



WHITE PAPER

Connectivity Through Backhaul

The critical role of satellite services in supporting mobile connectivity through backhaul.

Table of Contents

Introduction	3
Mobile Network Operators (MNOs)	3
Confronting capacity and network Complexity issues	4
The evolution of mobile networks across EMEA	5
Types of Satellite Backhaul	6
Satellite technologies for 2G, 3G and 4G/LTE	7
Satellite Backhaul underpins 4G Network QoS, Capacity and Flexibility	9
Resolving the 4G Backhaul Challenges	10
Conclusion	11

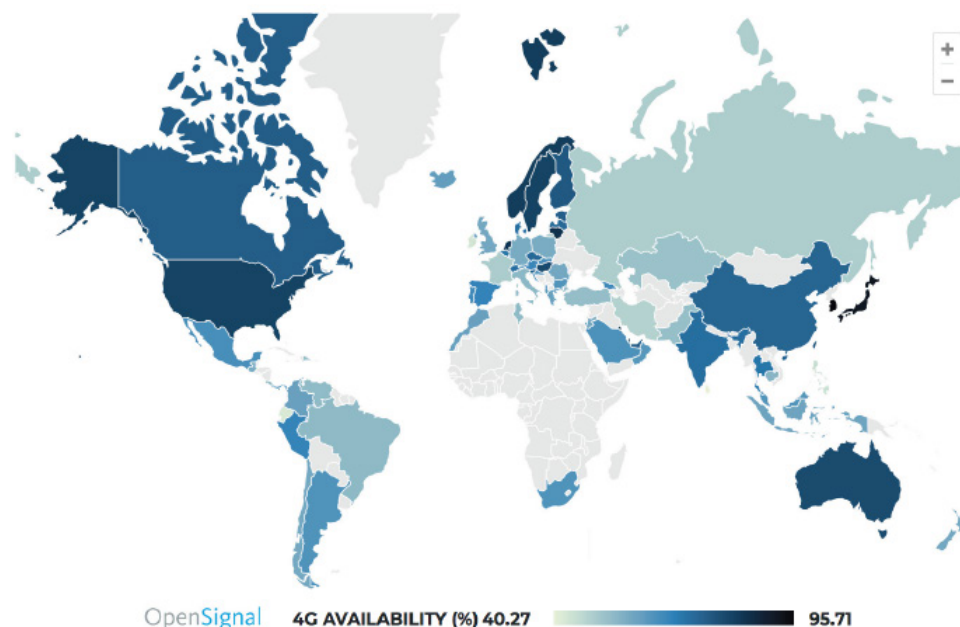
Introduction

The importance of mobile connectivity cannot be overstated in today's world, whether for the most developed economies or emerging ones. This is especially true as the networks of today prepare to transition to the 5G "network of networks". Important challenges remain about how to provide coverage and connectivity to all populations around the globe. Whilst there are many different ways to accomplish this, utilising satellites as the backhaul component for mobile terrestrial connectivity remains one of the best ways to support the world's growing need for mobile communications. By incorporating satellites into the mobile terrestrial infrastructure, terrestrial mobile operators are able to quickly deploy scalable, reliable, and cost-effective means to bring mobile connectivity to the world's citizens, no matter where they are located.

Mobile Network Operators (MNOs)

Mobile Network Operators (MNOs) already use several transmission means (fibre, microwave, satellite) to connect their cell sites to the backbone and/or to back-up unreliable terrestrial connections. In developed markets, satellite is already playing a key role as MNOs deploy satellite enabled backhaul to improve their 4G coverage and relieve congestion in metro areas. In regions with poor or challenged terrestrial infrastructure (Africa, South America, etc.), MNOs rely extensively on satellite services to connect 2G, 3G and 4G/LTE cells to the central infrastructure. This will be even more important as 5G infrastructure is being deployed, as an increasing number of more and more consumers will demand reliable, wide-coverage, cost-effective mobile communications no matter where they are located. Without satellite, overcoming this challenge is commercially unviable.

The use of satellite to support wireless terrestrial backhaul began in the early 2000s and has increased as many countries adopted universal service policies and mobile operators had to cover more and more remote locations where terrestrial backhaul was not available in many cases, or could not be deployed on a timely or cost-effective basis. Today satellite connections are still a quick, low CAPEX and OPEX solution to the problem of connecting remote cell sites and there is significant satellite connectivity capacity to support the needs of MNOs globally.



Source: <https://opensignal.com/reports/2016/11/state-of-lte#map>

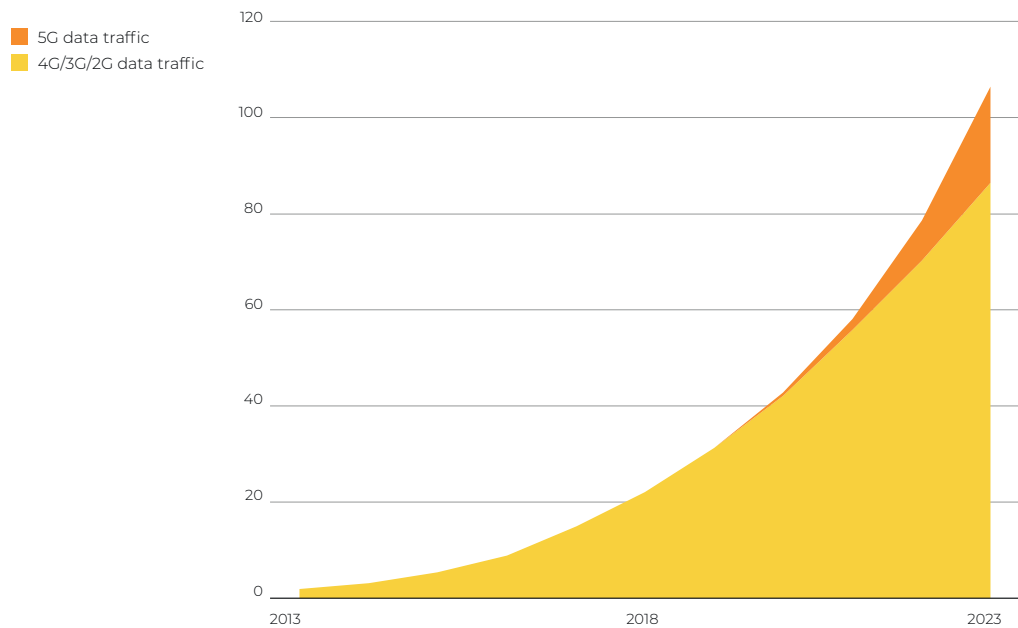
If the UN's 2030 Sustainable Development Goals are to be reached and digital, education, health and social divides are to be bridged, then cooperation between terrestrial and satellite operators must increase considerably.

Confronting capacity & network complexity issues

The capacity challenge

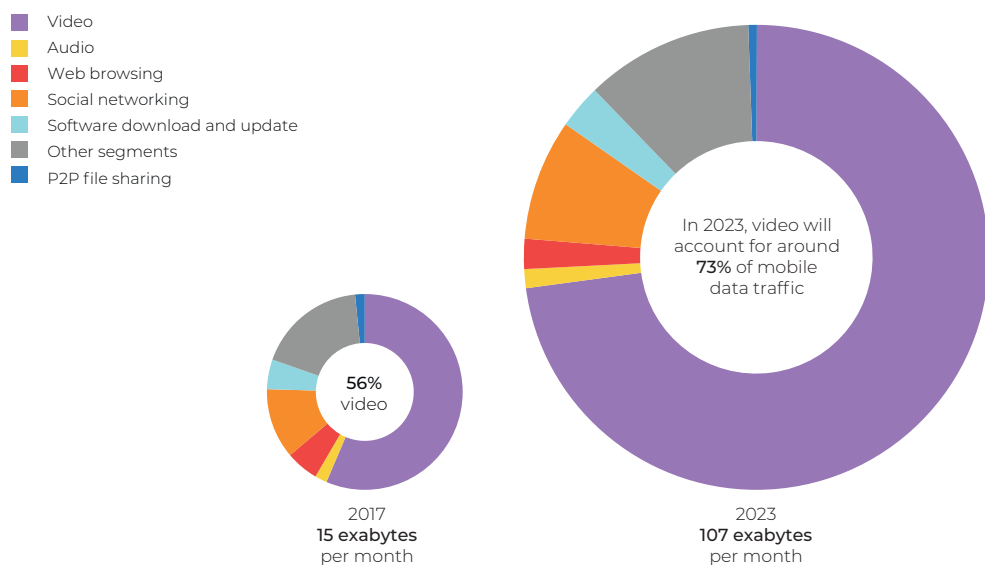
In 2019, 4G will become the leading mobile network technology worldwide by number of connections (more than 3 billion)¹. The increasing availability of 4G networks and LTE enabled devices has fundamentally changed user behaviour; consumer and enterprise users expect anytime, anywhere access to mobile data for browsing, social networks and videos. Mobile video traffic is forecast to grow by around 45 percent annually through 2023 to account for 73 percent of all mobile data traffic¹. MNOs must be prepared to meet customer expectations and improve their user experience.

Global mobile data traffic (exabytes per month)



Source: Ericsson Mobility Report, 2018

Mobile data traffic by application category per month (percent)



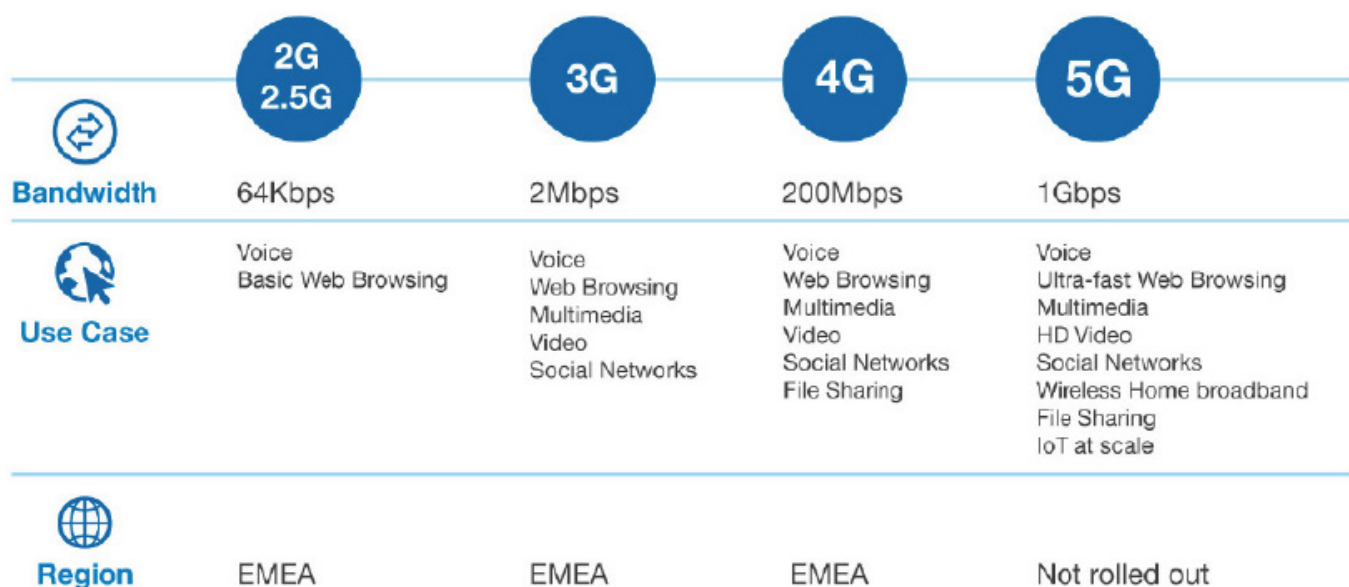
Source: Ericsson Mobility Report, 2018

¹GSMA, Global Mobile Economy 2018

Managing network complexity

As mobile data increases and mobile subscriptions rise, alongside the task of providing network capacity and speeds for 4G services, MNOs must contend with a further array of network complexities. Network technologies do not mature nor transition overnight. Alongside increasing speeds and capacity demands, MNOs need to support multiple standards and legacy systems over a period of years. For example, European MNOs are considering shutting down 2G and 3G networks and reusing spectrum for 4G, whilst in Africa, the majority of network roll-outs continue to be 2G and 3G based.

The evolution of mobile networks across EMEA



5G standards are still in development, though the aim to provide speeds in excess of 1Gbps is expected to require a new air interface and a virtualisation of the 4G core. The anticipation of an explosion in device numbers, driven by new services and the IoT, adds to the need for MNOs to maintain a robust backhaul strategy.

Not only must the network deliver the capacity, coverage and speeds needed to support anytime and anywhere access to applications, but also deliver OPEX savings in customer provisioning, service activation and billing. All without causing network congestion and outages which can directly impact and damage the MNOs' reputation.

Types of satellite backhaul

Dedicated Bandwidth

The most common satellite backhaul technologies have been either a dedicated point-to-point satellite link known as single channel per carrier (SCPC), or a shared link using time-division multiplexing access (TDMA). An SCPC connection consists of an antenna and a modem located in the central mobile switching centre (MSC) site connected to another antenna with a modem in the remote base transceiver station (BTS) site belonging to the MNO. The satellite bandwidth is dedicated to this connection and the throughput is guaranteed. This type of connection is more appropriate to serve higher data rate connectivity requirements.

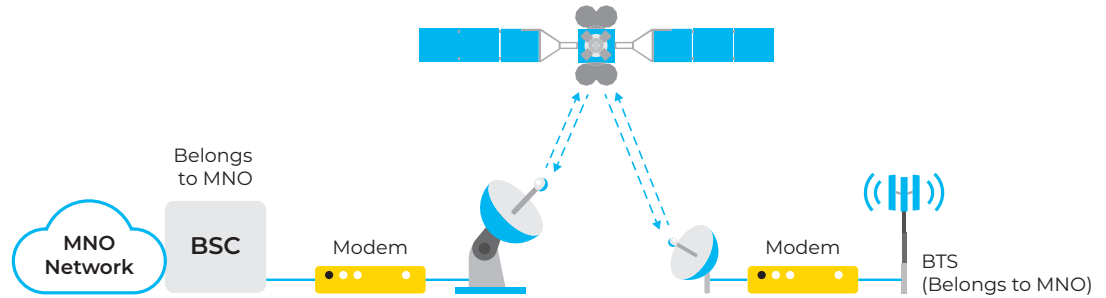


Figure 1: Satellite Backhauling using Dedicated Bandwidth

Shared Bandwidth

When multiple sites are to be connected, either TDMA or some other point-to-multipoint link may be the most economical solution. TDMA systems are able to deploy and support hundreds of sites at one time, saving on capacity which is the biggest cost element in OPEX. Point-to-multipoint links involve installing an 'intelligent' satellite hub in the central site and an 'intelligent' modem together with an antenna at each remote BTS site. This 'intelligent' IP connectivity optimizes the bandwidth as it is dynamically allocated in real time depending on the transmission need of each remote site; For instance, 50Mbps can be dedicated to a pool of 100 sites and then dynamically allocated to the different sites depending on demand. This architecture is increasingly being used for 3G and 4G/LTE mixing voice and data in a single link as the data traffic is essentially asymmetric and opens up further multiplexing capabilities to help reduce both CAPEX and OPEX.

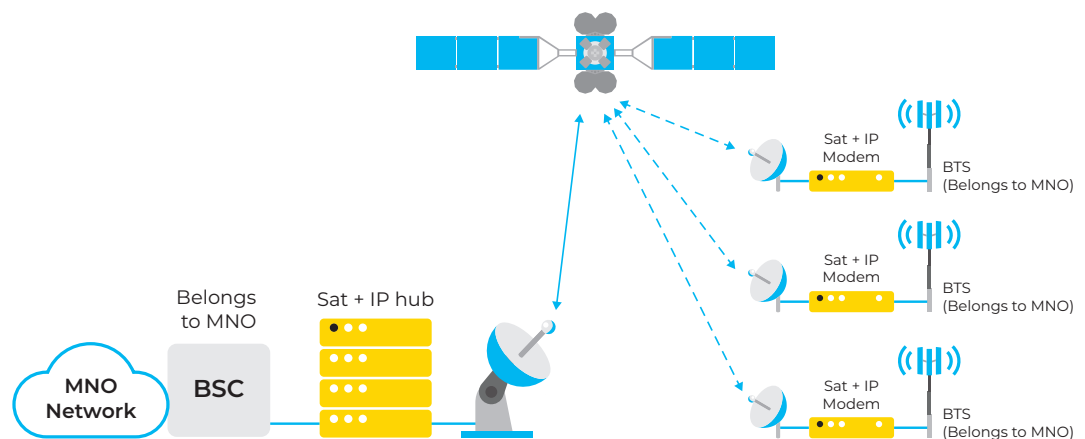
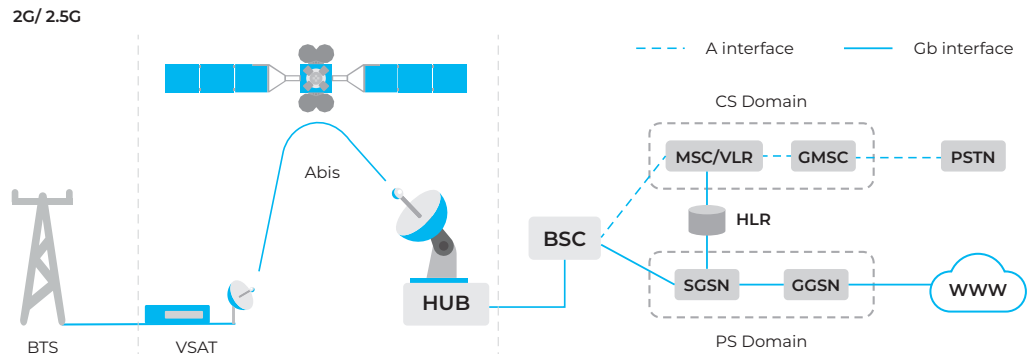


Figure 2: Satellite Backhauling using Shared Bandwidth

Satellite technologies for 2G, 3G & 4G/LTE

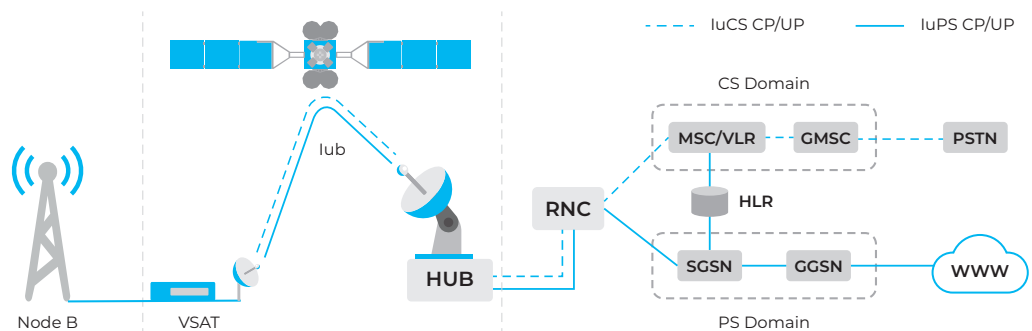
2G Technology

Satellite backhaul technology is widely used in the 2G environment, and GSM calls and SMS text messaging are fully compatible with satellite connectivity. The low CAPEX requirement combined with bandwidth optimization techniques such as Abis and a low OPEX cost ensure a profitable solution in the most scarcely populated areas.



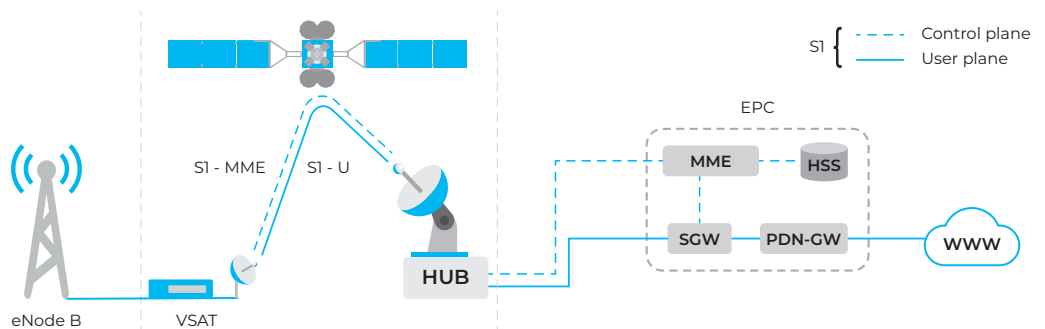
3G Technology

For 3G, optimisation solutions process incoming voice traffic and apply mobile-aware intelligent packetization techniques to ensure the network is using the least bandwidth possible while prioritizing the resources for real-time voice and signalling. Some of these techniques can also enforce the use of the most efficient voice codecs.



3G Technology

The proliferation of data over mobile has spurred the adoption of higher communications standards such as 4G/LTE. For 4G, the simplified architecture of 4G makes it easier to deploy backhaul over satellite. Innovative technologies including acceleration, compression, caching and traffic shaping help enhance the user experience, which is key, as traffic becomes more data and video centric.



Satellite backhaul is also frequently used to backup critical sites served by a single fibre or by unreliable terrestrial connections, as well as in cases of emergency response. In case of outage of the main connection, traffic is instantly swapped over to the always-on satellite connection resulting in little or no traffic loss.

Recent innovations allow voice and data traffic to be separated so that 'lighter' voice traffic can be routed over terrestrial connections while bandwidth hungry data traffic is routed via satellite. This provides MNOs with options by which to implement step-by-step bandwidth increases, as they are needed when extending data services to remote cell sites. Innovations are being done to improve return capacity since new 4G/LTE traffic profiles are driving users to upload content.

Also, as innovations in technology such as High Throughput Satellites at geostationary orbit and non-geostationary constellations at medium and low orbits continue to be deployed, the cost of satellite service for backhaul has dramatically reduced in price.

5G

5G AND THE FUTURE OF SATELLITE IN CELLULAR NETWORKS

The cellular industry is currently driving towards the adoption of the 5th Generation of global cellular standards (5G) with the first version of the standards released in 2018, with an updated broader version expected in 2019/20. The Next Generation Mobile Networks (NGMN) group which represents the views of the world's major global operators defines 8 goals for 5G:

5G GOALS

1. Broadband access in dense areas,
2. Broadband access everywhere,
3. Higher user mobility,
4. Massive internet of things (IoT),
5. Extreme real-time communications,
6. Lifeline communications,
7. Ultra-reliable communications, and
8. Broadcast-like services.

Goal 2 clearly can only be met by including satellite technology, which offers true geographic ubiquity. Equally, goals 3, 4, 6 and 8 will also benefit greatly from the contribution of satellite services. Global mobile coverage can only be achieved through the deployment of a combination of cellular and satellite technologies. This is the vision for the role of satellite in cellular networks for 2020 and beyond.

Satellite backhaul underpins 4G network QoS, capacity & flexibility

The advent of Ka-band satellite technology has unlocked a powerful new capability for MNOs to transform the economics of Satellite Backhaul and to easily accommodate the complexities of overlapping network technologies.

Avanti Ka-band Satellite Backhaul solutions deliver important advantages for MNOs compared to terrestrial fibre, microwave solutions, and Ku/C-band alternatives.

Highly scalable & flexible

- Rapid and cost-effective expansion into rural and remote locations
- Improves and expands 4G service coverage and adds incremental revenues for enterprise and consumer applications
- Open APIs ensure our network is agnostic, allowing quick and easy integration
- Avanti's Satellite Cellular Backhaul is compatible with 4G S1 interface standard, as demonstrated through commercialised deployment by EE
- Supports multiple backhaul scenarios



Network Rapid Roll-out



Fast Response Capacity



Cell on Wheels



Remote Cell Sites



Network Extension & Infill



Backhaul Backup

Delivers 99.9% network availability

- Avanti's multiple data centres and Gateway Earth Stations (GES) deliver "carrier grade" redundancy and resilience
- Integrates into MNO network management systems to highlight network issues before network congestion/outage events occur
- Provides immediate and reliable backhaul solutions for 2G, 3G and 4G sites to the network core

Optimises network cost of operations

- Access to the Avanti bandwidth pool allows reduction of OPEX and total flexibility for bandwidth demand
- Increased efficiency of frequencies reduces the Mbps cost
- CAPEX reduction via hub managed services and small antennas

Ways to overcome latency

Latency in satellite systems have historically been caused by three issues:

- Latency of the geostationary satellite round trip which is an unavoidable result of the speed of RF propagation
- Latency caused by network congestion and poor or absent traffic management

Thanks to traffic landing locally in the region and our Gateway Earth station network linked via resilient fibre network, Avanti is able to reduce the latency to its lowest possible and to offer a service compatible with the latest standards.

Resolving the 4G backhaul challenges

Avanti is the world's first satellite operator to deliver 3G and 4G Satellite Backhaul services using Ka-band technology. Fundamental to the success of Avanti's Satellite Backhaul is the integration of Ka-band technology into MNOs' complex networks.

EE



EE (part of the BT Group) was the first to launch 4G service in the UK in 2012. As part of its requirement to upgrade network resilience, reach and flexibility, EE has tasked Avanti to test, install and integrate a Satellite Backhaul service. This is the world's first major commercial deployment of 4G Satellite Cellular Backhaul. Avanti is providing backhaul to over 1,000 fixed base stations integrated into EE's national 4G network. The Avanti backhaul solution will provide management reports to ensure 4G network congestion and outage events are identified and resolved before a loss of customer experience can occur.

Mansoor Hanif, Director of Convergent Networks and Innovation at BT stated:

"We are delivering a highly resilient, truly nationwide 4G network and Avanti will play a key part in providing resilience and extending this network into rural areas"

Avanti is also working with another mobile network operator to extend 3G mobile data connectivity to base stations that experience seasonal fluctuations in traffic. We deliver ultrafast, ubiquitous coverage and provide flexible bandwidth capacity to meet the MNO's network demand, wherever it is.

Conclusion

Satellite backhaul is being used extensively today supporting MNO efforts to extend their network coverage, both for cellular and mobility applications. Urban and semi-urban areas enjoy congestion relief and seamless connectivity by using satellite backhaul (which is key to 5G). But rural coverage worldwide remains poor and governments and MNOs often have competing priorities for their investments.

High performance mobile data is the future of revenues for mobile networks, and satellites are the ideal choice to deploy in challenging or remote areas, or to increase the capacity provision in the network to address the surge in traffic demand. Customer demand for data-hungry applications creates an opportunity for operators to close the business case for 3G and 4G/LTE in remote markets. With a lowered cost/Mb, there is increased data usage resulting in higher average revenue per user (ARPU) and an increase in market share and subscribers resulting in overall higher profitability.

Given the technological and business options available for using satellite backhaul and recent technology innovations such as High Throughput Satellites and new constellations of lower orbit satellites, there is good reason for MNOs to make more intensive use of satellite service for backhaul. In addition to the dramatic socio-economic impact, cellular backhaul via satellite significantly increases the MNO subscriber base and allows them to guarantee full reach.



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