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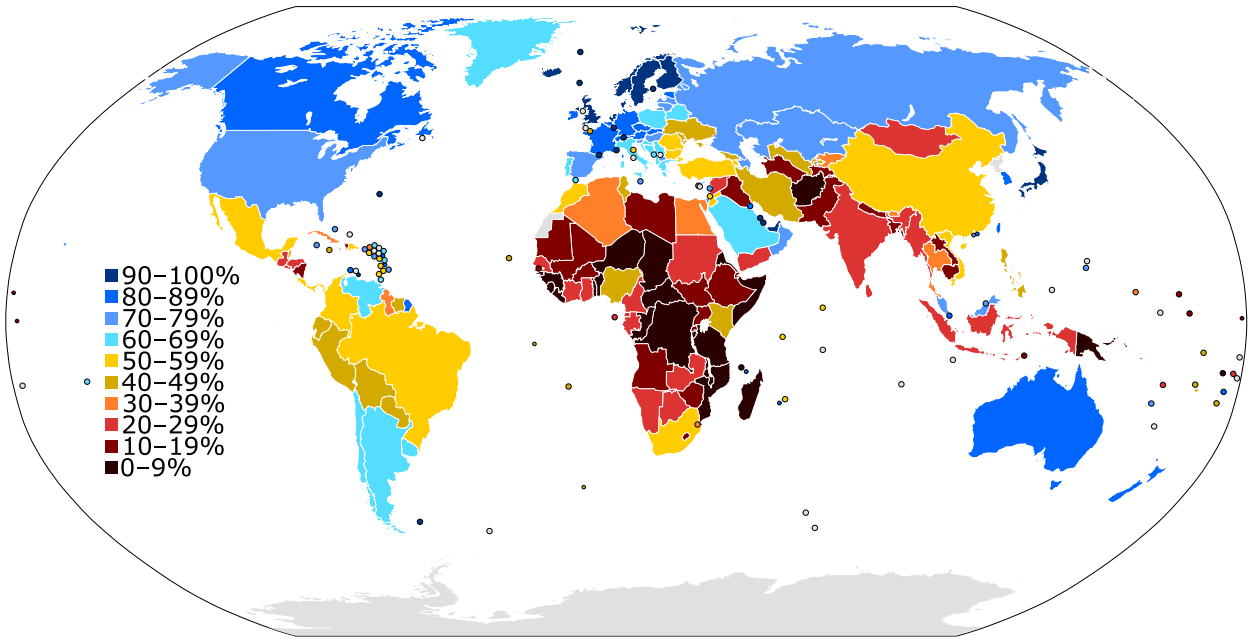
WHITE PAPER

Hughes Enables High-Performance 4G/LTE Backhaul via Satellite

Global Outburst of Internet Connectivity

With the rapid advancement and growth of technology, access to the Internet today is more important than ever. Internet connectivity has proven to bridge the digital divide, thus, giving people a way to improve human development factors directly or indirectly. According to the following illustration by ITU, the percentage of Internet users in many developing nations around the world is less than 40%; and in some countries even lower than 10%. Based on analytical reports from GSMA intelligence, about 40% of the world's population will not have Internet access in 2020.



Internet users in 2015 as a percentage of a country's population
Source: International Telecommunications Union

The constant growth in smartphone use is pushing Mobile Network Operators (MNOs) to deliver advanced network connectivity with higher speeds, and therefore, increasing broadband penetration around the world. An Ericsson mobility report released in June 2017 forecasts that the number of smartphone users will grow three-fold from 2016 to 2020. The report also suggests that about 90% of smartphone users are 3G/4G (mobile broadband) subscribers.

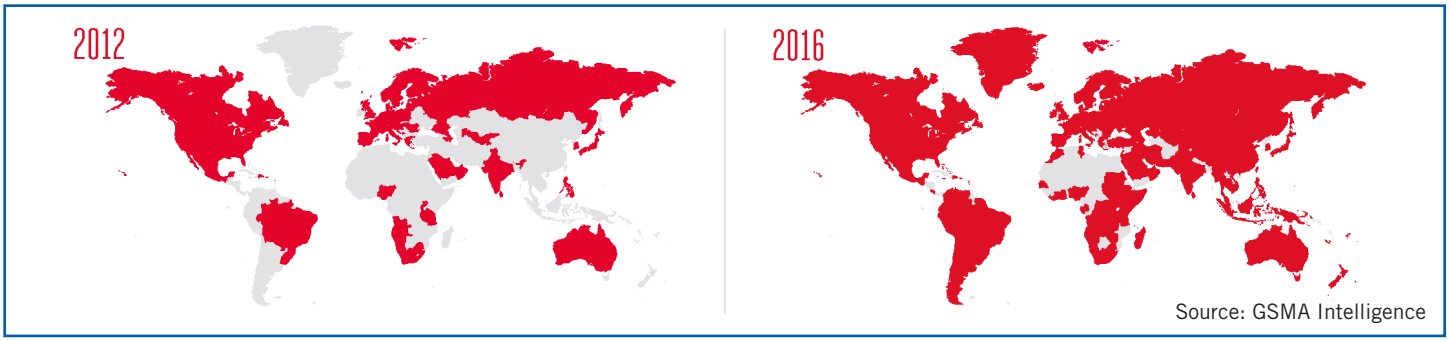
Technology	Subscribers (in millions)			CAGR
	2015	2016	2022	
EDGE	3600	3050	670	-22%
HSPA	2080	2280	2780	3%
LTE	1090	1860	4960	18%

Source: Ericsson Mobility report June 2017

Although there is a great incentive to provide services in untapped cellular broadband markets in developing countries, deploying fiber optic backhaul networks to connect wireless nodes may take a very long time and require heavy, long-term infrastructure investments. Beyond the high-density metropolitan areas, terrestrial backhaul technologies are not always cost-effective, which in the past has constrained growth of modern wireless services in rural and underserved ex-urban areas. However, satellites can deliver a cost-effective, high-performance solution to deploy LTE cell sites in these areas.

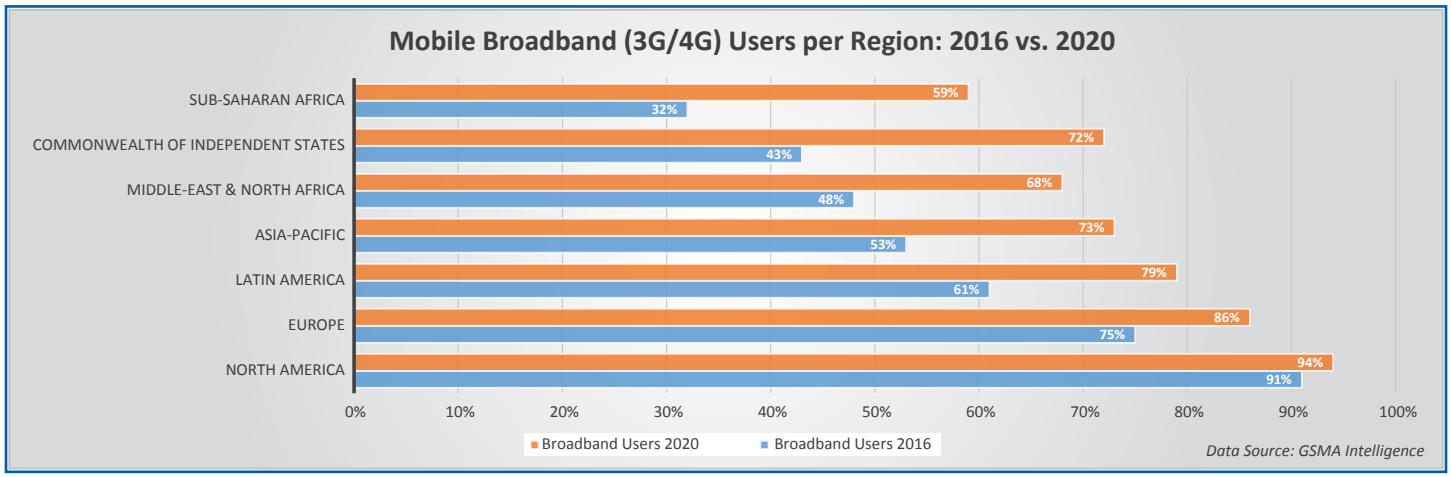
Current Market Trends: Rapid Global LTE Expansion

While 4G LTE has dominated cellular markets in developed countries, it is still in different stages of deployment around the world. According to the Cisco Virtual Network Index, 4G connections represented only 26% of mobile connections in 2016, yet accounted for 69% of mobile data traffic.



4G/LTE deployments 2012 vs. 2016

According to data compiled by GSMA Intelligence the below chart characterizes the remarkable growth of mobile broadband, specifically in the developing regions of Africa, CIS, Latin America and Asia-Pacific. Anticipating this increase in the number of mobile broadband subscribers, network operators need to strategize the deployment of 4G/LTE networks.

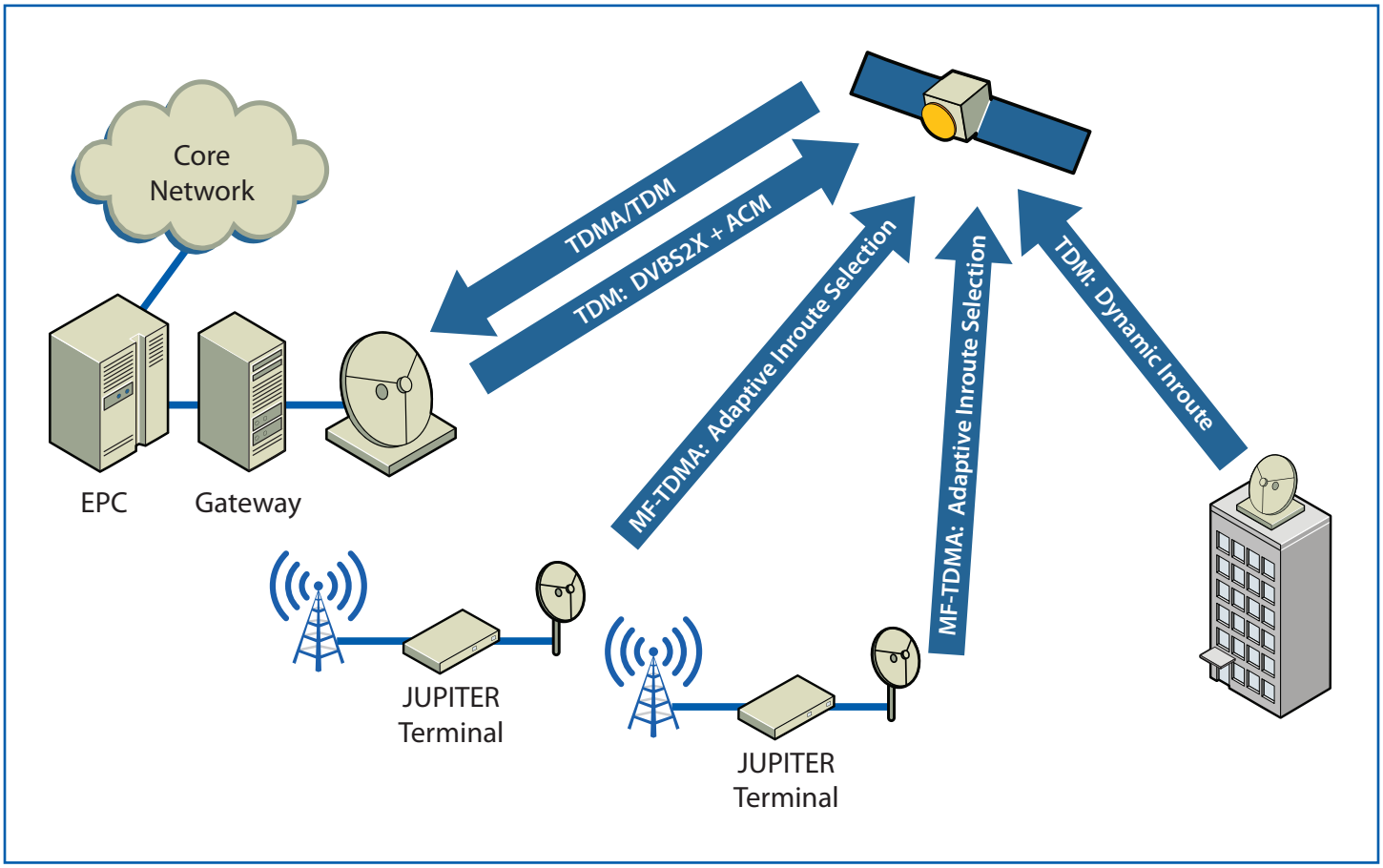


While steady overall, the growth of the cellular industry has been uneven in less dense areas, primarily due to unrealistic requirements or inaccessibility to economical backhaul systems. Northern Sky Research predicts that cellular backhaul will be one of the key contributors to the growth of the satellite industry in the coming years. More than 70,000 new sites are expected to be deployed and commissioned using satellite backhaul within the next 10 years, resulting in an annual growth rate of over 10%.

The Average Price per User (ARPU) in North America is about $50/month, whereas this number in developing nations is significantly lower due to various factors. Therefore, network operators must cope with the diminishing ARPUs and increasing user traffic volumes while delivering a great user experience. Furthermore, widespread 4G/LTE network deployment necessitates the need for high-capacity backhaul. Due to the abundantly available High-Throughput Satellite (HTS) capacity, the forecasted drop in its cost is substantial, thus creating an opportunity for network operators to economically roll out large-scale 4G/LTE networks.

JUPITER™ System for Cellular Backhaul

Identifying the difficulties faced by MNOs and aforementioned market demands, Hughes has developed a comprehensive, cost-effective solution to backhaul LTE traffic over satellite networks. Coupled with inexpensive satellite capacity, the JUPITER platform is a highly scalable system, tailored to provide cellular backhaul solutions over conventional and HTS networks. It encompasses a powerful satellite gateway that is seamlessly integrated into the packet core network, while embracing both the universally adopted access schemes—Single Channel per Carrier (SCPC) and Multiple Frequency - Time Division Multiple Access (MF-TDMA) on the return channels. Its versatility, highly scalable nature, low cost, and integrity with multiple radio access technologies makes the JUPITER System an ideal fit for MNOs to deploy 4G/LTE networks.



The JUPITER System supports dynamic TDM and MF-TDMA return channels

The JUPITER System supports more than 200 Mbps on the forward channel, 30 Mbps on MF-TDMA return channel and 50 Mbps on dynamic TDM return channels. The flexibility to switch between MF-TDMA and dynamic TDM on the return channel enables MNOs to accelerate network efficiency, thus making the JUPITER System ideal for LTE backhaul over satellite.

Access Technology: SCPC vs. MF-TDMA

Star topology VSATs, most of which use the DVB-S2X standard for the forward channel, are the most effective way to deliver satellite-based backhaul for cellular systems. To date, many of the global implementations of satellite cellular backhaul have been implemented using dedicated (SCPC) return channel, owing to the fact that these networks have been primarily 2G and 3G. However, 4G/LTE traffic is dominated by Internet traffic, such as Web browsing, and these cell sites transport varying amounts of traffic throughout the day. This typically creates multiple busy hours where data traffic through a cell site fluctuates notably, hence, well-suited for MF-TDMA return links. On the JUPITER System, the MF-TDMA backhaul links constantly monitor the cell site traffic and adjust the satellite bandwidth assigned to a particular site. Any excess capacity on the return link is then made available to other cell sites, ensuring maximum utilization and efficiency at all times>

Cell sites with a steady and high volume of data traffic require dedicated bandwidth. Outside of usual business hours, these cell sites may have steady, but significantly lower traffic volumes. Such cell sites may be configured to use dynamic TDM return channels. The MNO can therefore configure either MF-TDMA or TDM return channels based on the real-time traffic volumes. Furthermore, while using a TDM return channel, the JUPITER System can dynamically adjust the channel bandwidth similar to MF-TDMA, resulting in better efficiency. Thus, an ideal VSAT cellular backhaul solution would support both MF-TDMA and dynamic TDM on the return channel.

The JUPITER System offers a full range of satellite-based RAN backhaul solutions, giving MNOs the freedom to leverage either TDM or MF-TDMA to efficiently manage data traffic and satellite bandwidth resulting in an economical system.

JUPITER: An Optimal Cellular Backhaul Solution

The JUPITER Cellular Backhaul System can be implemented in a variety of scenarios, including:

- **Traffic offloading:** Cellular networks in many countries may not have a well-connected fiber-optic backhaul network. This leaves MNOs to either rely on upgrades to existing T1/E1 links or microwave backhaul, compelling the operators to alleviate bandwidth limitations or interference issues. Therefore, cellular backhaul over satellite links facilitates the need for high bandwidth and an extremely short time to deploy.
- **Extending connectivity in rural areas:** Deploying wired backhaul over difficult terrain like forests, mountains, or deserts involves heavy investments and meticulous planning for mitigating interference for microwave backhaul. In contrast, a satellite backhaul solution can be deployed within no time and at a significantly low cost of ownership.
- **Cellular connectivity on wheels:** In the event of a huge public gathering, where existing cellular network capacity may be throttled, MNOs may choose to temporarily deploy eNodeB sites to handle the additional data traffic. Satellite backhaul enables rapid and easy commissioning of these temporary sites.

With a significantly lower CAPEX, and a short deployment time, the Hughes JUPITER Cellular Backhaul System incorporates advanced techniques to optimize the link between the eNodeB and the EPC, besides supporting the highest quality of service required for an LTE network, including: GPRS Tunneling Protocol (GTP) acceleration, payload and header compression, fast track processing, and jitter buffer that are especially designed to achieve low latency (600 ms) and jitter (10 ms).

A hierarchical and comprehensive Network Management System (NMS) enables network operators to easily manage their network through a Web-based graphical user interface. The JUPITER NMS is a part of the JUPITER Cellular Backhaul System and can manage thousands of remote terminals and seamlessly interface with external OSS/BSS. Besides network management, the JUPITER NMS enables MNOs to identify several KPIs, including voice/packet statistics, backhaul link availability, and reliability to optimize the network for a better user experience.

Powered with a high-performance yet cost-effective terminal, the JUPITER System supports seamless integration with a variety of RAN technologies from different RAN vendors. Utilizing a built-in GPS receiver and implementing IEEE1588 PTP, these terminals can achieve clock accuracy in the sub-microsecond range, making it ideal for handling data and call flows using satellite backhaul.

The JUPITER cellular backhaul terminal is specifically designed to backhaul 4G/LTE traffic with additional processing and memory to process thousands of packet sessions and support higher throughputs. The terminal comes in two packaging profiles: an indoor, rack-mountable unit that fits into a standard cabinet or an IP67-certified, all-outdoor enclosure. Both of these variants are available with AC and DC power inputs, support LTE acceleration, and can use either TDM or MF-TDMA return channels, thus making it a truly universal system>

JUPITER 4G/LTE Backhaul Gateway

JUPITER HT2500 Series Modem

JUPITER HT2600 Series Modem

Proprietary Statement

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