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CONNECTIVITY THROUGH **BACKHAUL**

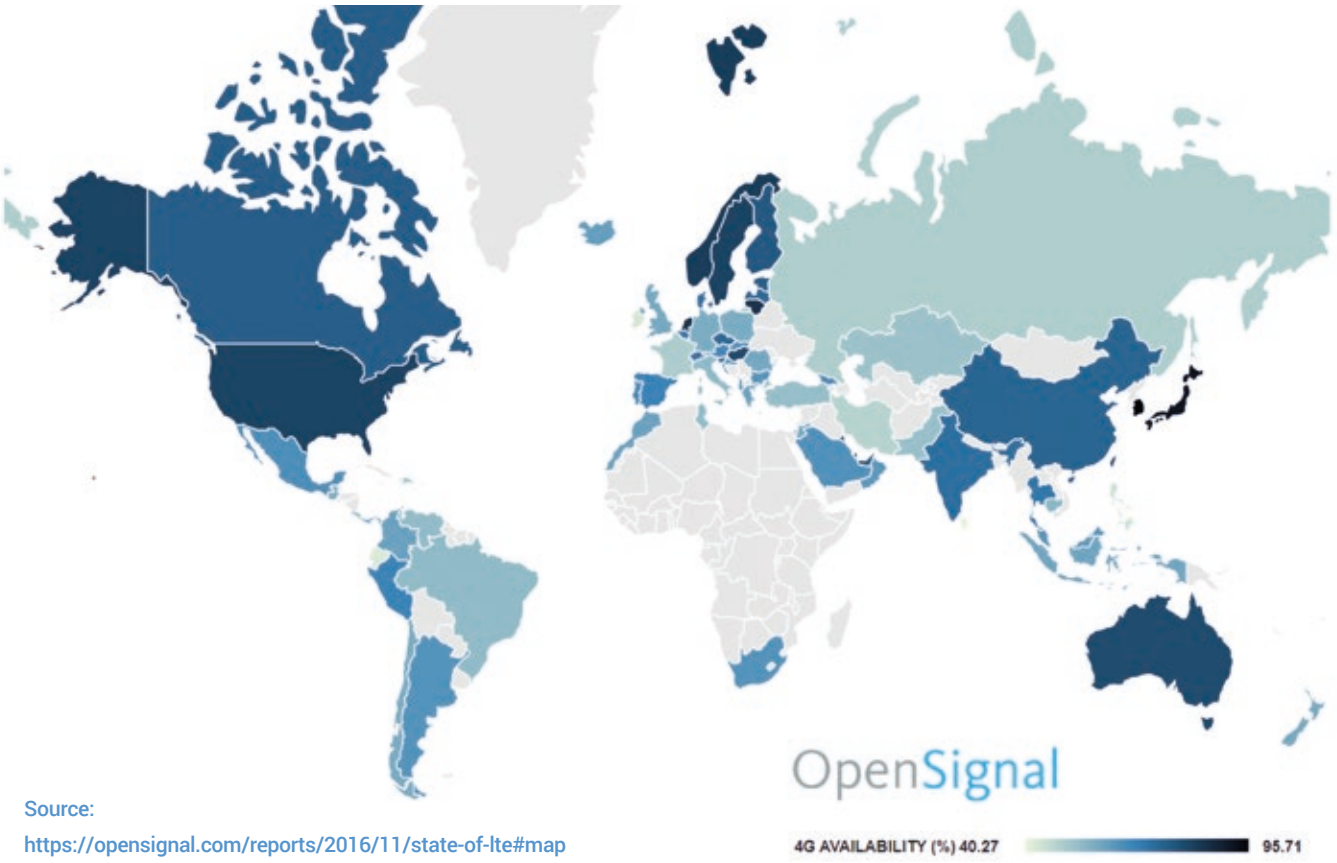
The Critical Role of Satellite Services in Supporting Mobile Connectivity Through Backhaul.

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, utilizing 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 (Asia and North America), 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.

Types of Satellite Backhaul

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.

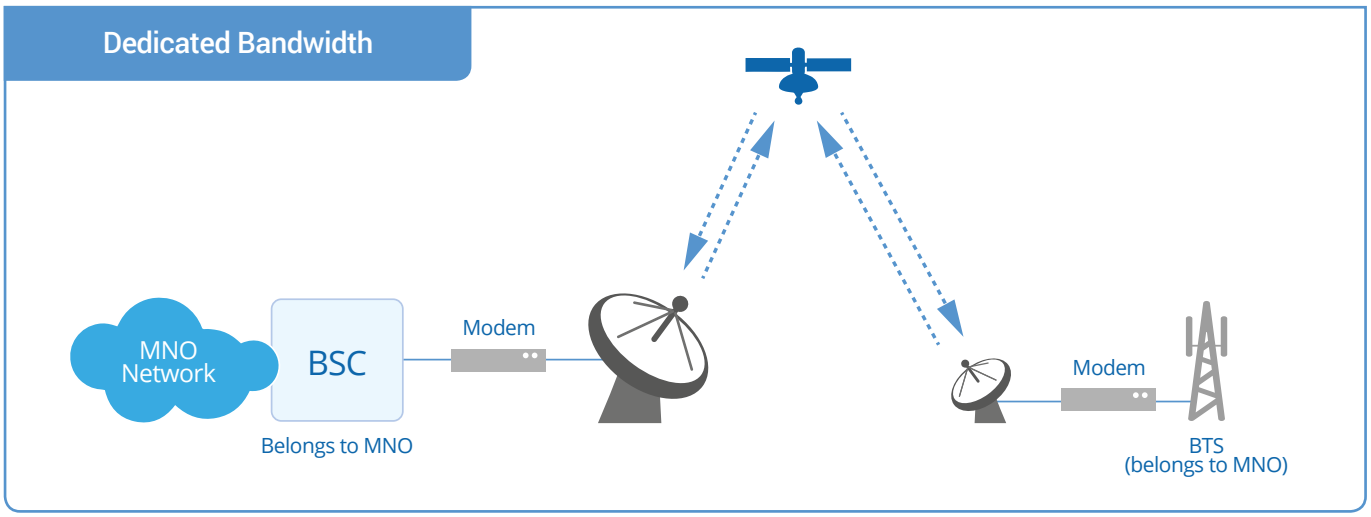


Figure 1: Satellite Backhauling using Dedicated Bandwidth

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.

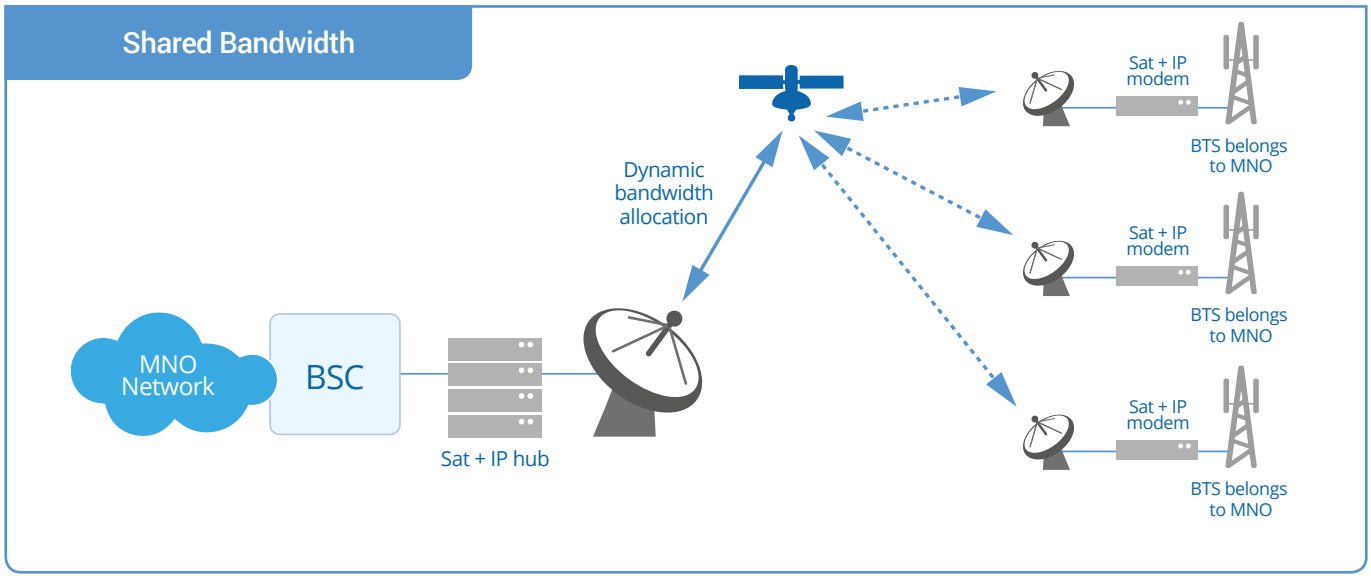


Figure 2: Satellite Backhauling using Shared Bandwidth

How 2G - 3G - 4G Backhaul Works

2G GSM Networks

MNOs use satellite to connect their GSM/GPRS remote Base Transceiver Stations (BTS) to their central Base Station Controller (BSC) or Mobile Switching Centre (MSC).

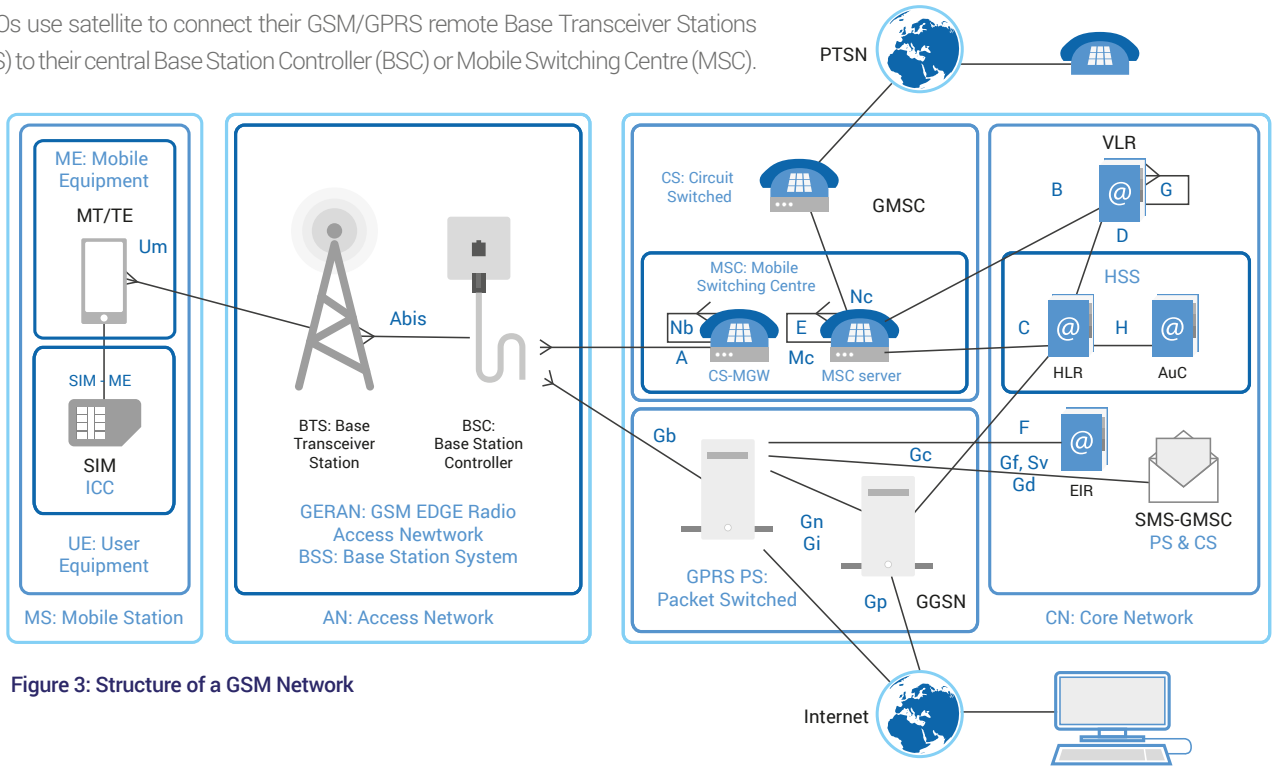


Figure 3: Structure of a GSM Network

3G/UMTS Networks

Similarly, MNOs operating 3G/UMTS networks in remote regions use satellite to connect so called Node B to the central infrastructure.

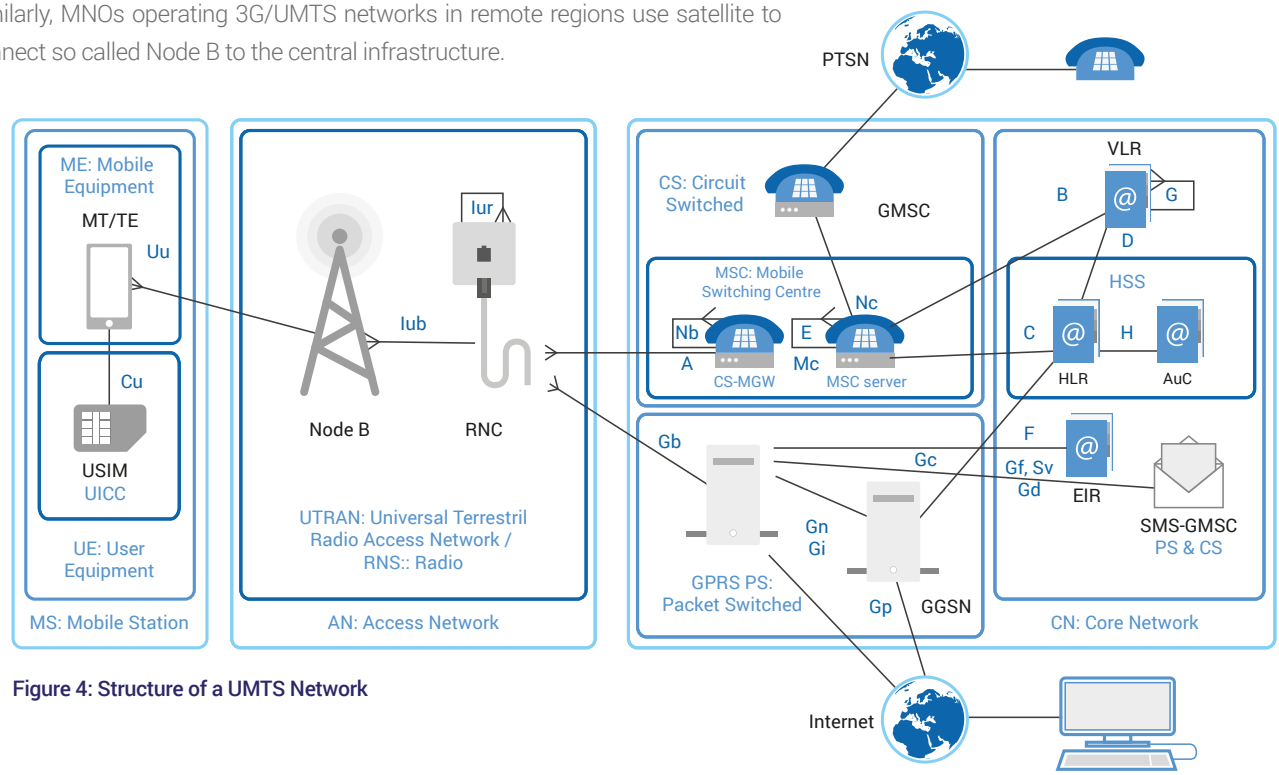


Figure 4: Structure of a UMTS Network

4G Networks

Similarly, MNOs operating 3G/UMTS networks in remote regions use satellite to connect so called Node B to the central infrastructure.

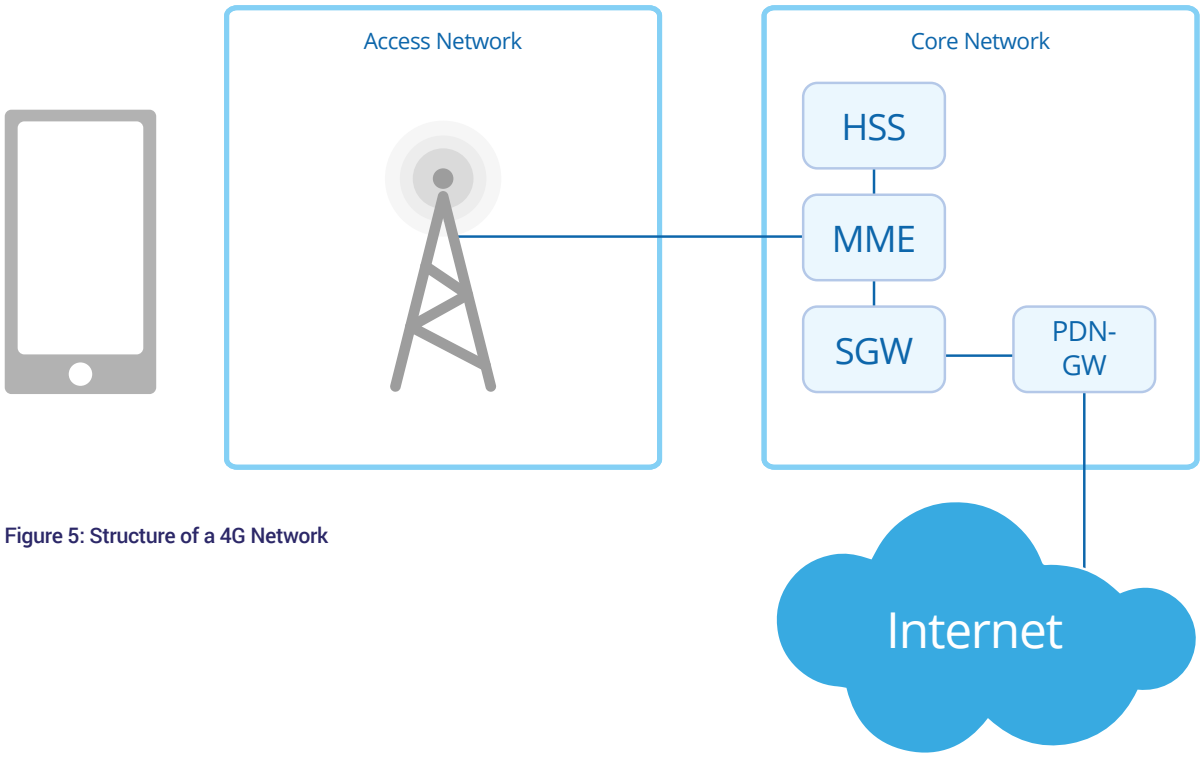


Figure 5: Structure of a 4G Network

Satellite Technologies for 2G, 3G, and 4G/LTE

2G 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 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. Higher throughput satellites in GEO and MEO have accelerated deployment of 3G as they offer the bandwidth required to serve data users.

4G 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. MEO systems (not to mention the upcoming LEOs) are well aligned with the performance benefits of 4G/LTE technology to provide a true broadband experience, with speeds up to 2Gbps and RTT latency below 150 ms.

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 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 due to be available 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.

Business Models

Satellite backhaul is a critical component of the wireless terrestrial infrastructure today, and will continue to be vital for 5G as well. Business models should include consumption-based billing, which matches how consumers are procuring their mobile services, and which reduces the risk and the exposure of the MNO and closely ties OPEX to revenue. There are several business models available for MNOs who wish to make use of satellite services for back haul. These include:

1. Directly contracting with satellite operators for raw capacity. In this case, the MNO leases satellite capacity, buys a hub, and runs its own satellite network.

2. Directly contracting with satellite operators for an end-to-end managed service solution ("one stop shopping"). In this case, the satellite operator provides and manages the ground equipment, bandwidth, and support, based on a Service Level Agreement (SLA).

3. Entering into a service agreement with a service provider or who provides end-to-end connectivity solutions and operates the satellite network.

And of course, business models can always be tailored to the particular needs of an MNO.

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 satellite 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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