of range of a 3G or 4G signal. The divide is also widely manifest in rural and remote regions of the US and Europe. Combined with households that have slow speed connections, the addressable 'not-spot' audience would be in the range of 1–1.5 billion people. Demand for business connectivity comes from a number of sectors, most notably manufacturing, hospitals and health facilities, oil and gas, energy generation, and local governments.

Changing economics and evolving competition

The major change with new LEO constellations compared to traditional GEO architectures, which primarily connect to slower-speed 2G and 3G networks, is a lower deployment altitude to drive enterprise-grade data throughput and lower latencies while still affording a wide ground area coverage to extend the reach of terrestrial base stations. The smaller form factor, improved tracking and stabilisation technology from leading satellite communications user terminal (UT) innovators such as Intellian, faster manufacturing capabilities, and reduction in UT prices have helped lower the cost of deploying and maintaining communication satellites in orbit and ultimately improved the economics of providing rural coverage.

OneWeb and SpaceX have announced their plans for initial constellations of approximately 650 and 4,400 satellites respectively – equivalent to 2× the total number of satellites in operation today. Both companies have reached a third of their target constellation size, with further commercial launches staggered towards full deployment and global coverage by 2023. Telesat (with Lightspeed) and a host of other companies are also firmly in play, even if at a lower scale. One notable exception in the wings is Amazon, which involves an integrated play between Blue Origin and a vast network of AWS ground stations – presumably to provide connectivity and higher-order cloud and edge compute services to enterprise customers with rural or dynamic coverage needs.

HAPS, which are unmanned aerial vehicles equipped with a communications equipment payload, fly in the stratosphere at approximately 20 km above sea level. This places HAPS at roughly double the altitude of a commercial aircraft but well below any satellite configuration, including LEO, which operates at around 1,000 km up. HAPS were examined as a connectivity option back in the 2000s such as with Sky Station and Google's Project Loon – a flying mesh network of balloons with good intentions but that ultimately lacked economic viability absent commercial partners and was discontinued in early 2021. However, the viability and attractiveness of new HAPS efforts should be helped by the increased flying time of the light aircraft and better equipment and network performance. Integration with spectral frequencies of the mobile operators would also help link HAPS with terrestrial networks, although this in part depends on negotiations and allocations to come at the next World Radiocommunication Conference in 2023. HAPS Mobile (backed by SoftBank) and a venture led by Stratospheric Platforms Limited (backed by Deutsche Telekom) are two notable current efforts.

Wholesale revenue models generally make most sense

Providing wholesale backhaul access via partnerships with the mobile operators is the most common route to market. This may be structured as a revenue share or priced on a data volume basis (cost per GB transferred). The wholesale model is symbiotic and pragmatic: providers with leading UT integrators such as Intellian can help operators extend their network footprint to regions that would otherwise remain underserved or unconnected and receive wholesale revenue, while telcos can reach new customer segments in areas not economically viable with terrestrial backhauling solution, bringing economic and societal benefits.

Businesses are also an important target audience. Our survey of enterprise verticals suggests that 15–25% of businesses already use satellite connectivity as a primary or back-up access technology. Public sector agencies (including schools), manufacturing groups and healthcare facilities are the highest adopters so far outside of the traditional buyers in maritime, aviation and logistics. Utilities, oil and gas, and energy grid operators show the highest spikes in intention to use satellite, reflecting their need for IoT connectivity in off-grid areas and cellular service for their employees. Covid-19 places further urgency on bridging divides in all instances.

An alternative model is to go direct to consumers and businesses. This appears to be the strategy of SpaceX under the Starlink brand. The challenge here is not one of coverage but rather pricing, specifically that of customer-premises equipment and distribution. In the UK beta trial of Starlink, for example, the monthly tariff of £89 is already at the top end of the market, on top of which sit equipment and shipping costs of nearly £500 upfront – making it a full 30% of the total cost of ownership over 12 months. While this may be a price worth paying for households with slow or no internet access, it is likely to constrain widespread adoption even in high-income countries absent significant reductions.

We expect current market momentum to accelerate as established constellations increase towards their target size. Forming commercial partnerships with operators will be key over the next 2–3 years to test and deploy solutions in practice, providing feedback loops to inform tech and business model iterations. Operators will also need to focus on infrastructure deployment logistics in rural areas as part of a wider package of educational support for such communities. Coverage is, after all, one of several barriers to mobile internet and broadband access along with costs, digital literacy and relevance. Tying these together through joined-up efforts is most likely to succeed rather than tackling each in isolation.

1

Bridging a large and persistent internet divide

Satellite broadband continues to undergo a period of reinvention through the LEO constellation model. LEO is not a new concept per se, having been plied for years in meteorological and military applications.

It is, however, a new way of providing connectivity for mass-market communications and internet access, underpinned by a reduced cost structure for satellite launch and operations and higher performance capability relative to legacy geostationary satellites that operate at much higher altitudes. Much has transpired since OneWeb and SpaceX's licences were approved by the Federation Communications Commission in 2018, including the entrance of new participants (principally Amazon), the expansion of infrastructure scale and the move towards live commercial services. These commercial services can either be direct to consumer (e.g. SpaceX) or via wholesale models with telecoms operators (e.g. OneWeb) and innovative user terminal (UT) suppliers (e.g. Intellian). In parallel, HAPS, a newer mode of aerial connectivity, has also emerged as a potential complementary aerial option in the earlier stages of development.

Aerial connectivity is an umbrella term we use to cover any non-terrestrial solution that helps extend the coverage footprint of ground-based communications networks. This includes satellite – low Earth orbit (LEO) and geostationary orbit (GEO) – and the newer high-altitude platform station (HAPS) technology. While we use aerial connectivity in this context throughout the report, the underlying technology, maturity, deployment model and commercial timelines of satellite and HAPS are different and analysed on their own merits.

Activity builds but underlying drivers remain unchanged

When we wrote about satellite connectivity and business models last year[1] we took a generally favourable and pragmatic stance, despite there being significant scepticism (at the time) as to the viability and willingness among telcos to partner. With momentum having built up since then, our focus in this analysis is on the commercial implications of scaled LEO constellations and targeted HAPS deployments, and the potential effect on internet access for consumer and businesses. First, it is important to revisit the context that these new LEO and HAPS connectivity models are operating in.

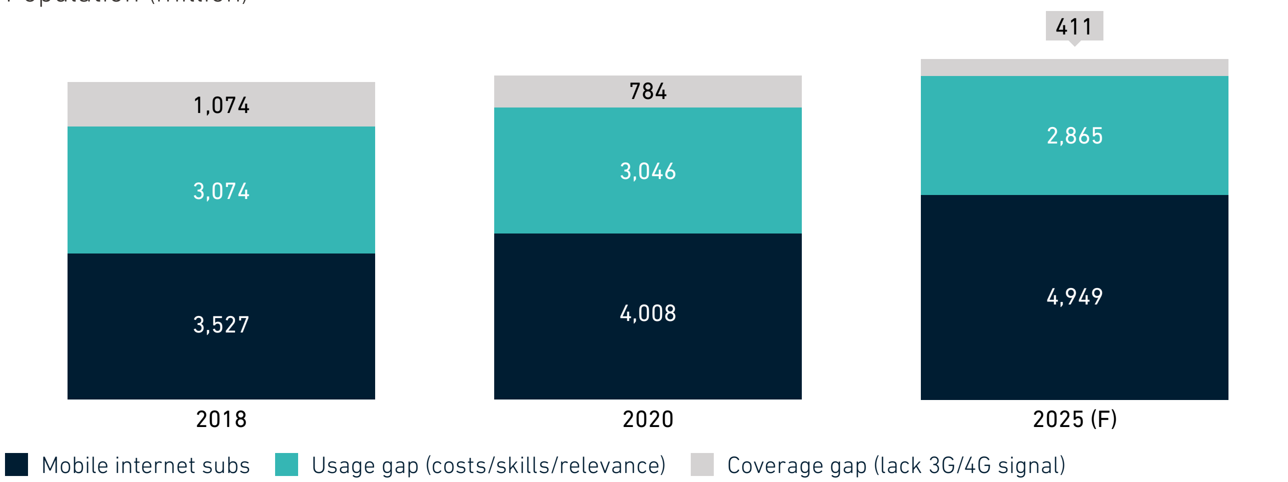
What is driving the push for satellite and broader aerial connectivity has not changed: the size and persistence of the internet divide and the consequential – but less appreciated – connectivity barriers for businesses in rural areas.

Given that internet access is near ubiquitous in most western countries, it can be easy to forget that on a global scale, penetration is only 50% (see Figure 1). This leaves around 3.7 billion people (or 3 billion adults) offline; we forecast that continued network expansion and smartphone price declines will help bring this down over the next five years but only to 3 billion, leaving 40% of the world still offline. The vast majority of unconnected individuals live in India, Africa and a handful of populous, lower-income Asian countries such as Pakistan and Indonesia (see Figure 2).

Figure 1

Half of the global population remains offline, of which a fifth (780 million) lack network coverage

Population (million)



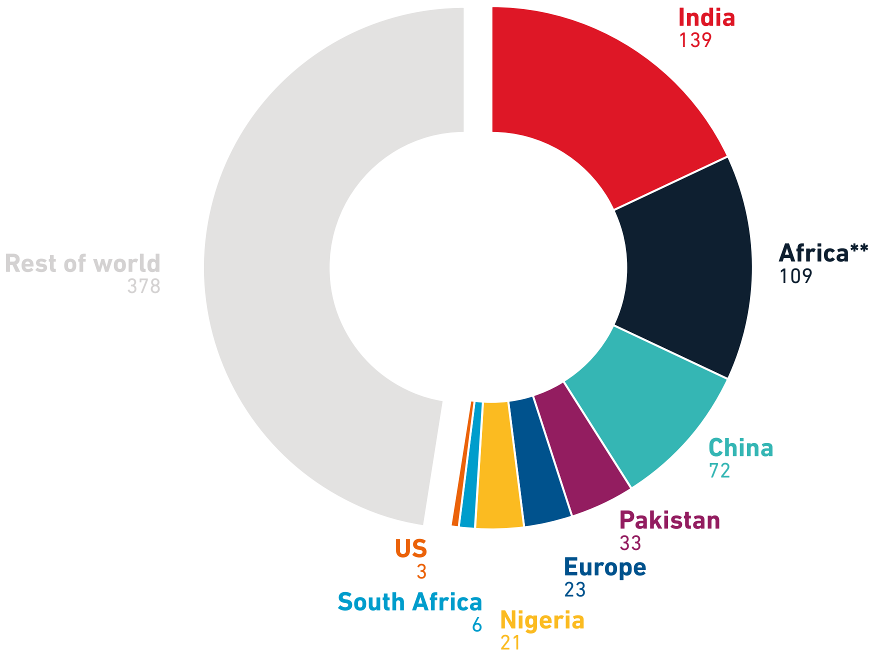
Source: GSMA Intelligence

1 Radar, February 2020, GSMA

Figure 2

India and a handful of populous LMICs* account for most of the mobile coverage gap

Number of people living out of range of a 3G or 4G mobile network (million)



*Low- and middle-income countries ** Excluding Nigeria and South Africa
Note: Figures represent the population within a given country that lives outside of range of a mobile network signal with speeds sufficient for a standard mobile internet access experience (3G or 4G). The global total is around 780 million (approximately 10% of the global population).
Source: GSMA Intelligence

There are a number of reasons for the coverage gap, some obvious (e.g. having access to an affordable network and smartphone) and some less so (e.g. digital literacy and the relevance of online content). As a result of network expansion and network-sharing deals, the coverage barrier has lessened. Notwithstanding this, around 25% of the unconnected population (approximately 780 million people) live outside of range of a 3G or 4G signal. The economics of network expansion are rendered highly unfavourable by the rural dispersion of emerging market populations, challenging topographies to reach far-flung villages and low population densities. This also holds true in high-income populations such as in Australia, Europe, the US or Canada. Land network expansion alone is unlikely to change the situation significantly. Adding up those without coverage and those with broadband slow spots (mostly in higher-income regions), the total 'not-spot' addressable base would be 1–1.5 billion people worldwide.

Business demand for connectivity in rural areas comes from a number of sectors, most notably manufacturing, hospitals and health facilities, oil and gas, and power generation. Civil and local government agencies are also in play for operating public services and as buyers of connectivity for their own premises and staff. In some instances, the demand for LEO satellite (and eventually HAPS) service is based on it being the primary access method because no other options exist or are economically viable. In other cases, connectivity may be purchased as a back-up or redundancy option, such as for freight and logistics vehicles traversing large distances in and out of terrestrial coverage. The advantages include reach, flexibility and cost efficiency. We discuss this in more detail in section 4.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2

Connectivity from space: under the hood

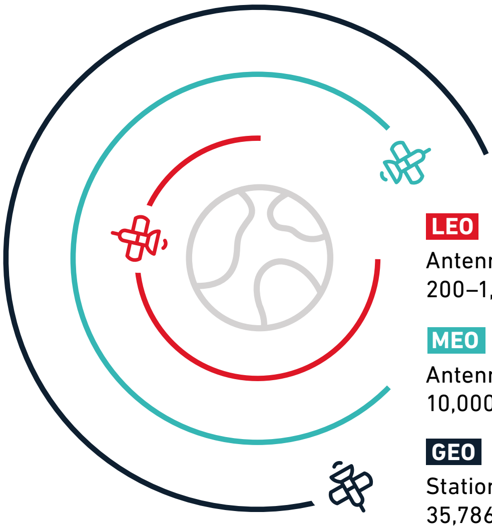
The basic model for LEO constellations is to integrate with mobile operator networks: 3G, LTE and eventually 5G. The major change with LEO constellations compared to traditional GEO architectures, which primarily connect to slower-speed 2G and 3G networks, is a lower deployment altitude to drive higher data throughput and lower latencies. There are a number of other trade-offs in geopositioning and density, which we outline below to help elucidate the practical implications of new satellite constellations.

Geopositioning

Every satellite in orbit is designated based on longitudinal positioning. This is measured in degrees, with coordinates moving either westward or eastward from the Prime Meridian (0^0, running through Greenwich, London). It is possible for multiple satellites to share the same longitude by occupying different orbit inclinations (higher inclinations move closer to the polar regions).

Figure 3

LEO satellites' lower altitudes increase speed and reduce latency compared to traditional models



LEO Low Earth Orbit
Antennas in motion
200–1,500 km

MEO Medium Earth Orbit
Antennas in motion
10,000–20,000 km

GEO Geostationary Orbit
Stationary antennas
35,786 km
(the only positioning with a specific point altitude)

Note: Not drawn to scale

Source: GSMA Intelligence

Altitude/signal strength trade-off

This is the most important element of satellite topology. There are multiple types of satellite orbits, which are distinguished by their altitude and inclination (angle from the equator). With increasing altitude, ground coverage is increased but with a consequent reduction in speed and increase in latency. LEO and GEO configurations illustrate the trade-off (there is also a middle ground, medium Earth orbit (MEO), though there is less competitive activity at this altitude so we do not cover it in this report):

- **Low Earth orbit (LEO) –** Satellites at LEO are nearest relative to Earth, roughly 200–1,500 km above sea level (for context, commercial airplanes fly at an altitude of 10 km). The rotational period around the Earth takes about 100 minutes, which means satellites at LEO circumnavigate the globe approximately 16 times each day. Lower altitudes mean that it takes less time for signals to make a round trip from satellite to Earth, so LEO satellites also have the lowest latency, typically 30–40 ms.
- **Geostationary Earth orbit (GEO) –** GEO satellites are furthest away from Earth, occupying an altitude of approximately 36,000 km directly above the equator. This altitude is chosen for a specific purpose, which is that the orbital period matches the Earth's rotation (24 hours). For a person on the ground, the position of a GEO satellite remains the same throughout the day, preserving line of sight and reducing the risk that coverage is lost. For this reason, the majority of communication satellites have traditionally been stationed at GEO. However, GEO satellites have a latency of typically 600 ms (20× higher than that of LEO satellites) and slower speeds, which limits their use in communications to applications that do not require low latency such as broadcasting or narrow bandwidth (e.g. backhaul for 2G and 3G networks).

Density

Density refers to the number of satellites operated by a company within a given orbital plane. LEO constellations generally involve a significantly increased density to expand coverage area and throughput levels and allow for more seamless signal transmission between satellites. The smaller form factor, improved manufacturing capabilities and, in some cases, vertical integration with rocket launching services have all helped lower the cost of deploying and maintaining communication satellites in orbit.

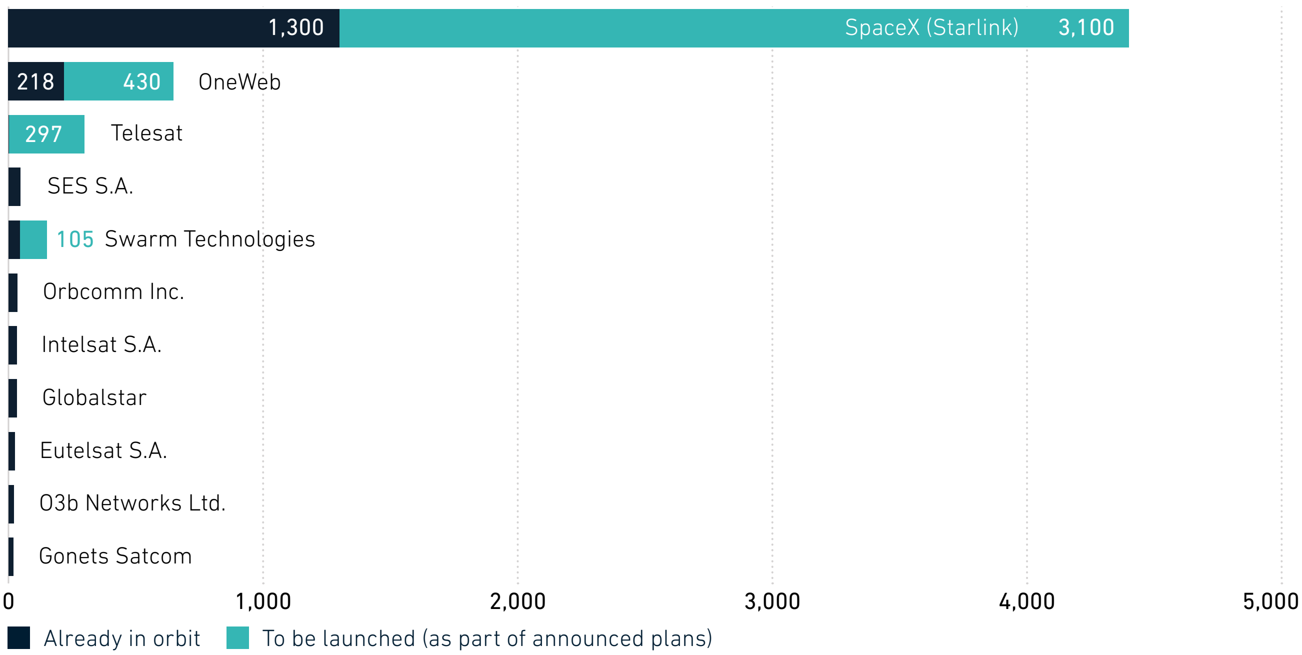
Publicly announced deployment plans underline the point (see Figure 4). OneWeb and SpaceX have thrown down the gauntlet in this the field. SpaceX, for example, has now launched around 1,300 satellites out of a total planned fleet of approximately 4,400. The company is running at a launch cadence of around 60 satellites every two weeks; should the current pace continue, the fleet would be fully deployed by the middle of 2023. OneWeb, which holds priority spectrum rights, has a smaller planned constellation, but it is at a more advanced stage to achieve global coverage, having launched around 218 satellites, more than 30% of its 648 total. The now-settled joint ownership structure of OneWeb between the UK government, Bharti Enterprise, SoftBank and Eutelsat, in addition to the upscaling of the manufacturing base in Florida, will help deliver coverage to all latitudes from the North Pole to the 50th parallel by mid-2021 and roll out commercial service by the end of 2021.

There are a number of other companies in the LEO space. Publicly available data suggests almost all of these, including Telesat through its Lightspeed constellation, are planned to be on a lower scale. In some cases, this reflects a targeted business model, particularly for servicing IoT applications for maritime and other enterprise customers (e.g. Swarm) or to complement existing satellites in use (e.g. Intelsat).

Figure 4

OneWeb and SpaceX have upped the ante in the LEO space

Planned constellation size (total number of satellites)



Note: Data as of 31 May 2021. Planned launches are shown where publicly available. Includes initial constellation size for SpaceX and OneWeb. Where a figure is not shown, this does not necessarily mean there are no plans, only that those are unavailable in the public domain. Excludes GEO and MEO satellites.
Source: Union of Concerned Scientists, company filings, GSMA Intelligence

The one notable exception lurking in the wings is Amazon, which involves an integrated play between Blue Origin and a vast network of AWS ground stations. While Amazon has been tight-lipped on the rationale behind its undertaking, it is most likely a means of extending the AWS footprint for rural enterprise customers to provide connectivity and higher-order cloud and edge compute services.

Ground Segment

In satellite communications, one of the less covered topics – but just as important to the business model – is the ground segment, which is comprised of gateway antennas and UT antennas. These are used to transmit and receive satellite signals at an end-user premises. Unlike a traditional GEO satellite, where a simple fixed earth-based antenna looks at a fixed point in the sky, what makes the ground segment particularly challenging with LEO constellations is that the antennas are in constant motion, tracking the satellites 24/7 as they move across the sky. Recent advancements in antenna tracking hardware and software have helped make LEO satellite broadband possible.

One of the important technical improvements is the reduction in cost and improved ease of use of UTs. The nature of traditional satellites requires customers to install large parabolic antennas to track and receive a signal, be that at home or a community gathering point such as a school or hospital. The cost and time to install receiving equipment has long been a barrier to satellite broadband adoption outside of commercial segments. Both cost and time to install have, however, decreased with newer-generation LEO satellites and low-cost antennas that require no pointing installation.

Intellian, one of the leading satellite communications terminal providers in the world and UT partner for OneWeb, exemplifies the gain. Commercial rollout of OneWeb's initial antenna will occur in late 2021, with a planned second-generation release in 2022. The antenna is a high-gain dual antenna set-up that enables significantly improved signal quality and data throughput. The dish can be installed in one hour, reducing labour and overall costs, which should help drive uptake. Intellian's UTs are not just available for fixed sites (cellular backhaul, enterprise, community Wi-Fi, schools and homes); there are also fully industrialised product lines designed to serve numerous other markets such as maritime, land mobility and, eventually, aviation.

In a similar context, many providers have introduced APIs to allow seamless integration with operator billing and support systems. Such changes make it a simpler proposition for interested operators to integrate satellite technology into their network operations.

HAPS

Wholly separate from satellite options, HAPS are unmanned aerial vehicles equipped with a communications equipment payload that fly in the stratosphere at approximately 20 km above sea level. This places HAPS vehicles at roughly double the altitude of a commercial aircraft but well below any satellite configuration, including LEO satellites, which operate at around 1,000 km above sea level. HAPS therefore offer lower ground area coverage compared with satellite options.

HAPS were examined as a connectivity option back in the 2000s such as with Sky Station. An earlier pioneer of HAPS deployment was Google's Project Loon, launched in 2011 and ultimately discontinued in early 2021. The method devised was to create a mesh network of balloons that would fly in the stratosphere at an altitude of 20 km and navigate through a complex set of aeronautical analytics that capitalised on the power of the Earth's trade wind patterns. Over the course of multiple iterations and improvements, balloons were able to fly for over 300 days. The problem was that Google was not able to form a large enough number of operator partnerships to make the venture economically viable. Loon's efforts and learnings are, however, relevant to how newer HAPS models have been architected.

There are three primary improvements among more recent HAPS efforts:

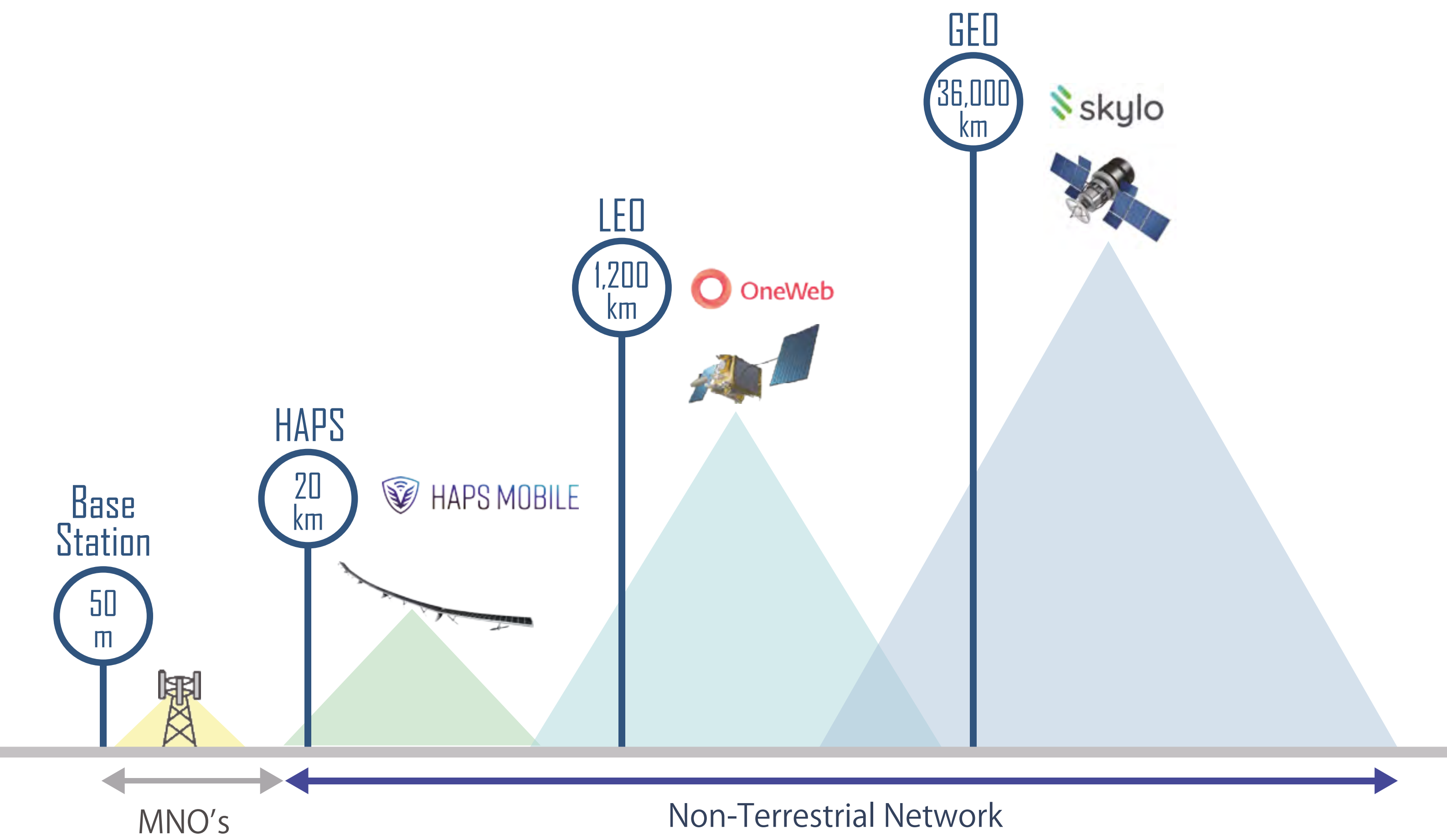
- **Increased flying time and energy efficiency of the light aircraft:**
  - This has been made possible with improved solar panelling technology and, in some cases, the use of hydrogen fuel cells (a more concentrated form of power generation).
- **Better equipment signalling and network quality:**
  - There have been improvements in the signalling power of on-board equipment along with reductions in size and mass.
  - The ability to separate mobile signals into different beams – akin to ground-based cells – has further opened the door to more targeted coverage, such as to track a truck or ship.
- **Integration with the spectral frequencies of mobile operators**
  - There is potential capability for direct harmonisation with spectrum owned by mobile operators in a given country, including 3G, LTE and 5G.
  - This is particularly important because it enables HAPS to provide connectivity to smartphones, broadband modems and IoT devices without the need for specialised receiving equipment – or the cost that it entails.

HAPS Mobile (backed by SoftBank) and a venture led by Stratospheric Platforms Limited (backed by Deutsche Telekom) are two notable current efforts. It is important to note that HAPS efforts are at an earlier stage of development compared to most LEO satellite deployment plans (SPL's target, for example, is to launch in Germany in 2024). They are also smaller in number and scale. This could create some level of competitive disadvantage given the geographic reach that satellite can command. However, the strategic investments made by participating telcos speak to a long-term commitment and support the case for a multi-modal market for aerial connectivity, rather than a single technology (or company) dominating.

SoftBank

Bridging the world's digital divide

SoftBank Non-Terrestrial Network Solution Concept



3

Rural/remote coverage is a matter of economics

Providing network coverage and backhaul links to rural areas is foremost a challenge of economics rather than anything to do with technology. Large distances, uneven topography and the presence of impediments such as forests all make rural coverage more difficult than in urban or suburban areas. Low population densities also mean that usage and revenue per mobile cell site (or broadband exchange point) are much lower than in a city or suburban environment.

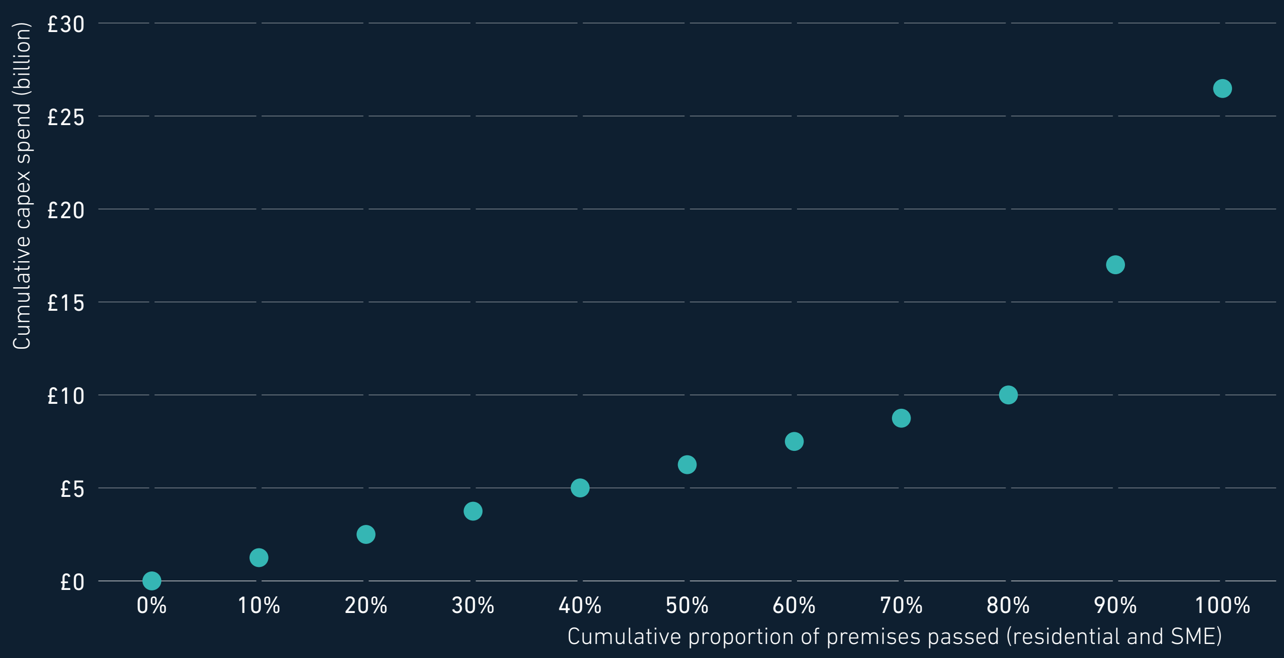
Taken together, the capex efficiency is therefore far less favourable. This has been alleviated by network sharing, in which two or more operators situate RAN equipment on a single mast, and the growing involvement of third-party tower companies that can spread their own costs over multiple operator tenants. Open RAN systems could further help lower costs, although these will not likely be commercially deployed at meaningful scale (upwards of 25% of base stations in a given country) for several years.

However, the problem of a limited user base spread over a large geographic area and cost base remains. Even with network sharing, around 10% of the global population still live outside the range of a mobile-broadband-capable network (i.e. 3G or LTE).

While in absolute numbers the size of the unconnected population is largest in developing countries, the network economics challenge also exists in higher-income regions. Scenario modelling for the National Infrastructure Commission in 2017 to roll out fibre across the UK shows the steep cost curve involved in expanding to rural areas (see Figure 5). Up to around 80% of premises passed, the cost in net capex rises in a linear fashion, meaning the incremental cost of reaching the next premises is roughly the same. However, the last 20% – and especially the last 5% – triggers a steep upwards inflection. These are theoretical projections and, of course, fibre has not been passed to 100% of UK premises. However, it shows the cost involved to provide fibre broadband access to the most remote regions of the UK – which would be similar for many other countries. Constructing new backhaul links is one of the most expensive portions of this cost; with fibre, averages are around $3,000–5,000 per kilometre of backhaul. Microwave is an alternative, but it is not always available due to line-of-sight requirements over large distances.

Figure 5

The final 20% – and especially the last 5% – of premises would account for the lion's share of a total national fibre build (UK, 2017)



Note: Above costs are based on a scenario of 100% FTTP coverage, assuming some re-use of existing infrastructure poles.
Source: Adapted from National Infrastructure Commission (Costs for Digital Communications Infrastructures, 2017)

In Table 1, we show indicative costs of running a rural base station compared to one in an urban environment. Backhaul carries the highest price premium, at more than double the cost for a city environment, making it around 15–20% of the total cost of ownership (TCO). Satellite and HAPS can improve rural coverage economics by removing distance as a factor, which would otherwise drive up costs in linking remote base stations with fibre or microwave backbones to the core (the same is true for power costs). It is for this reason that operators have become increasingly receptive to such solutions, which help to expand coverage in a cost-effective way – with or without government support.

Disaster recovery situations are a further use case given the need for 'pop-up' connectivity in areas with no existing base stations (or where a base transceiver station suffers an outage). Finally, there is the need to upgrade existing 2G/3G base stations to LTE and 5G, which carry higher traffic throughput rates and therefore require higher-grade backhaul not always possible through microwave transmission.

Table 1

How much more does it cost to run a mobile base station in rural areas?

	Share of cost envelope (urban environment)	Cost premium in remote region compared to urban
Towers and civil works	48%	+27%
Active network costs	12%	0%
Power	30%	+37%
Backhaul	10%	+110%
Total	100%	+35%

Source: GSMA Intelligence and GSMA Connected Society (2019 figures)

4

Scaling the business model: wholesale versus retail

There are two main emerging business model options with satellite and HAPS connectivity. The first and most common is connectivity provided on a wholesale basis to mobile operators, which continue to own the end-customer relationship. The second is to sell access directly to consumers or enterprise customers.

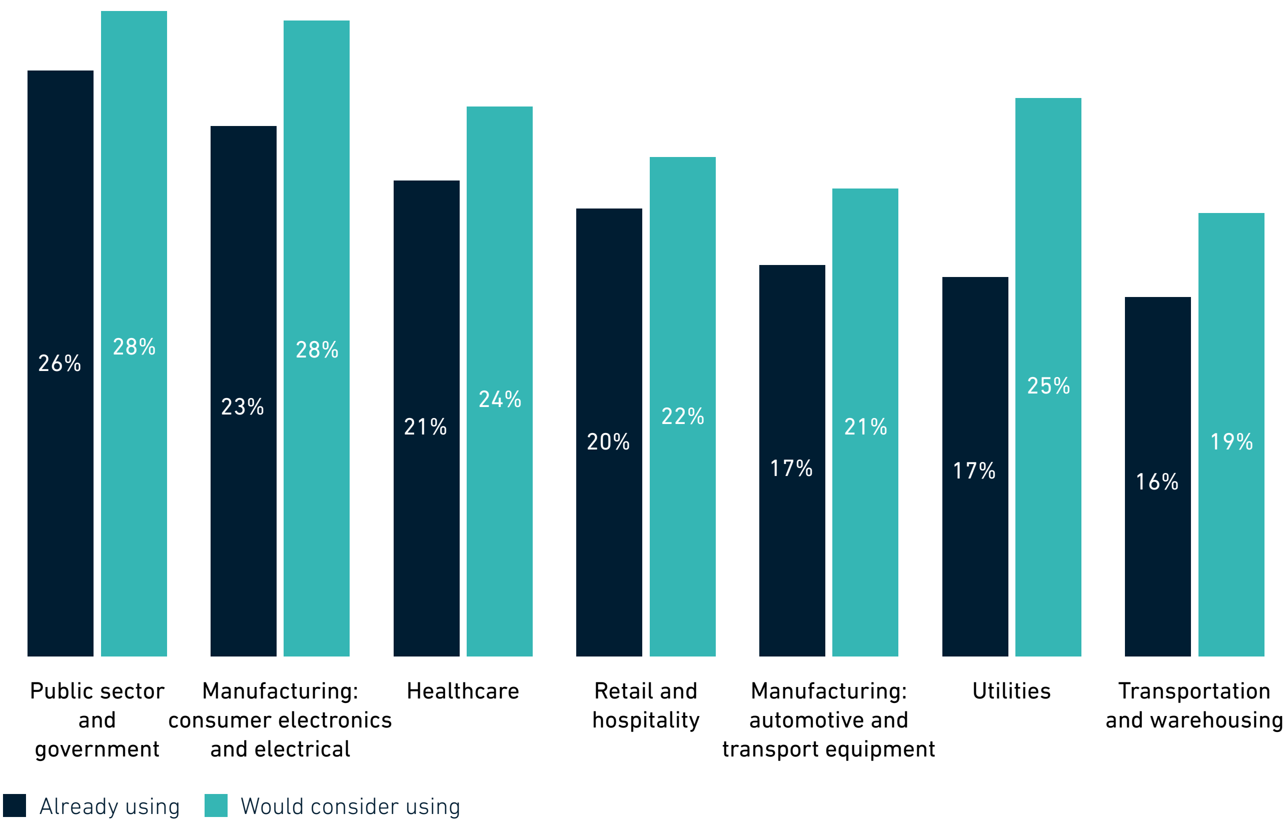
Wholesale via telco partnerships

For both satellite coverage and HAPS models, providing wholesale backhaul access via partnerships with mobile operators is likely to be the most common route to market.[2] This would see satellite operators provide a backhaul link to remote villages, hamlets or businesses where mobile cell sites are installed by operators without fibre-optic cables or microwave links. This may be structured as a revenue share or priced on a data volume basis (cost per GB transferred). The wholesale model is very much symbiotic and borne of pragmatism: satellite providers can help operators extend their network footprint to regions that would otherwise remain unconnected (at least for the foreseeable future) and receive wholesale revenue, while telcos can reach new customer segments, bringing economic and societal benefits.

Business verticals are an important (if often underrepresented) target audience. Our survey of enterprise verticals suggests that 15–25% of businesses – ranging from SMEs to corporates – already use satellite connectivity as a primary or back-up access technology, with slightly higher percentages than this range for those that intend to use satellite connectivity (see Figure 6). Public sector agencies, manufacturing groups and healthcare facilities are the highest adopters of satellite outside of the maritime, aviation and logistics sectors (not shown on the chart). Interestingly, those in utilities demonstrated the highest spike in intention to use satellite, reflecting their need for IoT connectivity in off-grid areas.

Figure 6

Which B2B verticals are most likely to consider satellite for IoT connectivity?
Percentage of respondents



Note: Data based on survey of 2,500 enterprise customers ranging in size from under 50 employees to over 10,000. Questions: "Which of the following connectivity options has your organisation used for an IoT implementation?" and "Which of the following connectivity options would your organisation use for a future IoT implementation?"
Source: GSMA Intelligence Enterprise in Focus Survey, 2020

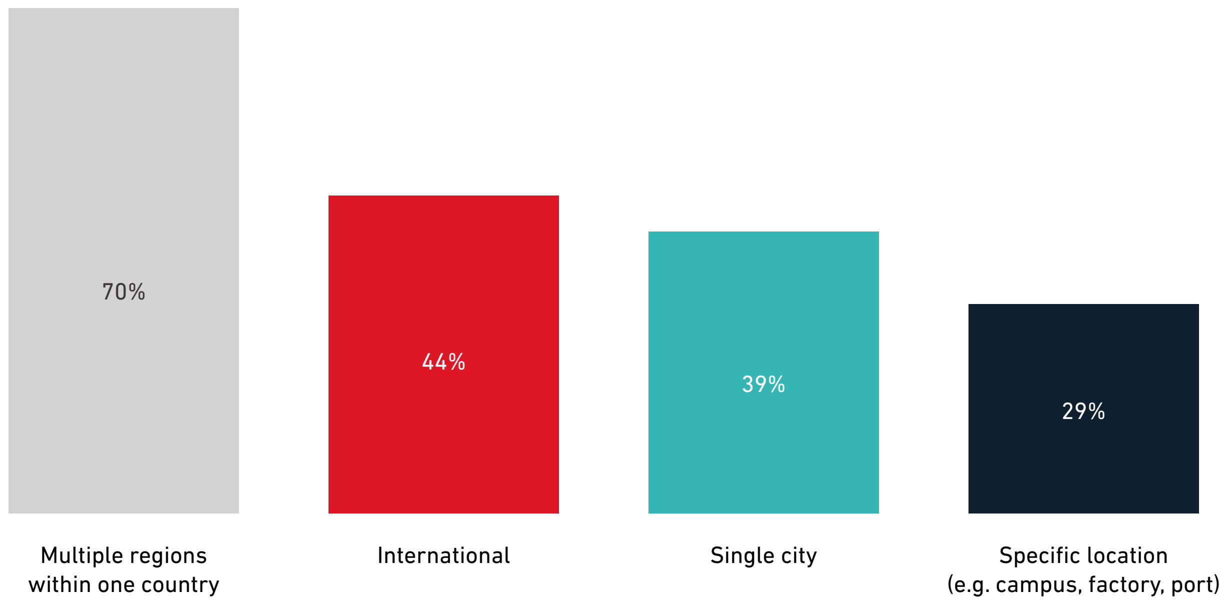
2 For HAPS, a further revenue model may involve leasing aircraft to operators and providing operational and/or maintenance services.

We also solicit views on the requirements for how big a coverage area is needed (see Figure 7), ranging from a specific location such as a factory to multinational footprints. National-level coverage is the most common requirement, but it is also worth noting the high share of demand for international-level coverage (44%). This is a good match for satellite and HAPS because of the wide ground area coverage afforded by aerial constellations and the ease of deploying in multiple countries where regulatory approval has been permitted. Our survey results also indicate that there is likely to be greater flexibility in how services are sold. For example, should a telecoms operator be a wholesale partner, this may require joint investment in new network infrastructure at an enterprise location, particularly if it requires high-bandwidth applications such as edge compute.

Figure 7

The scale of coverage requirements for companies that plan to use satellite connectivity

Percentage of respondents



Question: "What is the scale of your coverage requirement?" (multiple responses allowed)
Source: GSMA Intelligence Enterprise in Focus Survey 2020

Direct retail competition

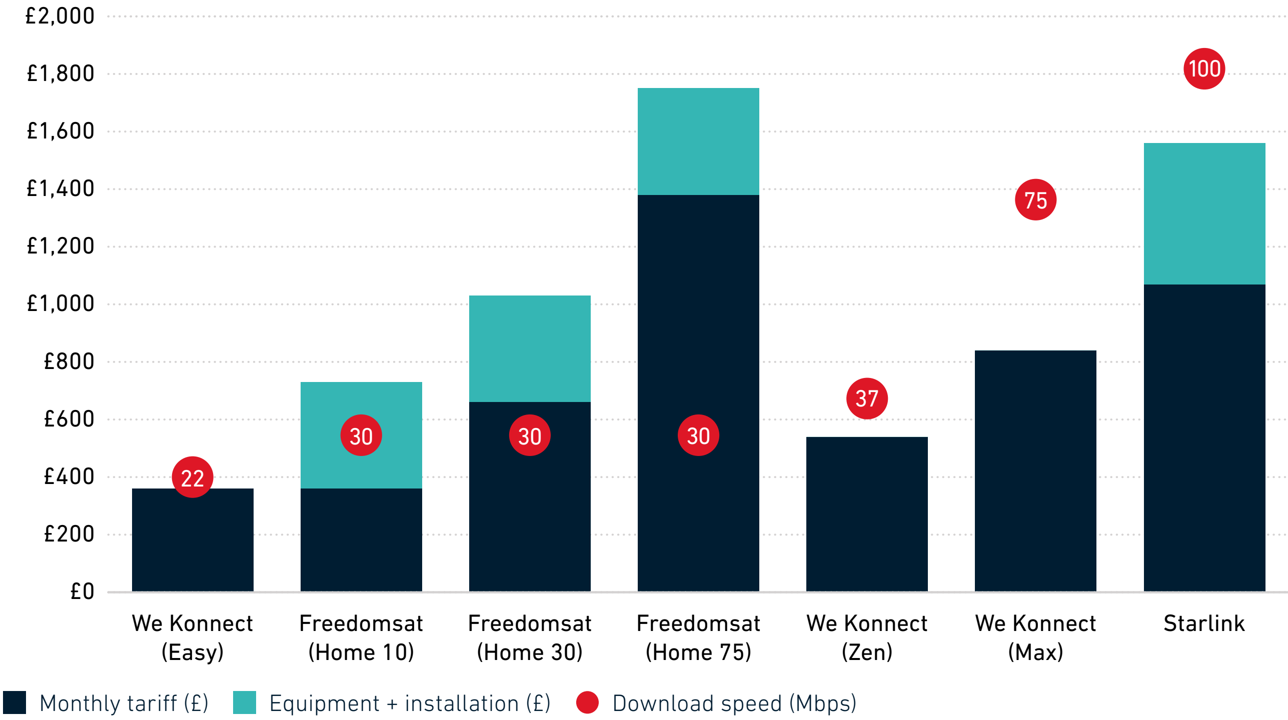
This approach has been used for enterprise broadband before, though it is less common in the consumer market. It does, however, appear to be the strategy of SpaceX under the Starlink brand. This approach would put it in direct competition with existing DSL, fibre and cable broadband providers. Rural areas are the likely (initial) target, particularly in the US where vast swathes of the Midwest and Alaska remain in coverage not-spots or have very slow internet speeds (usually 2 Mbps or less). In the US, the company will also benefit from government financial support tied to the Rural Digital Opportunity Fund (RDOF). However, retail pricing could be a purchase barrier, specifically related to customer-premises equipment (CPE).

To illustrate the challenge, we have compared the sole Starlink tariff announced as part of its beta trial against competing offers from two other satellite providers in the UK (see Figure 8). Most providers require a 12-month contract, so we have expressed figures as a TCO over this time frame. Satellite remains expensive for any kind of high-speed package (above 30 Mbps). Starlink's base monthly tariff is £89, with advertised speeds of 50–150 Mbps. Considering that there are no content packages tied to the tariff, it would place Starlink at the very premium end of other broadband packages from BT and Virgin Media. But the real kicker is the equipment cost, which requires each household to pay £493 upfront (which includes shipping costs) – making it a full 30% of the TCO over 12 months. This cost is likely subsidised, meaning SpaceX would need to significantly reduce input and manufacturing costs to make this a profitable business. Notwithstanding that this may be a price worth paying for a household in a rural area that lacks internet access or has slow speeds, this could be simply unaffordable for the majority unless the company absorbs the cost or is able to pass on a subsidy. Competing satellite offers at the lower end of the price scale generally compromise on speed and, crucially, data allowances. For example, Freedomsat's Home 10 plan only allows 10 GB of data, above which carries an additional charge.

Figure 8

Starlink sits at the premium end of an already costly range of tariffs, driven up by high equipment costs

TCO over 12-month contract



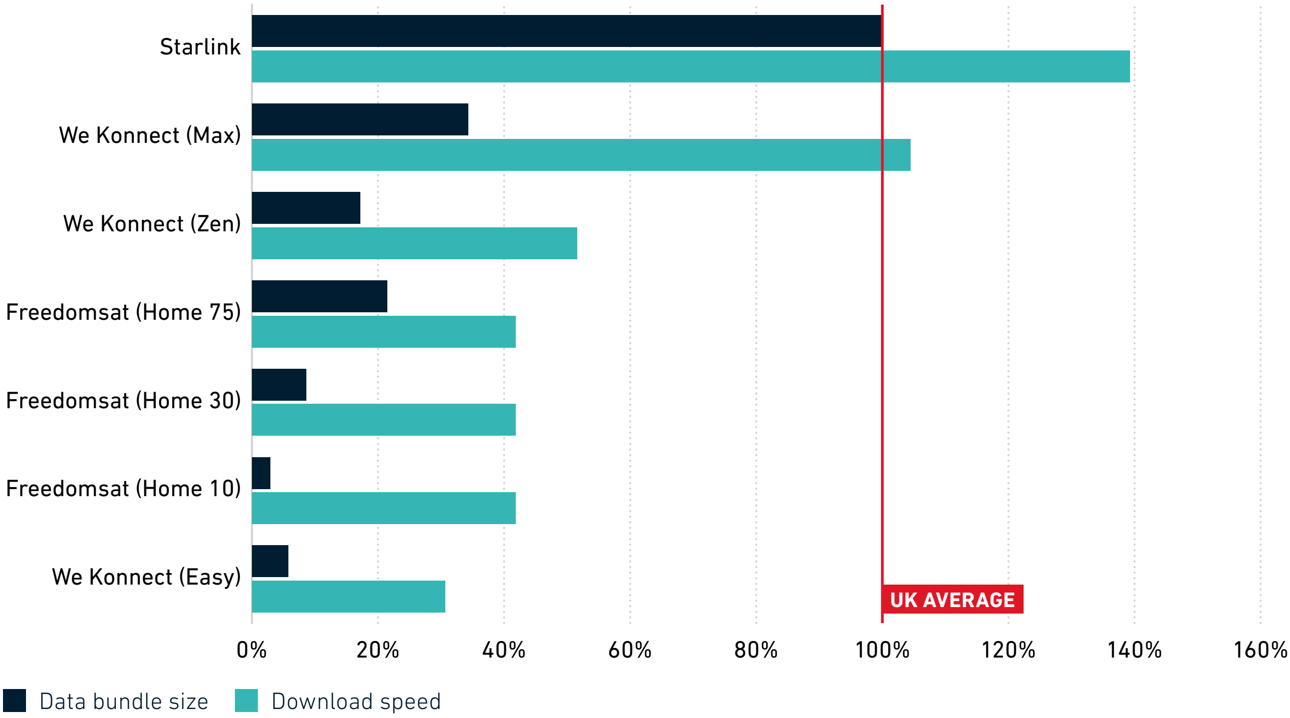
Source: Company websites, GSMA Intelligence

This becomes a significant trade-off given that most higher-income countries have moved to unlimited data allowances for consumer and business broadband customers. In the UK and the US, average household consumption sits at around 350 GB/month, meaning that most satellite offers provide only a fraction of the data allowance and speeds of DSL, cable or fibre products. Again, this can be understood in the context of sometimes being the only option for customers in rural areas of high-income markets. However, it also underlines the opportunity for emerging players should a satellite or HAPS platform be able to deliver commensurate service levels and prices compared with national averages. It also implies that CPE costs and continued reductions in backhaul rates will be a major battleground of competition over the coming five years as commercial offers are launched.

Figure 9

In most cases, performance specs are inferior compared to fibre, cable and DSL

Comparison relative to UK broadband market average



Note: Fixed broadband household data usage (350 GB per month) and prevailing download speeds (71.8 Mbps) are based on Ofcom readings in 2020.
Source: Ofcom, GSMA Intelligence

Future outlook: What comes next?

We expect current market momentum for LEO connectivity to continue as established constellations increase towards their target size. Forming commercial partnerships with operators will be key over the next 2–3 years to test and deploy aerial solutions in practice, providing feedback loops to inform tech and business model iterations. To a certain extent, regulatory issues surrounding spectrum licensing will persist, albeit to a lesser extent given progress over the last five years. Operators will also need to focus on infrastructure deployment logistics in rural areas as part of a wider package of educational support for such communities. Coverage is, after all, one of several barriers to mobile internet and broadband access along with costs, digital literacy and relevance. Tying these together through joined-up efforts is most likely to result in success rather than tackling each in isolation.

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