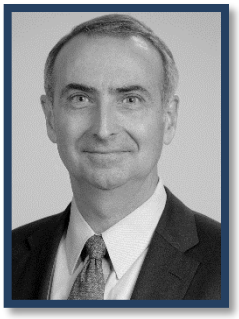

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The Role of Geostationary Satellite Networks in Meeting the Rural Connectivity Challenge

Introduction

Today we are seeing the connectivity gap closing, with mobile broadband coverage reaching an additional 1 billion people in the last five years, according to GSMA's 2020 Mobile Economy report. Yet there are still many challenges that remain in bringing affordable access to broadband in rural areas, especially those with sparsely populated remote communities often dispersed across distances. In most cases the only viable solution for bringing broadband to these hard-to-reach unserved areas is by means of wireless networks encompassing mobile (3G/4G) and Wi-Fi technologies. However, building out wireless communications networks in rural and remote areas using traditional means of terrestrial backhaul, such as fiber and microwave, has continued to prove challenging both from an economic as well as a geographic feasibility standpoint. Running terrestrial backhaul across long distances, often made more difficult because of topographical challenges like dense forests, mountains and valleys, becomes cost-prohibitive quickly when factoring the high CAPEX investment of physical backhaul infrastructure in these scenarios against the limited revenue that can be generated from smaller user populations.

As has always been the case, satellite-based backhaul for wireless networks (cellular and Wi-Fi) is the only viable solution to connecting most rural areas and remote communities from both an economic and geographic feasibility standpoint. Only satellite offers the means to connect hundreds even thousands of rural and remote sites, spread out geographically, to a provider's core network and the internet using a single pipe of satellite capacity, which is then distributed across the entire network of sites (cellular and or Wi-Fi) based on peak usage per site. Only by including satellite-based backhaul in a strategy to bring connectivity to rural areas and remote communities can the connectivity gap ever be closed.

A World Unconnected

Much research has been conducted over the years that continues to show how connectivity to the internet improves individual lives and entire communities. From material improvements in health, education, personal freedom and overall quality of life, to more efficient ways for consumers, workers and businesses to trade, communicate and access information, enabling communities to connect to the internet results in significant social and economic advantages.

However, there are still billions not connecting to the internet, millions of whom live in areas without even the means to connect.

According to GSMA, there are still roughly 3.3 billion people in the world who live in areas where access to mobile broadband (3G/4G) coverage is available (most often backhauled over a mix of fiber and microwave), but they are not connecting for various reasons, including lack of affordability, lack of consumer readiness, or lack of relevant digital content. We all have a responsibility to work together to tackle these obstacles to connecting. However, as GSMA points out, there are still roughly 750 million people around the world who could not connect if they wanted to simply because the communications infrastructure necessary to provide access is not available where they live. While 750 million may not seem like a large number, it is

approximately the populations of the United States, Indonesia, Brazil and South Africa combined. Given that context, we clearly have a long road ahead if we are going to ensure everyone around the globe has access to quality broadband connectivity wherever they live, work and play.

When considering the digital divide at a regional level, represented by those living in areas without access to mobile broadband (minimum 3G) coverage, the severest gap is found in the region of sub-Saharan Africa, with roughly 40 percent of the population living in areas without access to mobile broadband, according to GSMA. South Asia follows sub-Saharan Africa with a connectivity gap of 16 percent, followed by Middle East North Africa with a gap of 15 percent, and Latin America with a gap of 8 percent, according to GSMA. But percentages can be misleading and not tell the whole story, especially when examining data at a country level in these regions. For example, using market intelligence from GSMA and world population data, while only 5 percent of the population of Argentina living in areas where 3G/4G is not available may seem small, that 5 percent equates to a population of over 2 million people without access to mobile broadband. In Africa, approximately 28 percent of the population of the country of Cote D'Ivoire live in areas without mobile broadband coverage, representing a digital divide of over 7 million people. In Ethiopia roughly 15 percent of the population live in areas without minimum 3G coverage, however, that still represents nearly 17 million people without access to mobile broadband. Even in Central & East Asia and Pacific, with only around 4 percent of the region's population not having access to minimum 3G, the digital divide is severe when examining actual population numbers. For example, in the Philippines, only about 7 percent of the population live in areas without access to minimum 3G coverage, but that translates to over 7.5 million people without access to mobile broadband. To truly understand the impact of the digital divide, we must shy away from using only population percentages and begin to focus on population numbers by region, by country, by district, even by local communities.

Rural Connectivity Challenges

So why are there still hundreds of millions of people in the world today, spread out over various regions, countries, and districts, who live without access to even basic mobile broadband connectivity? The primary reason is because they live in non-urban areas where distance and sparse populations make it economically and even topographically (due to mountains, forests, etc.) challenging for building out costly communications infrastructure to support mobile broadband coverage. Many of the areas without mobile broadband coverage are anywhere from 1 to 3 hours from the nearest city, while still other areas are even more remote, being greater than 3 hours from the nearest city. The further a community is from an urban area, the greater the connectivity gap.

While affordability (affordable connectable devices and service plans), consumer readiness (knowledge and skill) and relevant content (applications and digital content designed for local languages and cultures) continue to be challenges in getting people who live in areas with access to broadband coverage to actually connect to the internet, for the 750 million who live in areas without access to broadband connectivity, infrastructure is the primary challenge. Infrastructure challenges include lack of access to power grid, poor roadways and bridges and absence of telecommunications infrastructure to include fiber or microwave backhaul and cell towers. However, the primary barrier to expanding broadband coverage into rural and remote areas and communities has been, and continues to be, the high cost of building out and operating the telecommunications infrastructure, especially backhaul, and the lower return on

investment due to smaller population densities often coupled with lower individual and household incomes.

In 2019, Intelsat conducted a webinar hosted by GSMA, with mobile operators and industry verticals in attendance. During the webinar, two polls were conducted to better understand the challenges mobile operators face when considering expanding broadband coverage into remote, hard-to-reach areas. Their responses confirmed our existing assumptions. In the first poll, we asked: “What is the biggest challenge to building mobile coverage in rural and remote areas?” And the responses were in line with what we expected. 33.7% of responses were “High CAPEX and OPEX costs of installing and maintaining remote infrastructure,” 25.6% were “Low and/or slow return on investment,” while only 18.6% were “Lack of supporting infrastructure (i.e., electricity, roads, bridges).” Based on the poll, cost and return on investment (ROI) are main barriers to mobile broadband expansion into rural and remote communities. Most of this cost is related to cellular backhaul using traditional methods such as fiber and microwave.

There is no doubt that fiber may be the optimal cellular backhaul solution from a cost and ROI standpoint in densely populated urban areas, especially in developed economies. However, the business case for it breaks down when running it across long distances to rural and remote areas, especially in undeveloped economies. As an example, according to data from the U.S. Dept of Commerce and NTIA, fiber combined with conduit material can cost, on average, $11.56 per meter; so just 10 kilometers of fiber can cost $115K. Add to that the additional costs that come from trenching, and it quickly becomes cost-prohibitive to run fiber over long distances to even one rural/remote cell site. Of course, time can also be viewed as a cost, and it can take six months to a year or more to cover just 10 kilometers with fiber. Furthermore, considering that many rural communities have populations of fewer than 1,000 people, with even fewer than 500 in the surrounding areas, one can readily see how low revenue potential (a.k.a. ARPU) creates an ROI barrier to rural broadband connectivity using fiber for backhaul. And the business case for mobile broadband in remote areas using microwave for backhaul is also cost-prohibitive, given that areas without existing telecommunications infrastructure require a complete microwave site, with just one complete site (including generator, 75-feet tower, etc.) costing on average $121K, according to U.S. Dept of Commerce and NTIA.

Fiber and microwave are the most common means of cellular backhaul today, but satellite is another means -- often used as a last resort by mobile operators. But why as a last resort, especially given the advantages of geostationary satellite ubiquitous coverage? In the second poll conducted by Intelsat during its webinar last year, attendees were asked: “What is the main impediment to employing satellite-based backhaul in mobile network planning as a means for covering remote areas?” The responses were very telling. Nearly half of the responses were “Cost of satellite-based backhaul is too high,” while the remaining responses were split across “Lack of familiarity and/or expertise in satellite solutions” and “Satellites don’t support high-speed broadband.” What made these responses so telling is that they reflect outdated perceptions of satellite services and capabilities. Many people today, even those within the telecommunications industry, still think of satellite as giant dishes behind buildings that were clunky, slow and expensive to use, with complicated technology that involved non-terrestrial platforms somewhere in space. But that is not 21st Century satellite.

The Case for Geostationary Satellite

As noted by research and consulting firm Frost & Sullivan: “Several technology options exist for backhaul of RAN [Radio Access Network part of cellular networks] (e.g., fiber, microwave, and satellite). Of these options, only satellite technology is suitable from either a cost or practicality standpoint for use in deploying wireless access networks in hard-to-serve areas such as rural communities.” So why is satellite more suitable for wireless backhaul in hard-to-serve areas from a cost and practicality standpoint than fiber or microwave? In answering this question, we will also be addressing the challenges, barriers, even objections that communications service providers (CSPs), such as mobile operators, raise today as constraints to expanding their networks into rural and remote areas and communities. Let’s begin with practicality.

From a practicality standpoint, satellite is the optimal solution for wireless network deployments in rural, remote and hard-to-reach areas where sparsely populated, geographically dispersed communities live, work and play without access to the internet. The most obvious is the ubiquitous reach of satellite. Geostationary satellite networks provide ubiquitous coverage to 99% of the world’s populated areas. Because of the ubiquitous nature of GEO satellite networks, distance, topography, even the line-of-sight restrictions of microwave are not constraints when providing backhaul connectivity to hard-to-reach areas. Also, because satellite coverage is everywhere, CSPs can connect any number of rural and remote wireless sites in far less time than if using fiber or microwave.

Advances in satellite technologies also make geostationary satellite networks the most practical backhaul solution for rural and remote wireless networks. Today’s satellite technologies can meet quality of service (QoS) and quality of experience (QoE) requirements, supporting mobile broadband, community Wi-Fi and local Wi-Fi hotspots, as well as cellular and non-cellular internet-of-things (IoT) deployments. With continuous innovations in space platforms, such as high-throughput satellites, and satellite hubs and modems that incorporate forward error correction (FEC) and transmission control protocol (TCP) acceleration technologies, users are ensured fiber-like experiences when connecting their devices to satellite-backhauled networks. Modern satellite systems also make possible the use of much smaller antennas, which are more readily transported across long distances and even challenging terrain. These very small aperture terminal (VSAT) ground stations also require less power to operate, ideal for solar power supply (with battery backup) when electricity or fuel generators are not available or practical.

There are also cost and ROI advantages to modern satellite backhaul solutions for rural and remote broadband networks. To backhaul a wireless network using fiber, such as a cell site for providing mobile broadband to a sparsely populated rural or remote community, costly delicate fiber must be run (typically underground) across long distances and topography (such as mountains, forests, rocky terrain, and rivers) to that one site. If more than one cell site is needed to support a single rural community, or multiple rural communities dispersed across a large geographic region, fiber must be run to each site. That is extremely costly, and a significant waste of capacity given the lower user population demand for each site. The same is true with microwave systems, where multiple hops are required for each rural cell site. However, with twenty-first century geostationary satellite networks, bandwidth can be dynamically allocated to hundreds even thousands of rural and remote network sites across a geographic region using a single pool of satellite capacity. This means that capacity is efficiently utilized based on traffic patterns across the network of sites, ultimately reducing the cost of backhaul per site compared

to fiber or microwave. VSAT equipment costs are also lower because of the smaller antennas required. Add to all of this the significantly lower costs to power a site using solar energy with battery backup compared to electricity or fuel generators, and one can readily see why using geostationary satellite for wireless network backhaul is the optimal solution for closing the connectivity gap in rural and remote areas of the world.

When the World Connects

As the digital divide shrinks, social and economic improvements follow. Communities once living in areas without access to the internet can now, through mobile and Wi-Fi broadband backhauled over satellite, access online information, web-enabled applications and a variety of public and private online services that help drive improvements in health, education, overall quality of life, and social progress. Men and women can learn new skills that equip them to compete for higher-paying jobs or for launching a small business, helping them escape poverty. Access to the internet over satellite-backhauled mobile broadband and Wi-Fi enables them to sell their local products and crafts in the global marketplace. Local connectivity means communities now have access to banking services, real-time telemedicine, regional news and weather reports, and emergency alerts. It means people in these communities can now communicate with friends, loved ones, and others real-time wherever they are.

Having access to voice and data services for the first time also means the future of once unconnected rural and remote communities is brighter. It is Nelson Mandela who once said: “Our children are the rock on which our future will be built.” According to UNICEF, roughly 29% of the world’s youth are not online today. Providing access to the internet in rural and remote unconnected communities helps the youth in the communities, as UNICEF points out, “fulfil their potential and break intergenerational cycles of poverty.” Broadband connectivity over satellite-backhauled mobile and Wi-Fi networks gives youth access to quality education and information that helps them improve their own lives and the communities they live in.

Today’s advanced geostationary satellite networks are being leveraged to quickly and economically bring life-changing 3G/4G and Wi-Fi service to rural and remote communities for the first time. For example, a leading mobile operator in Uganda is providing connectivity to hard-to-reach communities, providing access to mobile money services and education for primary schools. Mobile network infrastructure companies Africa Mobile Networks, for example, is using satellite backhaul to work with mobile operators to deploy solar-powered cell sites that provide voice and data services to millions in sub-Saharan Africa for the first time. Small rural and remote communities in countries like Cameroon, DRC, Liberia, Nigeria and Zambia are now able to use mobile phones for the first time where they live, work and play. Projects are underway in many countries like Rwanda, where solar-powered Wi-Fi service backhauled over satellite is providing schools access to quality educational programs. And refugee camps are utilizing satellite-backhauled Wi-Fi service, most often powered by solar energy, to support ICT labs and other applications, which equip refugees with the knowledge and skill needed to eventually leave the refugee camps and rebuild their lives.

While much is being done to close the digital divide across sub-Saharan Africa, many other communities in countries around the world are now able to connect as a result of satellite-backhauled mobile coverage. For example, approximately 5% of the population of Peru live in areas without access to mobile broadband (minimum 3G). While 5% may not seem large, it equates to roughly 1.6 million unconnected Peruvians, most of whom live in deeply rural areas.

To close this digital divide in Peru, creative solutions have been necessary, with satellite operators and private entities partnering together to build out vital connectivity infrastructure where fiber and microwave backhaul are not practical, enabling mobile operators to provide access to 3G coverage in more than 150 rural Peruvian communities. And Peru is just one of multiple examples of how satellite backhaul is being used to close the connectivity gap in other countries of the world. The Marshall Islands is an isolated, sparsely populated island country located in the Pacific Ocean that has faced many challenges in providing mobile broadband connectivity to its population, especially communities in the outer islands. Recently the Marshal Islands National Telecom Authority (MINTA) launched an initiative to connect dozens of cell sites for mobile coverage, as well as hospitals and schools, in these hard-to-reach and unconnected areas using satellite backhaul. Today, satellite operators, governments, mobile operators, and private enterprises around the world are working together to quickly and cost-effectively bring the life-changing benefits of connectivity to unconnected communities.

Conclusion

While there has been much progress in closing the global connectivity gap, there is still much work to be done, especially in bringing access to broadband to the 750 million people who still live in areas without access. While investments continue to be made in expanding mobile broadband and Wi-Fi service beyond urban borders using traditional backhaul approaches of fiber and microwave, this will never close the gap, and any impact to it will take months to years using these approaches. Only by integrating satellite backhaul into strategies to deploy mobile and Wi-Fi networks into rural and remote communities can the gap be closed quickly and economically. With satellite-enabled mobile and Wi-Fi broadband services, every man, woman and child around the globe can have access to the social and economic advantages that result from internet connectivity.