



SATELLITE-BASED Cellular Backhaul: Myths & Facts

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ADDRESSING THE CELLULAR BACKHAUL CHALLENGE

As the mobile network continues to evolve in terms of technology, endpoints and services, mobile network operators (MNOs) need to adapt their cellular backhaul solutions to these changing requirements. For example, as data usage grows exponentially, cellular backhaul strategies must adapt accordingly taking into account user expectations in terms of performance and reliability. User experience is particularly critical for rich media and broadband services over 3G and 4G networks. As an example, many still use E1/T1 bundles for cellular backhaul, still in place from the voice oriented networks, that are far from suitable for broadband data, both from a performance perspective and commercially.

In the past, the satellite option for cellular backhauling was used only for hard to reach rural areas such as islands, mountains and deserts, where terrestrial infrastructure such as fiber, next-generation copper or microwave were either too expensive or unfeasible. Today, we see that the increasing need for high-throughput data networks together with improved economics and advancements in technology in both the satellite capacity and on the ground segment are causing MNOs to rethink old habits.

The emergence of high throughput satellites (HTS) have expanded the use cases for satellite backhaul connectivity, beyond remote and rural connectivity. Satellite capacity is rising fast and bandwidth costs (\$/Mbps/month) continue to drop. This means that thousands of cell sites can now be served economically by satellite, opening up a broadening range of new applications such as metro-edge coverage extension, urban network densification, roads and highway coverage and emergency connectivity and backup.

While the business case for satellite backhaul has never been stronger, there still remains one major barrier to widespread deployment – and that is perception. Common negative misperceptions of satellite backhaul revolve around three themes – satellite capacity cost, performance (i.e., latency) and complexity.



MYTHS AND FACTS

One of the main reasons for these misperceptions is a lack of familiarity with satellite technology, which leads to fear, uncertainty and doubt (FUD). The best way to debunk these false impressions is to examine them one-by-one and let the facts speak for themselves.

MYTH #1: LTE PERFORMANCE CANNOT BE MET WITH SATELLITE BACKHAUL

As satellite communication has inherent delay, some MNOs are concerned that this will result in poor backhaul performance and consequentially, a poor user experience. However, satellite technology has evolved to overcome this delay, and certain VSAT platforms enable a true LTE user experience.

FACT: TERRESTRIAL-GRADE LTE SATELLITE BACKHAUL IS PROVEN IN THE FIELD

Gilat's new VSAT modem technology has achieved true LTE performance for major MNOs around the world (some of these deployments are described later in this paper). This modem features a multi-core processor, protocol optimization and application acceleration techniques that enable unprecedented LTE performance. In an Ookla SpeedTest, throughput performance was

measured at nearly 150 Mbps of TCP traffic to the handset.

FACT: NEW ACCELERATION TECHNOLOGY MITIGATES LATENCY EFFECTS

Application acceleration is especially critical when high bandwidth is required, like in LTE deployments. Gilat overcomes inherent satellite delay by using an innovative acceleration technology that mitigates the latency effects. Jointly patented by Gilat and SoftBank, this technology enables true LTE speed through acceleration of traffic inside the LTE GTP tunnel. This acceleration technique has been implemented in Gilat's VSAT system and is being used in LTE deployments to achieve the breakthrough performance mentioned above in tier-1 mobile networks.

The following chart demonstrates the significant benefit of accelerated throughput, by showing the





actual throughput to the handset achieved over satellite with and without acceleration. The inherent GEO satellite delay, typical round trip of 600ms, causes a severe degradation in performance reversely correlated to the handset window size - the smaller the window size the lower the throughput. The chart illustrates how Gilat's



Typical Handset Device

patented acceleration provides full utilization of the 150Mbps bandwidth for any window size handset-device. It is important to note that typical handset devices have window sizes less than 500KB and therefore non-accelerated satellite performance would be lower than 10Mbps.

Furthermore, Gilat integrates the acceleration functionality into the VSAT, rather than using an external card or box. This single-box solution reduces costs and allows for a single point of contact for all hardware and software issues. Embedded acceleration also reduces complexity by using a single network management system, while the QoS is maintained with end-to-end bandwidth management. The integrated solution guarantees maximum traffic efficiency in any link condition by eliminating sync delay between cards, which is critical for avoiding packet loss during fade conditions.

MYTH #2: SATELLITE CONNECTIVITY IS EXPENSIVE

In the past, the cost of satellite bandwidth capacity often rendered satellite-based communications prohibitively expensive for providers of broadband services (MNOs). Today, improvements in satellite technology, particularly the emergence of high throughput satellites (HTS), have changed the rules of the game.

FACT: SATELLITE CAPACITY PRICING AT TIMES WILL RIVAL TERRESTRIAL BANDWIDTH COSTS

HTS provides a major improvement in throughput over traditional wide beam satellites. The result has been a steep drop in bandwidth costs across all applications. The graph below shows global HTS bandwidth supply, demand and average price per Mbps. The expected 16 times growth in the HTS global supply from 2017 to 2025 is attributed to hundreds of high throughput satellites being launched.





GLOBAL HTS BANDWIDTH SUPPLY, DEMAND AND PRICE PER MBPS

At the same time, we can see that the HTS Global demand is significantly less than the supply. The weighted average price of the GEO-HTS capacity across applications has fallen from approximately \$800/Mbps/month in 2013 to \$250/Mbps/month in 2017, (see red line). This price is expected to further decrease, primarily due to the abundance of satellite capacity expected to come from multiple launches of LEO and MEO satellites. We can see from this trend that the bandwidth costs of satellite backhaul will rival that of many terrestrial backhaul deployments in the future.

FACT: BANDWIDTH SHARING FURTHER REDUCES COSTS

Bandwidth sharing access schemes, such as Multi-Frequency Time-Division Multiple Access (MF TDMA), also significantly contributes to cost reductions. Utilizing the inherent point to multipoint nature of satellite communication, bandwidth sharing is a good fit for data-intensive 3G and LTE networks. This is because 3G and LTE data traffic is asymmetrical – users download much more than they upload – and the traffic is bursty which means it has a high peak to average ratio (often higher than 10:1).

Given these network traffic attributes, the traditional dedicated link or two-way symmetrical pipe is often no longer the most cost-effective access scheme.



Source: Gilat, 3G Small Cells traffic patterns. Real performance from the field, Oct 2015



Bandwidth should be and can be adjusted according to usage, for better cost efficiency. MF-TDMA provides MNOs with several key advantages:

- Avoid wasting bandwidth where it's not needed
- Provide sufficient capacity to meet peak usage
- Enable better QoS by sharing bandwidth among cell towers and prioritizing bandwidth in the same cell for critical applications such as voice and signaling

MYTH #3: SATELLITE CONNECTIVITY IS TOO COMPLEX

A third common misperception is that satellite technology is too complex for cellular backhaul networks. MNOs already have their hands full with their rapidly evolving mobile networks, and the last thing they want is added complexity for backhaul. To be suitable, satellite backhaul should be deployed in a way that reduces complexity.

FACT: GLOBAL NETWORK MANAGEMENT REDUCES COMPLEXITY

One way to reduce satellite backhaul complexity is to use a sophisticated global network management system (NMS). Centralized management enables full provisioning, configuration, control and monitoring of all satellite hub elements, as well as remote terminals, regardless of their physical location. This is crucial for streamlining the management of large, distributed satellite networks. NMS also helps to simplify service fulfillment, which allows for quick and easy configuration of each service for each cellular site, as well as supporting comprehensive service assurance, based on performance monitoring and traffic usage reports.

A universal NMS lets MNOs easily and cost-effectively scale to support any network size, enabling them to start small and add sites as needed. Smooth integration with the Operational and Business Support System (OSS/BSS) further reduces complexity.

FACT: ACCELERATED LAYER 2 SUPPORT FACILITATES SATELLITE NETWORK INTEGRATION

Another factor contributing to satellite backhaul complexity relates to the OSI network layer at which the integration of the satellite and cellular terrestrial networks takes place.

Satellite networks traditionally operate at Layer 3 (network layer) in order to be able to accelerate the user data, while MNO networks in some cases operate at Layer 2 (data link layer). Accordingly, satellite networks that can operate at a carrier-grade Layer 2, while enabling acceleration can simplify the extension of existing terrestrial infrastructure to include satellite while increasing operational efficiency.

The benefits of carrier-grade Layer 2 support over satellite include:

- Simplified operations Layer 2 connectivity allows the MNO to work in the same standard way with satellite as it does with any other transport method
- More connectivity options Accommodates the use of existing MPLS/PPPoE protocols over satellite
- Transparent Layer 3 MNOs can keep the same IP network design and operational procedures



FACT: MANAGED SERVICE REDUCES COMPLEXITY

A significant reduction in complexity can be achieved by regarding satellite backhaul as a managed service. The MNO specifies the requirements, the service level agreement and key performance indicators, as well as the required site locations and the schedule. Considering the managed service as a black box and giving end-to-end responsibility to the satellite backhaul provider will enable the MNO to focus on their core competency and promote their business.



The below table summarizes the many tasks that all or some can be done by the satellite backhaul provider, who is providing the managed service, thus dramatically reducing complexity.

	TASK	SHORT DESCRIPTION
	Satellite Network Design	Done per the required SLA/KPI, as well as the MNO's network topology
S-y	Capacity Setup & Management	Includes choosing the relevant satellites for available capacity, location & efficiency. Also includes continuously monitoring the network for resource optimization
	Network Integration & Onsite Installation	Includes integration with the MNO's core network and the 3G/4G nodes and cell sites installation
	24x7 Network Operation Center	Ideally provided remotely from multiple global sites, to ensure constant monitoring and operation
	Call Center	Ensures around the clock service, there will always be someone who will pick up the phone
	Sevice Level Management	Critical parameter for the MNO to ensure the promised service quality to its end-users
	Program Management	Includes logostics, fulfillment, professional installation and ongoing service for the network and VSAT sites



FROM THEORY TO PRACTICE

As the trends and capabilities mentioned above continue to converge, satellite communication technology is rapidly transitioning from a niche play to a prime time technology.

Satellite backhauling is no longer just the fallback option when terrestrial solutions are not feasible. Today, we are seeing that it is often the preferred choice for various applications of 3G and 4G mobile backhaul. The following examples of live satellite backhaul deployments at leading MNOs worldwide demonstrate the economic and technological viability of satellite across a number of different use cases.

SoftBank

SOFTBANK - REMOTE REGION CONNECTIVITY IN JAPAN



Softbank, a Tier-1 operator in Japan, deployed an LTE network over small cells in underserved areas where it is difficult to install terrestrial infrastructure and macro cell base stations. Softbank required backhaul support for highspeed LTE services, as well as the ability to provide network backup capacity and connectivity for first responders in emergencies.

Both use cases are typical for connecting remote regions, such as islands, vacation resorts, tourist attractions and highways. Moreover, this deployment in Japan was the first implementation of Gilat's breakthrough acceleration technology, jointly patented with Softbank. Gilat's satellite backhaul solution has enabled Softbank to achieve true LTE speeds over small cells in remote areas, significantly enhancing the user experience with high availability and high performance on a par with terrestrial networks.



EE - NETWORK RESILIENCE AND BACKUP IN THE UK



Everything Everywhere (EE), part of the BT Group and an operator of one of Europe's largest 4G networks, is using Gilat's satellite backhaul solution to support network resilience and backup, as well as 4G network coverage extension throughout the UK.

EE achieves network resilience and backup using both fixed and portable cell sites. An example of EE's portable on-the-pause deployment is shown here. This vehiclemounted solution contains both the cell node and the VSAT that provides the backhaul over satellite.

This quick-to-deploy solution supports network resilience in the event of a cell site failure, as well as providing immediate high-speed voice and data connectivity to emergency response teams in the field.





GLOBE - MANAGED SERVICES BUSINESS MODEL IN THE PHILIPPINES



Gilat has delivered a satellite backhaul as a managed service solution to Globe Telecom, the leading full-service telecommunications company in the Philippines. Gilat is responsible for providing data and voice services over 2G/3G/4G to regions requiring improved connectivity and broadband access, in compliance with a strict service level agreement (SLA).

This end-to-end managed service for satellite backhaul substantially reduces project complexity for Globe Telecom. Gilat is responsible for satellite capacity, network setup, 24x7 network operations (hub and remote sites), equipment installation and service management. Globe defines the SLA and KPIs and Gilat provides all the services and resources necessary to ensure smooth and cost-effective operations. This business model allows Globe to focus on its core mobile network, while Gilat handles the satellite backhaul as a "black box" for Globe.



SPRINT - METRO EDGE CONNECTIVITY IN THE US



To enhance its competitive position and grow its customer base, Sprint decided to extend its nationwide LTE network to underserved markets in metro edge and other areas. Using Gilat's satellite-based cellular backhaul solution, Sprint is delivering high-speed LTE voice and data services to areas that previously had limited 2G/3G service. This use case illustrates the applicability and effectiveness of satellite backhaul in non-rural/remote areas, such as metro edge, where suburban areas are often sparsely populated and lack mobile coverage.

Requiring only hours to deploy per site, Gilat's solution allowed Sprint to rapidly and cost-effectively expand its network to new areas ahead of the competition. Sprint's subscribers enjoy true LTE performance over satellite with an outstanding user experience.





KDDI - NATIONWIDE LTE COVERAGE & EMERGENCY RESPONSE IN JAPAN



KDDI Corporation, a Fortune Global 500 company and one of Asia's largest telecommunications providers, is deploying a satellitebased LTE cellular backhaul solution to extend reach and resilience with high speed data and high-quality voice throughout Japan.

KDDI will deploy hundreds of Gilat VSATs nationwide, including both remote and metro-edge areas. VSATs will be installed in fixed cell sites as well as on deployable vehicles for emergency response – known as cellular on wheels (COW). Gilat's satellite backhaul solution will enable KDDI to provide a superior LTE connectivity to residents and visitors throughout Japan, as well as serving as a basis for KDDI's disaster recovery capabilities.



BOTTOM LINE

This paper has made the argument that LTE satellite backhaul is now both viable and economical. Three common misconceptions have been discussed and debunked.

MYTH 1: "LTE PERFORMANCE CAN'T BE MET WITH SATELLITE BACKHAUL"

Technology has evolved to deliver speed, performance and terrestrial-grade user experience

MYTH 2: "SATELLITE CONNECTIVITY IS EXPENSIVE"

Today's satellite TCO rivals terrestrial solutions in many cases

MYTH 3: "SATELLITE BACKHAUL IS TOO COMPLEX"

A comprehensive suite of services simplifies deployment, integration and operation

And finally, this paper is not just theory. The "proof is in the pudding".

Today, there are multiple LTE satellite backhauling applications deployed worldwide with Gilat's technology delivering true LTE performance.



GILAT SATELLITE NETWORKS www.gilat.com

