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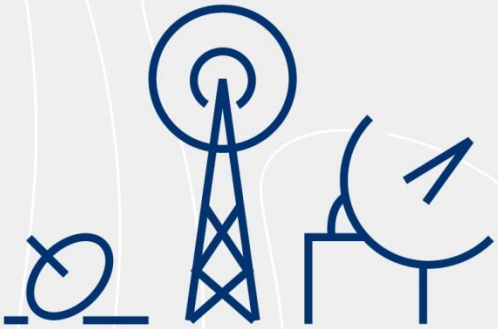

Satellite Backhaul vs Terrestrial Backhaul: A Cost Comparison

Boundless Communications

A perfect storm

The mobile industry and the satellite industry have worked in parallel for decades, occasionally targeting the same market but mostly not. While mobile operators satisfied the vast demand for personalized on-the-move connectivity in population centers, satellite focused on connectivity in remote regions.

But then - two phenomena converged.

One was that mobile traffic became increasingly data-driven. This meant that the throughput requirements for mobile networks would need to grow exponentially. As the diagram below shows, using the United States as an example, mobile network traffic is expected to double between 2015 and 2017.

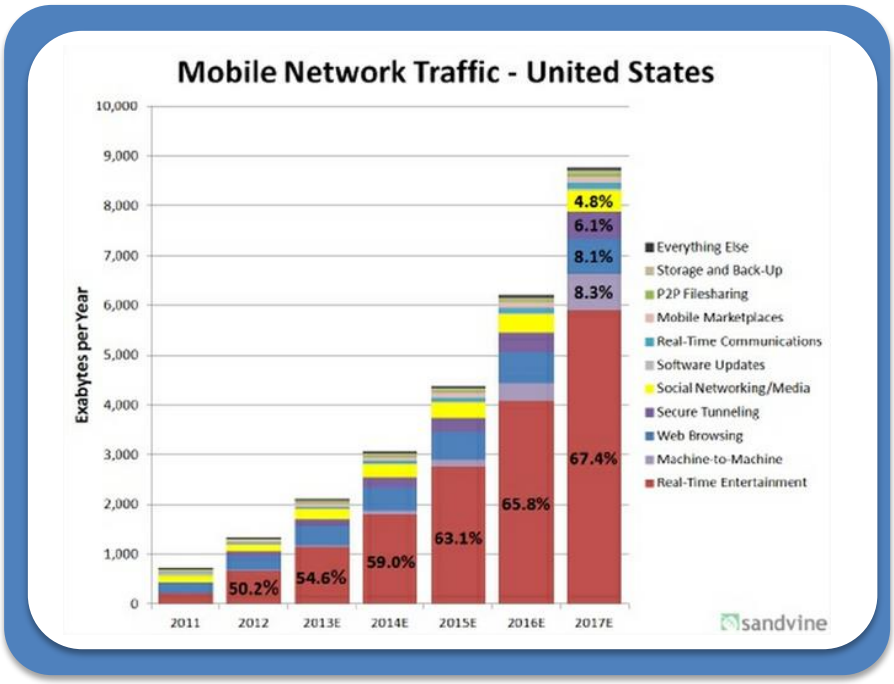

Figure 1: Mobile Traffic Forecasts

The proliferation of data over mobile has spurred the adaption of higher communications standards such as 4G/LTE. While these standards have not yet been implemented everywhere, they are surely on their way, and standards with even higher capacity – 5G and beyond – will follow.

At the same time, advances in the satellite industry have slashed the cost of bandwidth. High-Throughput Satellites (HTS) offer significantly increased capacity, reducing bandwidth costs by as much as 70

percent. This breakthrough has helped position satellite communication as a cost-effective alternative for delivering broadband while reducing operating expenses.

The crucial role of backhaul

The ramping up of networks to handle data traffic has an overarching need: a backhaul transmission mechanism that is reliable, quickly deployable, and cost-effective.

Another consideration affecting the cost impact is the backhauling access scheme. When providing a satellite backhaul link, the question of bandwidth efficiency is crucial. The goal is to save money by using the exact amount of bandwidth that meets the subscriber's performance needs, and no more. Satellite offers access schemes with either fixed or adaptable bandwidth in the download as well as the upload direction: TDM/TDMA or TDM/SCPC. Selecting the right access scheme depends on network traffic patterns. Whichever scheme is chosen, the goal is to reduce costs by optimizing bandwidth consumption.

With satellite costs plummeting on one hand, and demand for data skyrocketing on the other, a unique value proposition is taking shape for mobile network operators – backhaul of cellular data over satellite. In this paper, we'll take a closer look at how this model works in rural and semi-rural environments.

Network deployment comparison

Let's take a closer look at the options for mobile network operators looking to expand by comparing setup and ongoing expenses for satellite and terrestrial networks.

For purposes of this sample, we assumed the following:

- Deployment of a 100-eNodeB network with full connectivity to Internet core
- Average of 100-125 concurrent users per site at peak time
- User experience – 100Mbps per user at average use of 10-15MB use in peak hour

Let's start with a typical deployment of a semi-rural network with terrestrial (microwave) backhaul.

Semi-rural terrestrial backhaul deployment

In semi-rural locales, a blend of short- and long-range links cover the towns and smaller communities, which may be relatively remote or bunched together. In one or more hops, these links funnel into two

fiber PoPs, which in turn link to the LTE core. On roads connecting communities, coverage is full.

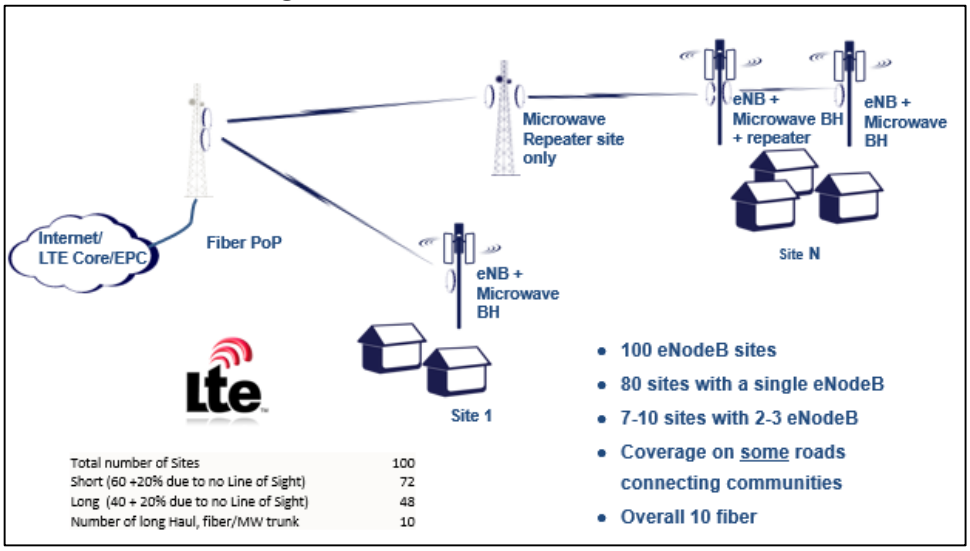

Figure 2: Deployment of Terrestrial Backhaul in Semi-Rural Area

Rural terrestrial backhaul deployment

Now let's look at a rural locale covered by terrestrial backhaul.

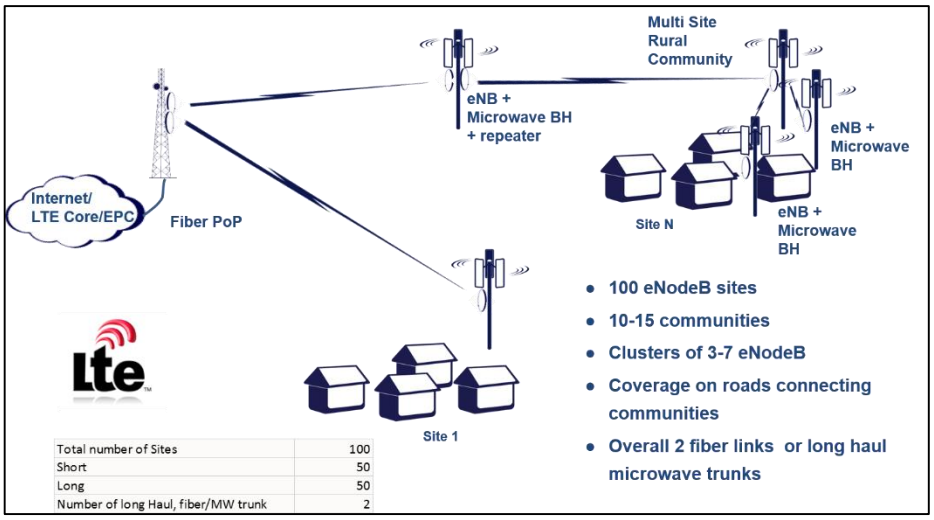

Figure 3: Deployment of Terrestrial Backhaul in Rural Area

Due to a sparse population and large distances between communities, we can assume a larger proportion of long-range links relative to shorter ones. In one or more hops, these links funnel into ten fiber

PoPs, which in turn link to the LTE core. On roads connecting communities, coverage may be intermittent.

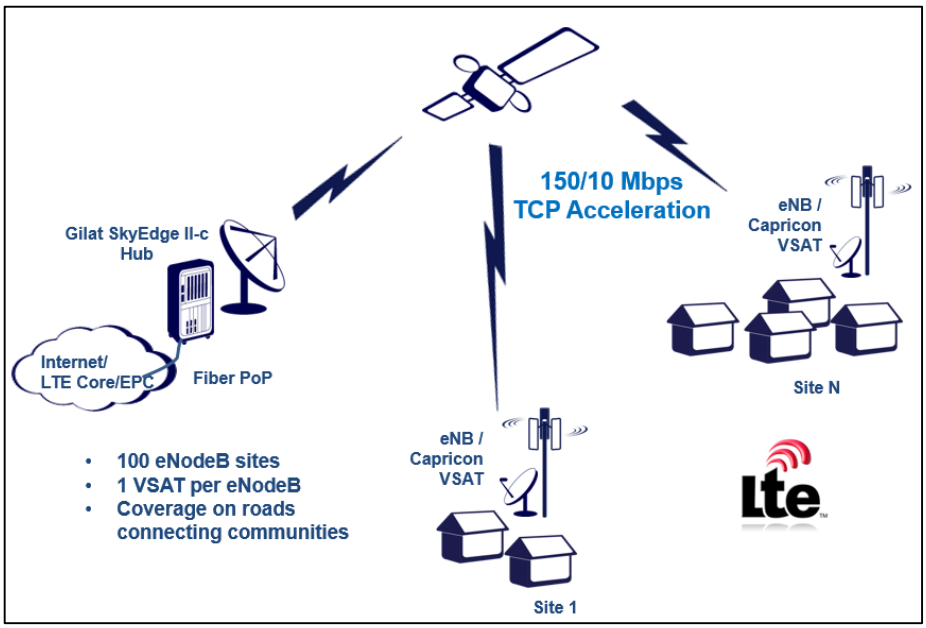

Figure 4: Deployment of Satellite Backhaul in Semi-Rural/Rural Area

Rural/semi-rural satellite backhaul deployment

In these same locales, a satellite-based backhaul solution allocates one VSAT per eNodeB and can be deployed rapidly. Each VSAT is connected via satellite directly to the fiber PoP; this PoP connects to the Gilat SkyEdge II-c hub, which generally sits in close proximity to the Internet core. On roads connecting communities, coverage is full.

TCO Comparison

The above scenario shows that both backhaul methods are viable, but the bigger question is which is more cost-effective. For that, we'll have to delve into the numbers. We'll compare Total Cost of Ownership (TCO) figures, factoring in the variables than can affect cost.

Link	Cost
Short-range MW Link ($4,000) + services/accessories/installation ($3,000) (price of tower construction, if needed, is not included)	$7,000 x no. of short-range links
Long-range MW Link ($14,000) + services/accessories/installation ($8,000) (price of tower construction, if needed, is not included)	$22,000 x no. of long-range links
Short-range spectrum – annual	$1,200 x no. of short-range links
Long-range spectrum – annual	$5,000 x no. of long-range links
Short-range link other OPEX – annual electricity, site lease...	$1,000 x no. of short-range links
Long-range link other OPEX – annual electricity, site lease...	$2,000 x no. of long-range links
Fiber rural - US - up front 150 miles ($1,000 per mile)	$150,000
Fiber rural - US - OPEX 150 miles ($250 per mile)	$38,000
ANNUAL MAINTENANCE	15% of CAPEX
Note: In USA and Brazil spectrum may cost less – but there is less spectrum availability and equipment and installation is more expensive	

Figure 5: Microwave deployment. Price assumptions

Equipment	Cost
Required amount of MHz on satellite to support 100Mbps	36
1Mhz BW on Satellite WB per month	$3,300 x 36
1Mhz BW on Satellite HTS per month	$1,400x 36
Amount of VSATs (one per eNodeB)	100
Cost per VSAT	$4,000
Total cost - VSAT for 100 sites – one time	$400,000
Hub + antenna + installation – one time	$500,000
Teleport + fiber connection to EPC per month	$8,500
ANNUAL MAINTENANCE	15% of CAPEX

Figure 6: Satellite deployment. Price assumptions

The totals of these estimated expenses are compared side-by-side in Figure 7 below.

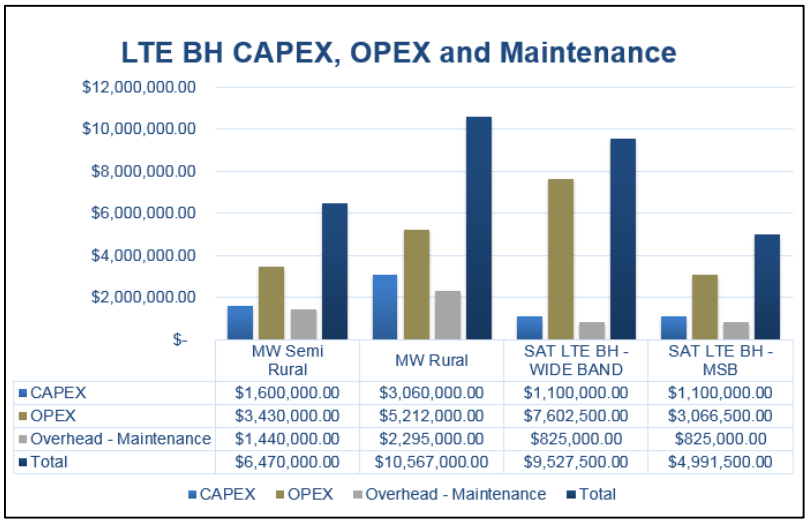

Figure 7: Backhaul TCO Comparison Over 5 Years

CAPEX – for terrestrial backhaul, capital expenses primarily consist of creating microwave links and laying fiber for from the rural PoPs to the Internet core. For satellite backhaul, this consists of purchasing and installing VSATs, antennas and a hub.

OPEX – for terrestrial backhaul, operational expenses consist of leasing spectrum, powering and leasing space for microwave towers, and running costs for the fiber hop to the Internet core. For satellite backhaul, this consists of purchasing MHz from a satellite operator.

Maintenance – as per industry best practices, this is measured at 15% of CAPEX.

Reviewing the figures above, several data points stand out:

- Multi-spot beam bandwidth, with a per Mhz cost half of wide-beam bandwidth, is the most cost-effective backhaul solution
- The more rural the region, the less cost-effective terrestrial backhaul becomes
- As CAPEX is a lower percentage of the overall expense in a satellite network, its maintenance costs are lower

Other differences between terrestrial and satellite are harder to quantify in dollars but nonetheless affect the bottom line. Satellite infrastructure is portable, so it can be reused wherever it's needed. Time to market is shorter. Licensing is per country, not per site. These

are just a handful of the many considerations that mobile network operators make when evaluating backhaul mechanisms.

To complement its satellite network offering, Gilat offers a complete package of Network Operation Centers, installation and field support. This one-stop service gets a network up and running quickly, and frees up mobile network operators to focus on what they do best – sell a high-quality service.

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