



Expand Your Mobile Coverage Even Further

Cost-effective Space-based Solutions for Cellular Backhaul



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Introduction

Internet connectivity delivers significant socioeconomic benefits to people and communities worldwide. The internet improves quality of life by connecting people to education resources, healthcare services, distant family members, employment opportunities, banking services as well as news and information that fosters engaged citizens. Indeed, it has become so important to society that the United Nations now considers internet access a basic human right.

Connectivity also drives economic growth. According to economic modelling by the International Telecommunication Union (ITU), a 10 percent increase in fixed broadband penetration globally generates 0.8 percent higher GDP while a 10 percent increase in mobile broadband penetration yields a 1.5 percent increase in GDP. There is an even greater impact in developing countries. In Africa, a 10 percent increase in mobile broadband penetration yields 2.5 percent more GDP per capita, according to the ITU.

Introducing connectivity directly and indirectly creates skilled jobs and enables businesses to trade and communicate more efficiently. The internet stimulates economic activity by providing a networked environment in which businesses can thrive and entrepreneurs can start new enterprises.

Today, only half of the world's population is connected to the internet and enriched by these socioeconomic benefits. There are still 4 billion people who are not connected, of which 1 billion live in areas where there is no mobile broadband coverage and 3 billion have access to 3G or 4G networks but do not subscribe to mobile internet services, according to the GSMA.

**Space-based
Communications:
The use of non-
terrestrial platforms
(i.e., geostationary
satellites) integrated
with a fiber-based
terrestrial backbone
to relay information**

The largest proportion of unconnected people that are not covered by infrastructure are in Sub-Saharan Africa (40%), according to the GSMA. But lack of connectivity affects every region, making it a global problem for the communications industry, national governments and society.

For mobile network operators (MNOs) and internet service providers (ISPs), closing this connectivity gap represents an opportunity to achieve their business goals while also helping to deliver profound social and economic benefits to the people and communities they serve.

This white paper explores how space-based communications has become an essential tool for economically and efficiently overcoming connectivity challenges and offers recommendations for how mobile operators can bring more people online to grow their businesses today and in the future.

Creating New Opportunities for Mobile Operators

Whether operating in Asia, North America or Sub-Saharan Africa, MNOs generally have common business objectives and face similar challenges with connecting people in rural and hard-to-reach areas. Just how operators pursue business goals will vary depending on local market conditions. In developing markets, revenue growth is driven by new subscriptions and data services. In saturated markets, where subscriber growth has slowed, operators compete to retain existing subscribers while also looking to new areas, such as Internet of Things (IoT) and content services, to grow revenues.

In the next seven years, 710 million people are expected to subscribe to mobile services for the first time, according to GSMA Intelligence. Of that number, half will come from the Asia/Pacific region and a quarter will come from Sub-Saharan Africa.

Expanding coverage to the world's unconnected communities and geographic areas, as well as ensuring reliable coverage for existing subscribers wherever they live, work and play, creates a tremendous opportunity for MNOs to accomplish their business goals, in the following ways:

Reach New Markets

- **Increase market share:** Gaining a greater portion of the industry's

voice and data sales is critical to being competitive and improving stock performance.

- **Grow subscriber base:** Making voice and data service available in more areas results in new subscriptions, including IoT connections.
- **Generate new revenue potential:** With more subscriptions, there is greater potential for new revenue and profitability over time.
- **Promote corporate brand:** The ability to quickly connect ultra-remote communities can be included in a company's corporate social responsibility (CSR) initiatives.

Protect Existing Markets

- **Improve customer satisfaction:** When current subscribers are unable to access voice or data services everywhere, customer satisfaction scores go down.
- **Reduce customer churn:** Poor coverage, reliability and availability are major drivers of customer churn.

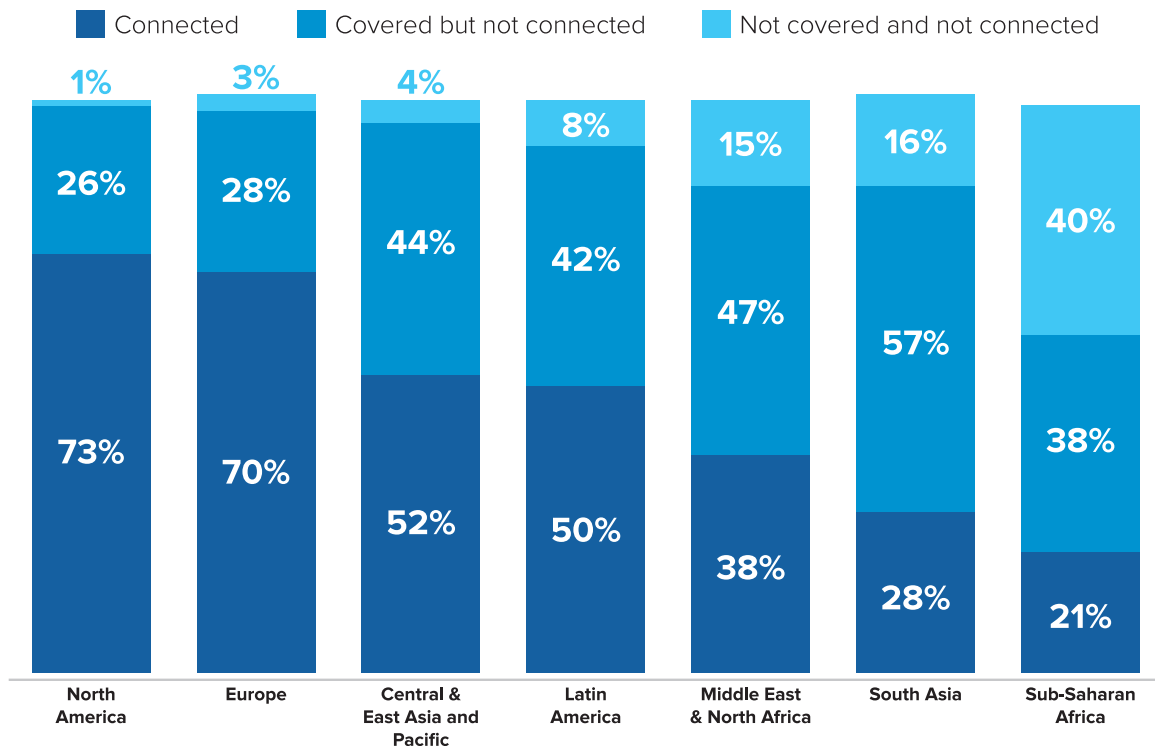
Preserve Future Markets

- **Gain first-mover advantage:** Being first to provide voice and data services in unserved areas with future growth potential helps to gain a competitive advantage.
- **Preserve unused spectrum:** Areas with unused spectrum is costly and licenses can expire.

Four Challenges to Connecting More People

The business opportunity is clear, but there are many challenges to overcome. The GSMA identifies four main reasons why the connectivity gap persists, and 4 billion people remain offline, with 1 billion of them living in areas without access to 3G or 4G. Only some of the factors are within an operator's control, but they all must be addressed if there is to be a truly connected world.

- Infrastructure:** People live in areas where internet infrastructure is not available, including infrastructure providing access to mobile broadband, which is often the only way people in these areas can access the internet. Other infrastructure challenges include lack of power grid and restricted access in some places due to poor roads and bridges.
- Affordability:** Service costs (including device prices, subscription fees and service taxes) are higher than what many people can afford, which keeps people from connecting, including those who live in areas with mobile broadband coverage.
- Consumer readiness:** Due to poor access to education in many rural and remote areas, especially in developing countries, potential subscribers do not have the knowledge or skills needed to use the internet.
- Relevant content and services:** Applications and content are not always available in local languages or not seen as useful to their daily lives, so people find no value in subscribing to mobile broadband services.



Infrastructure challenges

For the 1 billion people who are not covered by mobile networks, the biggest barriers for MNOs are related to infrastructure challenges – namely, the cost, complexity and return on investment (ROI) of rolling out mobile networks. It's important to understand that connectivity gaps exist mostly in non-urban areas where it can be difficult and cost-prohibitive to deploy infrastructure. According to the ITU, 60% of the unconnected population live in rural areas.

In a recent Intelsat poll of mobile industry stakeholders, a third of responses reveal the biggest challenge to building mobile coverage in rural areas is the

high CAPEX and OPEX costs of installing and maintaining infrastructure to support remote cell sites. A quarter of responses reveal another major hurdle to be low and/or slow ROI, followed by lack of supporting infrastructure and difficult geography.

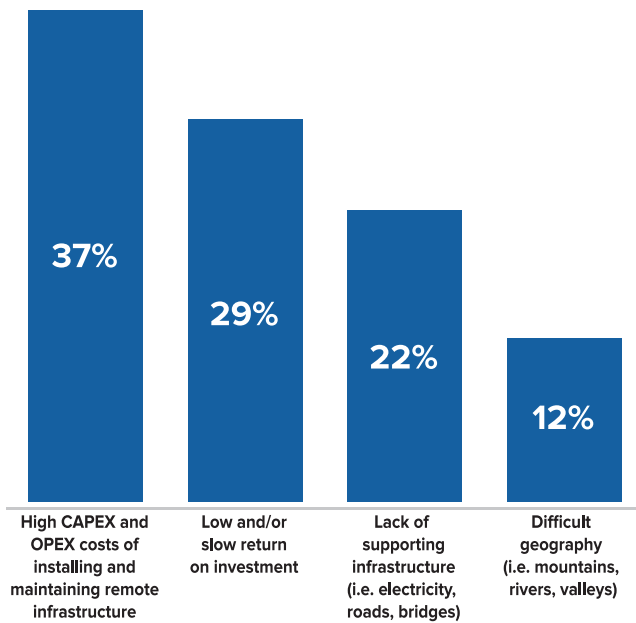
When asked about using satellite-based backhaul to expand coverage into unserved and underserved areas, nearly half of the responses from stakeholders indicate cost of satellite as a prohibiting factor, with the remaining half of responses shared across lack of familiarity and/or expertise in satellite solutions and perceptions of satellite being slow.

High Costs: Most of the cost of rural deployments is in the network construction and physical infrastructure expenses, including the backhaul connections between the cell sites and the core network. Traditional fiber backhaul (including conduit materials) can cost on average \$115,000 for just 10 kilometers, based on U.S. data collected by BroadbandUSA. Digging the trenches for fiber costs roughly \$13,000 for 10 kilometers. These costs increase dramatically with more cell sites, longer distances and difficult terrain. And these estimates don't even include other necessary costs, such as construction equipment, labor and permits.

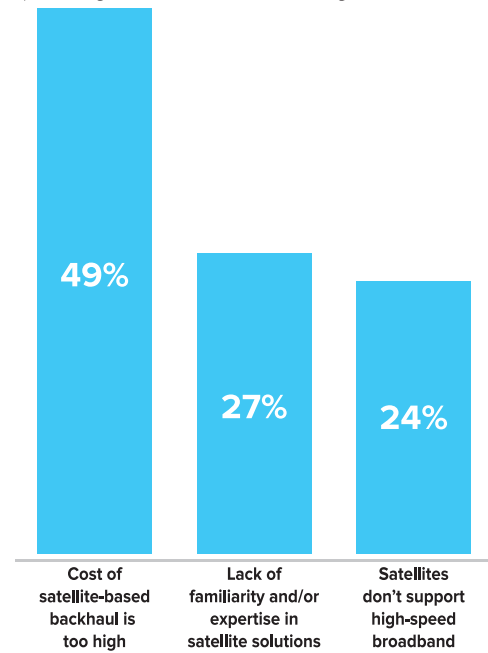
60% of unconnected people live in rural areas.



What is the biggest challenge to building mobile coverage in rural and remote areas?



What is the main impediment to employing satellite-based backhaul in mobile network planning as a means for covering remote areas?



For microwave backhaul, just one site can cost on average \$121,000 (which includes the cost of power generator and tower), according to BroadbandUSA. And because most rural and remote areas do not have existing infrastructure for placement of microwave relays, entire sites will need to be constructed where needed. Also, microwave links require line-of-site and signals fade between 48 kilometers and 64 kilometers, which means many sites will be needed to cover longer distances or mountainous, uneven terrain.

In extremely rural areas, there may be additional costs for building electricity infrastructure. After the initial deployment of new sites and buried fiber cabling, ongoing maintenance and technical support is also costly in remote locations.

Beyond the costs associated with fiber or microwave backhaul deployments in rural and remote

areas, many mobile operators still view the use of satellite for cellular backhaul as too costly. As a result, mass geographic areas where people live, work and play remain without access to mobile broadband coverage.

Slow ROI: Compared to densely populated urban areas in developed countries, ROI is slower and lower in rural and remote areas due to the large investment to build out mobile coverage in these areas and a combination of factors including smaller populations, lower average revenue per user (ARPU) and sometimes high poverty rates that prevent people from buying services.

Complexity: Remote network deployments are inherently complex. Difficult projects are complicated by shortages of workforce skills as well as the challenges of extreme, natural topographies such as mountains,

rivers and valleys. Traditional fiber and microwave backhaul can take anywhere from many months to over a year to deploy in these areas, which delays ROI and time to market.

Complexity is also considered a challenge for satellite backhaul in rural and remote areas. This is largely due to many mobile operators today lacking familiarity and/or in-house expertise to support satellite solutions, as indicated by 26% of the responses in Intelsat's poll.

Performance: In addition to the economic challenges associated with building out infrastructure to support mobile coverage in rural and remote areas, it is also important that the coverage meets quality of service (QoS) and quality of experience (QoE) requirements. According to Intelsat's poll, mobile operators perceive satellite as not supporting high-speed broadband, specifically 4G LTE.

The Case for Space-based Solutions

Today's space-based technologies help mobile operators address the challenges they face in cost-effectively connecting people and places anywhere. By including technological advances and other benefits of satellite-based backhaul solutions in their network planning, operators can overcome the cost, complexity and ROI barriers that have historically hindered reliable, quality coverage everywhere, even in hard-to-reach rural and remote areas.

Ubiquitous Coverage: Non-terrestrial geo-stationary platforms provide ubiquitous coverage to 99% of the globe's populated areas. There are no distance, topography or line-of-site constraints, which are typical of fiber and microwave backhaul. Also, satellites can rapidly provide backhaul for an entire network of cell sites, providing network resiliency in existing coverage areas while also enabling expansion into areas where fiber or microwave options are cost-prohibitive or not feasible.

High-Throughput Satellites (HTS): Next-generation HTS systems deliver up to 10 times more throughput using the same amount of frequency on orbit compared to traditional fixed-satellite service (FSS). These satellites take advantage of frequency reuse and multiple spot beams to increase throughput and

reduce the cost per bit delivered, regardless of spectrum choice.

Advanced Modem Technology: Today's satellite modems are high-performing, reliable and bandwidth-efficient. With advanced packet processing capabilities for maximizing throughput and optimizing latency, MNOs can ensure optimal quality of experience for their users. Today's modems also support VoLTE deployments.

Smaller Antennas: Advances in satellite technology means smaller antennas known as Very Small Aperture Terminals (VSATs) can be used today for space-based cellular backhaul instead of the large dishes that have been used in the past. VSAT dishes are less than 3.8 meters in diameter, which means lower cost, quicker installation and less space required at the site.

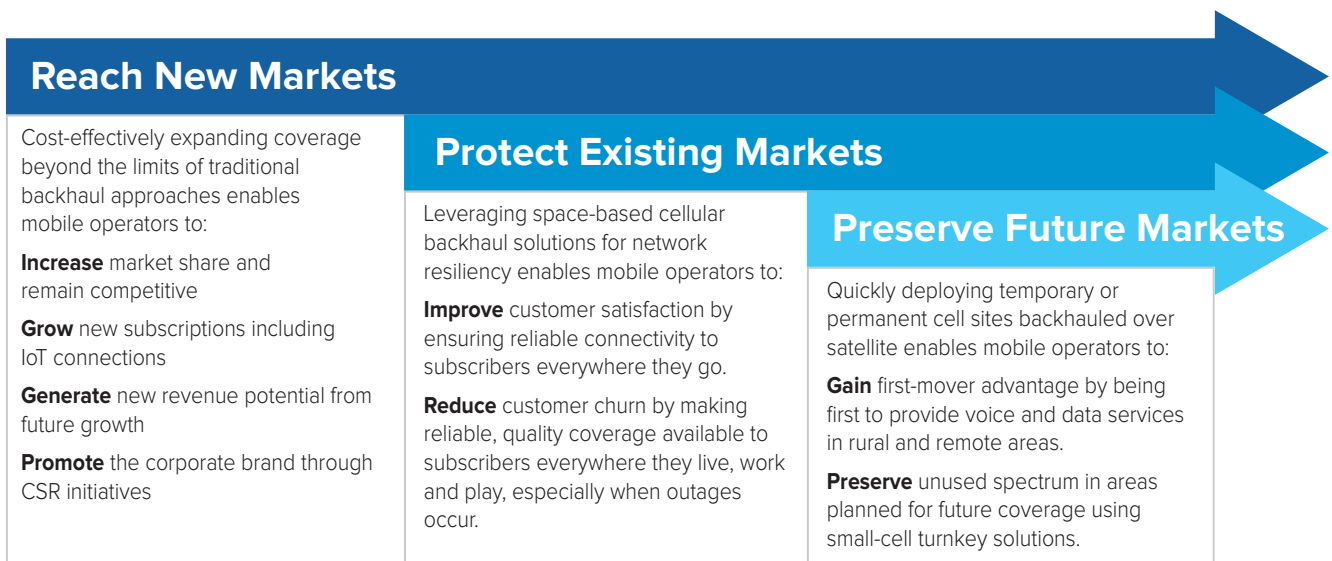
Dynamic Bandwidth Allocation: Bandwidth is dynamically allocated via statistical multiplexing across an entire network of cell sites – whether 10, 100, or 1000s -- based on traffic demand per site and quality of service (QoS) requirements. This minimizes OPEX by making the most efficient use of a single pool of capacity.

Managed Services: MNOs often lack expertise in satellite technology, but the availability of managed services for satellite backhaul removes this limitation and provides an easier way to incorporate space-based backhaul solutions. Services include network planning, design, management and 24-hour technical support. Software and hardware engineering and installation services are also available to minimize complexity.

How Space-based Solutions Enable MNOs to Reach Further and Achieve More

By incorporating today’s space-based cellular backhaul solutions into their network planning strategy, mobile operators can quickly and cost-effectively connect more people – and things – in more places, helping them achieve their business goals and objectives.

Business Goal		With Space-based Solutions
Reach New Markets Cost-effectively expand coverage beyond the limits of traditional backhaul approaches	Increase market share	Become an industry leader and gain a competitive edge in the market by offering voice and data services across more geographic areas
	Grow subscriber base	Add new subscribers to your existing base, including IoT connections, by providing more mobile broadband coverage everywhere
	Generate new revenue potential	Create new opportunities for revenue growth by offering voice and data services wherever people live, work and play
	Promote corporate brand	Leverage low-cost space-based turnkey solutions to bring connectivity to ultra-remote, often impoverished communities as part of corporate social responsibility initiatives
Protect Existing Markets Leverage space-based cellular backhaul solutions for network resiliency	Improve customer satisfaction	Build resiliency into existing networks to ensure subscribers always have a reliable, quality connected experience
	Reduce customer churn	Keep customers from churning by providing reliable, high-performing connectivity in existing coverage areas when outages occur
Preserve Future Markets Quickly deploy temporary or permanent cell sites backhauled over satellite	Gain first-mover advantage	Be first to enter unserved markets with voice and data services, especially hard-to-reach areas where fiber or microwave backhaul can take months or longer to deploy
	Preserve unused spectrum	Meet regulatory requirements and take advantage of unused spectrum in uncovered areas by quickly deploying remote cell sites



Recommendations for Closing the Connectivity Gap

Of the 4 billion people not connected to the internet worldwide, only 1 billion are not covered by mobile networks and can't connect. The previous section demonstrates how space-based backhaul managed services help mobile operators overcome infrastructure challenges, particularly in remote regions. But most of the world's unconnected (the remaining 3 billion people) don't connect because services are unaffordable, content is not relevant, or they lack the knowledge or skills to access the internet. That means mobile operators are only part of the solution.

Closing the connectivity gap worldwide will require a coordinated effort among many different types of organizations. There is strong momentum among international groups to find new solutions for bringing more people online in recognition of the huge impact the internet has on improving living standards globally.

For example, the United Nations' Broadband Commission for Sustainable Development's latest report calls for new collaborative strategies to deliver "meaningful universal connectivity," which is defined as broadband access that is not only "available, accessible, relevant and affordable, but also that is safe, trusted, user-empowering and leads to positive impact."

Another example is the World Bank Group's support for the African Union's digital "moonshot" to digitally connect every African individual, business and government by 2030.

The following recommendations aim to help mobile operators capitalize on the opportunity to close the connectivity gap:

- **Work Together with Everyone.** MNOs should seek partnerships and liaise with multi-national corporations, governments,

non-governmental organizations (NGOs) and regulators. By doing so, operators can help resolve issues that are beyond their control, such as creating relevant applications in local languages or setting up education centers where people can learn how to use mobile devices. Mobile operators can also inform regulators on how excessive taxation of internet services discourages take-up.

A recent rural deployment in Uganda shows the effectiveness of multiple parties working together (see sidebar). The project introduced 3G to two communities and involved mobile operator MTN, Intelsat, ITSO and

the country's Communications Commission.

- **Be Creative with Business Models.** It's clear that traditional deployment models will not fully eradicate the connectivity gap. MNOs should look for innovative business models, wholesale and revenue-sharing.

For example, Africa Mobile Networks is a mobile infrastructure provider that builds coverage to unserved areas and operates on a revenue-sharing model with mobile operators. It has so far deployed 500 remote sites to bring mobile coverage to 1.7 million people for the first time.

Closing the Connectivity Gap in Uganda

In Uganda, the rural communities of Bufundi in Rubanda and Kibuku in Ntoroko did not have access to mobile broadband. Intelsat partnered with the International Telecommunications Satellite Organization (ITSO), mobile operator MTN and Uganda's Communications Commission to deploy a satellite-enabled, solar-powered 3G small cell network, which brought connectivity to the communities for the first time.

The government of Uganda has a national broadband goal to cover 100% of the country's rural areas by 2020 and deliver minimum speeds of 3 Mbps.

The pilot project demonstrated the ease of deploying satellite solutions as well as the importance of private/public partnerships in achieving broadband access goals.

Conclusion

Roughly half the world's population is not connected to the internet and deprived of the socioeconomic benefits generated by digital economies. This connectivity gap represents an opportunity for mobile network operators to not only improve the lives of people in the communities they serve but also meet their business objectives. Closing the connectivity gap enables MNOs to achieve commonly held goals of expanding into new markets, protecting existing markets and preserving future markets. Until recently, expanding mobile broadband coverage to rural and remote, unserved areas was always hindered by the complexity and high cost of building out infrastructure as well as slow or low ROI. But space-based solutions have emerged that overcome these infrastructure challenges. By incorporating space-based communications into network planning, MNOs can quickly and cost-effectively connect more people in more places.



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To learn more about how mobile operators can expand their network planning strategy to reach new markets, protect existing markets, and preserve future markets, visit www.Intelsat.com/Connect-More.

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