Where Fiber Fears to Trench

by O3b Networks

Bringing High Speed Access to New Frontiers with Medium Earth Orbit Satellite Technology

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MEO Satellite Widens the Space Highway

The first and most oft-mentioned concerns of ISPs using geostationary (GEO) satellite Trunking today are cost, followed by quality issues such as limited bandwidth. As a decision maker for an ISP in an emerging market context – without access to fiber – what if these long-standing issues could be significantly diminished, enabling business to grow to new heights? How much more could you accomplish if, for example, cost could be bumped to third or fouth position on the list of key considerations?

ISPs who are currently buying GEO or inclined orbit satellite services and supplying corporate, government and consumer customers, will soon have alternatives that bring Trunking to a whole new level – MEO (Medium Earth Orbit) Trunking. Why does MEO Trunking have such a huge potential impact on these markets? The answer is threefold: bandwidth, latency and cost.

Addressing all these factors is O3b Networks through its creation of a new satellite Trunking product called O3b*Trunk*. This service enable world-class business applications and offers ISPs access to new markets once unreachable due to price and lack of connectivity.

O3b*Trunk* – O3b Networks' IP Trunking

O3b*Trunk* is O3b's solution to the problems underserved ISPs face now and into the foreseeable future. What is an underserved ISP? It is an ISP in an emerging markets context, where fiber has yet to reach; where GEO and/or inclined orbit satellite are the source of bandwidth; and where demand is at least 50 Mbps, rising by at least 20-30% per year (likely more if more supply were available at less cost).

Underserved ISPs located in the +/- 45° latitude range who choose O3b*Trunk* will be able to provide cost-effective bandwidth, with high speed and low latency that is on par with fiber, to enable new applications at a cost of 30% less than inclined orbit satellite. The doors will open to world-class technology solutions built to serve this market specifically. (See Figure 1.)

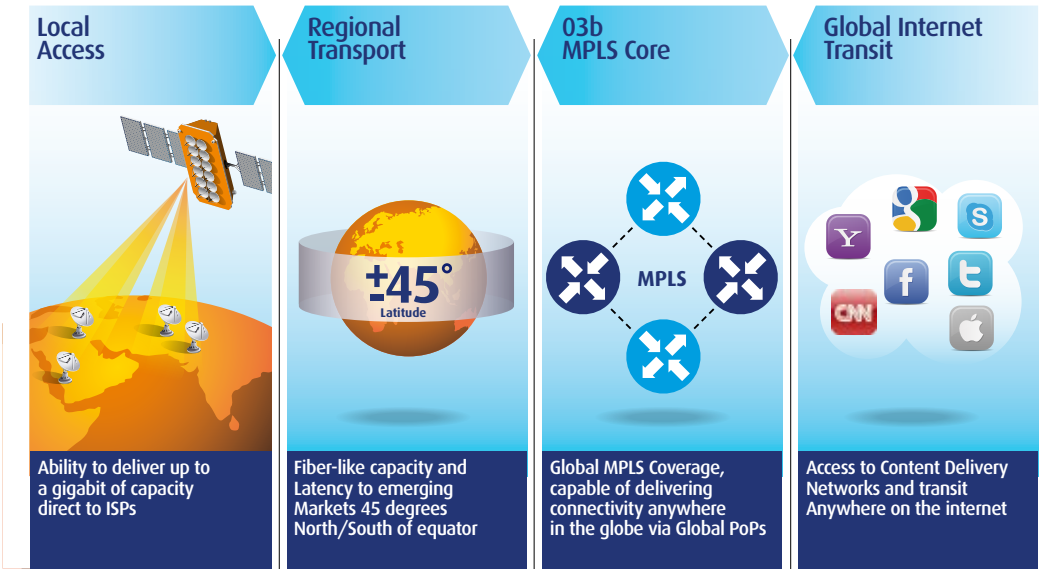

Figure 1: O3b*Trunk* Overview (Source: O3b Networks)

Building on a History of Satellite Innovation

Satellite technology has played a critical role in advancing telecommunications capabilities over more than 50 years. First used for elementary communications in 1958, satellite developments have brought radio, television, telephone, high-speed data, global positioning and other services. They have enabled millions of people worldwide to gain access to telecommunications services and benefit from the relatively low cost and broad coverage that satellites offer over other potential solutions.

O3b Networks has built on the successes of communication satellites over the last five decades by putting forward an innovative commercial solution. Where satellites have failed to deliver high-capacity, low-latency connectivity for IP Trunking in the past, O3b*Trunk* promises to deliver.

Year	Milestone in Satellite Functionality
1957	First successful man-made satellite launch – Sputnik 1
1958	Communications satellite – Project SCORE
1963	Satellite in geosynchronous orbit – Syncom 2
1964	Satellite in geostationary orbit – Syncom 3
1967	National TV network based on satellite – Orbita
1974	Direct broadcasting satellite – ATS-6
1974	Satellite communications relay network for spacecraft – ATS-6
1975	Satellite-to-satellite communications relay – AO-6 and AO-7
1976	Serial Direct-To-Home TV communication satellite - Ekran
1983	Full-time communications relay network for other spacecraft – TDRS-A
1997	Satellite for satellite telephone service – Iridium 1
2013*	O3b high-capacity, low-latency MEO satellites

Figure 2: Satellite Timeline (Source: HIP Consult analysis)

Applications Enabled

Due to the limitations of GEO satellites, O3b Networks is leveraging the capabilities of MEO satellites, which are commonly used for navigational purposes. Because of their greater proximity to the Earth, MEO satellites drastically reduce latency to only 150ms round trip times from at nearly 500ms for GEO satellites. Voice calls and video conferencing are more natural and allow for interactive conversations when the round trip time is less than 200ms. Many corporate business applications require 300ms or less to work properly, allowing O3b*Trunk* to succeed where GEO cannot.

Preferred Latency

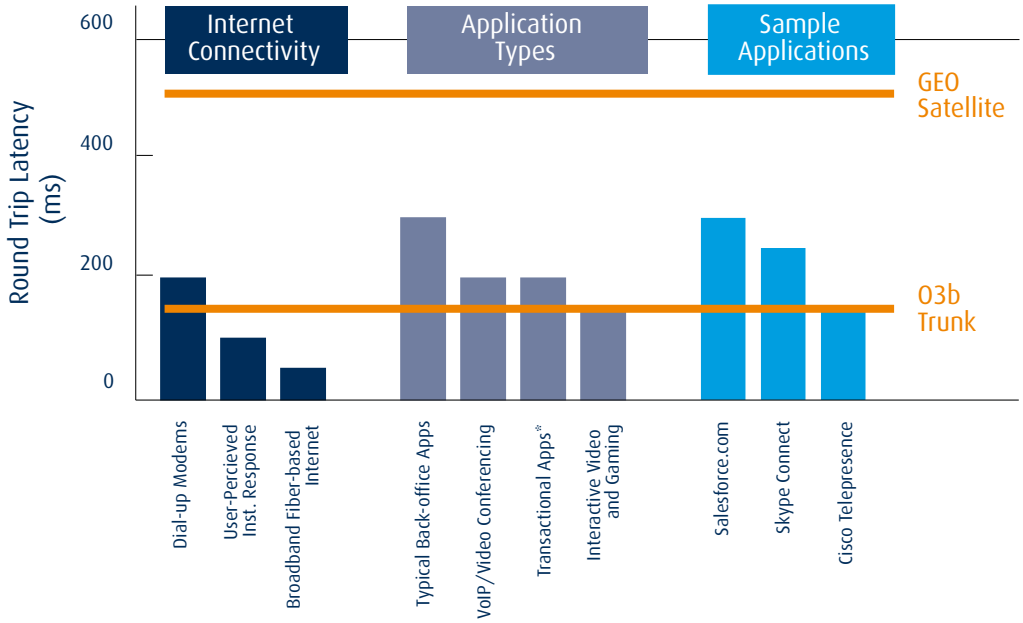

Figure 3: Application Latency Requirements (Sources: Applications documentation from Cisco, IBM, Nokia, Skype, Salesforce; HIP Consult analysis).

The Genesis of MEO

Medium Earth Orbit or MEO is a relatively newer term in the commercial satellite pantheon. An important differentiator for this type of satellite (and its accompanying IP Trunking solutions) is that it is designed to overcome many of the limitations of traditional GEO and inclined orbit satellite services. As such, O3b*Trunk* proposes high bandwidth, low latency (<150ms) and facilitates highly reliable private networks.

MEO satellites require transitions across a constellation of satellites in order to maintain continuous coverage, but their significant functional improvements by far compensate for this increase in complexity. Although a number of MEO configurations have been proposed in the past decade, the current O3b planned launch in 2013 is the only currently active MEO project for IP Trunking and will offer 70+ beams, of up to 1.2Gbps each, via 8 satellites to serve global IP Trunking, backhaul and redundancy needs.

Overcoming Traditional Satellite Limitations

Despite advances in satellite communications, criticisms exist, preventing currently available solutions from widespread adoption for some advanced services like IP Trunking. The commercial satellite market for IP Trunking today is dominated by several operators whose satellites operate in geostationary (GEO) orbit. GEO satellites offer the logistical advantage of remaining at the same point over the Earth at all times, enabling a single satellite to continuously serve a large geographic region. This benefit comes at a cost, however, as GEO satellites require a high altitude of over 35,000 km above the Earth in order to maintain their stationary position. This distance makes them unable to provide the low latency required by most business applications.

Newer satellite configurations, and more specifically MEO (Medium Earth Orbit) satellite IP Trunking, have significant, long-term areas of opportunity. Commercial launches of communications satellites have begun to rise again (see Figure 4) and are expected to reach new highs for 2011. Successful launches will backfill increased demand, creating greater bandwidth capacity globally.

Telecommunications carriers, ISPs and corporate network service providers rely on IP Trunking for wholesale, highspeed access to the Internet backbone. In terrestrially underserved areas, satellite IP Trunking is one of the most reliable means of supplying broadband access.

Successful Commercial Communications Satellite Launches

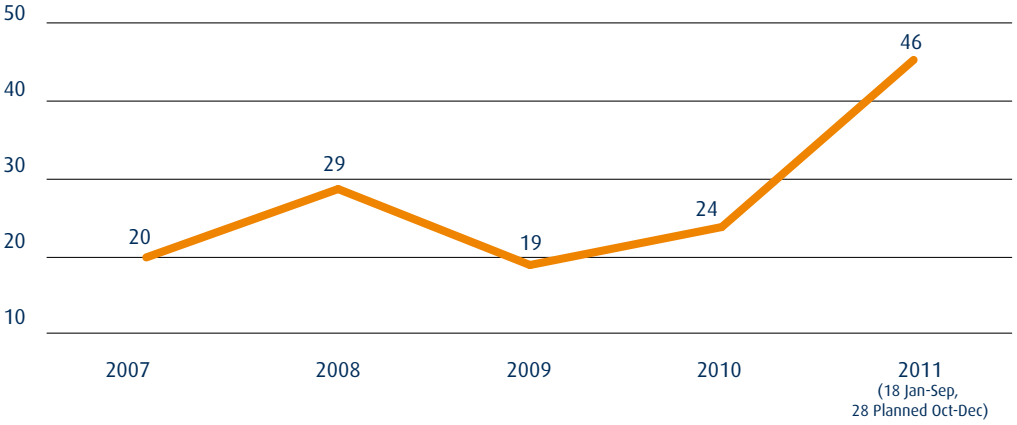

Figure 4: Successful Communication Launches (Sources: Microcom Systems UK, HIP Consult analysis)

O3b*Trunk's* high capacity beams targeted at narrow geographic regions enable it to provide customers with bandwidth of up to 1.2Gbps, an order of magnitude 10 – 20 times greater than standard IP Trunking offerings from GEO satellite providers. This greater scale enables O3b to meet the high demand of large customers while offering capacity at lower unit costs. On a per Mbps basis, O3b*Trunk* costs up to 68% less than standard GEO solutions, and enables customers to trade off between Capex and Opex expenditures based on their unique financial circumstances. O3b*Trunk* also provides standard redundancy capabilities, and mobile ground stations can be equipped for disaster recovery.

	Redundancy	Coverage	Speed/ Bandwidth	Latency/ Applications	Cost
GEO Satellites	Mechanical failures possible, but ubiquity limits impact	Depends on number of and direction of beams/ satellites	Bandwidth typically limited to 50 – 100Mbps	Typically >500ms, limiting the viability of many corporate and delay-sensitive services	Low relative Capex requirement, but Opex can be prohibitive
O3b*Trunk*	Built-in satellite redundancy	Targeted beam on selected zone (700km diameter)	High bandwidth available, offering up to 1.2Gbps/ beam	Low roundtrip latency of 150ms, superior to requirements of most applications	TCO focused on flexibility to the needs of customers for lower Capex or Opex

Figure 5: GEO v O3b*Trunk* (Sources: HIP Consult, O3b Networks)

Where Fiber Fears to Trench

A recent explosion in submarine fiber deployment has provided many emerging market countries with reliable connectivity for the first time. Submarine fiber has brought with it increased capacity and lower costs, allowing a previously unconnected population to gain internet, telephone, and/or mobile connectivity. Fiber is the first choice for many IP Trunking needs because of its virtually unlimited bandwidth, low latency levels and high degree of reliability. In many developed markets fiber networks have been extensively built out, making it easy and inexpensive to connect new sites or add capacity in business districts and population centers. The slower development of comprehensive networks in emerging markets, however, creates the need for alternative connectivity solutions.

In order for fiber to reach the masses, terrestrial fiber networks must develop and expand outward from submarine cable landing points, initiatives that are costly and often slow to materialize. Despite the fact that submarine cables target the most heavily populated areas to place landing stations in the case of Africa, only 4.4% of the population is within 25km of a landing station, while terrestrial networks reach a considerably larger portion of the population. Still, only 30.8% of Africans are currently within 25km of a terrestrial fiber node. Fiber and submarine cables have made giant strides in connecting people in emerging markets, but the high costs and long wait for expanding the network are leaving millions of potential customers without access.

	Percentage of the African Population		
	Within 10km	Within 25km	Within 50km
Operational Submarine Cable Landing Stations	1.8%	4.4%	5.9%
Planned Submarine Cable Landing Stations	2.5%	5.5%	7.2%
Operational Terrestral Fiber Node	15.6%	30.8%	47.7%
Planned Terrestrial Fiber Node	23.2%	46.1%	69.9%

Figure 6: Distances from Fiber Connections, Africa (Sources: Hamilton Research, HIP Consult analysis)

Connecting What Fiber Does Not or Cannot

Like many innovations, fiber for IP Trunking has wrought significant changes on the broadband internet market. The major limitations for fiber are all related directly or indirectly to cost and include (in order of relative importance): capital expendure on initial infrastructure, opportunity cost for lost business on lengthy implementations and fragility, whether for issues of normal maintenance or for damages from natural disasters or conflicts such as war. In addition, theft, third party damage (e.g., digging in the fiber trench), lack of good terresterial infrastructure such as electricity/power and access roads for maintenance commonly must be considered. Lastly, in the implementation category, there is a growing risk as governments can be slow to approve permits or may raise environmental issues that can delay implementations. All in all, the true total cost can add up to more than what is sensible for some locations and providers.

Satellites have a critical gap to fill. Maritime proximity is a requirement for submarine cable access, and terrestrial networks naturally develop outward from these hotspots of high bandwidth and reliable connectivity. Locations farther inland are at a disadvantage, as are second tier population centers and business districts. O3b satellites do not have this location dependency, and can quickly be installed to provide coverage to any point on the globe between 45°N and 45°S of the equator. Where fiber deployment costs increase as longer distances must be trenched from an existing point of connectivity, O3b*Trunk* has the same deployment cost regardless of location, making it competitive to or lower cost than fiber in many places.

Fiber Connectivity, Without the Fiber

Where satellite connectivity has typically resulted in service level compromises relative to fiber, O3b*Trunk* has addressed these gaps to provide fiber-comparable service quality. One of fiber's primary benefits, its low latency at under 100ms round trip, are nearly matched by O3b*Trunk*. This enables O3b*Trunk* to provide excellent connectivity to corporate applications, which exceeds the needs of most businesses. While fiber's ability to provide virtually unlimited bandwidth is optimal, O3b*Trunk's* 1.2Gbps offering meets all but the most high demand needs and can be expanded by purchasing multiple beams. O3b*Trunk* was designed to address the weaknesses of other satellite offerings and provides expanded coverage at a competitive price without degrading the functionalities of high quality IP Trunking.

Redundancy is an area where O3b*Trunk* is actually able to surpass fiber. Fiber deployments are vulnerable to infrastructure failures and broken cables that can take days or even weeks to repair, especially in the instance of submarine cables. This risk can be reduced by installing redundant fiber connections, but only at a significant increase in cost. O3b*Trunk's* risk of outage is minimal as its satellites have built-in redundancy.

	Redundancy	Coverage	Speed/ Bandwidth	Latency/ Applications	Cost
Fiber	Infrastructure failures such as damaged cables can cause extended outages	Extends to wherever the cable has been laid	Virtually unlimited bandwidth availability	Generally lowest of all available options at <100ms, but can be slowed by multiple switches on any round trip route	High Capex for infrastructure; can be prohibitive depending on terrain or other geopolitical conditions
O3b*Trunk*	Built in redundancy; mobile ground stations able to provide disaster recovery	Targeted beam on selected zone (700km diam.); can be adjusted	High bandwidth available, offering up to 1.2Gbps/ beam	Low roundtrip latency of 150ms; superior to the requirements of most applications	TCO focused on flexibility to the needs of customers for lower Capex or Opex

Figure 7: Fiber v O3b*Trunk* (Source: HIP Consult, O3b Networks)

O3b*Trunk* in the World Today

Regions with the most rapid growth in internet penetration are Africa and the Middle East, with nearly a billion people remaining to accessed, followed by Latin America and the Caribbean. Asia's internet growth is "lagging" in this cohort, with a 10 year growth rate of around 500%, versus 2,000% for the Middle East or 2,500% for Africa. Overall, the population remaining to go online is nearly 3 billion (See Figure 8.) O3b Networks' MEO satellites are poised to enable that growth in the many places fiber will not be present.

Scalability and Significant Bandwidth

In both satellite and fiber-served locations, usage has surged as inevitably users find outlets for more and better bandwidth capacity. This allows a provider to offer better service, or to expand the customer base, or both.

Most current satellite solutions are for fixed and relatively low amounts of bandwidth. They may meet some of the currently perceived market needs; albeit often at a cost per Mbps that is so high as to prohibit usage growth – even if more capacity were available. Where a bottleneck of bandwidth could continue, mounting pressures for commercial and consumer applications, alongside expectations for reasonable costs to end-users, seek an injection of new bandwidth supply. Fortunately O3b*Trunk* will soon be available to provide room for growth.

In addition, flexibility in planning for expanding bandwidth needs is important, though rare with current satellite services. Needing to service 50Mbps today and anticipating possible increases of 20-100% or more year-on-year are not unusual (see Figure 8), particularly in Asia, Africa and Latin America, which fall in the sweet spot of O3b's +/-45 degree latitude service area. Having the option to access burstable capacity and/or to build in for bandwidth expansion on demand are important considerations and key value-adds for O3b; where one beam can accommodate demand of up to 1.2 Gbps.

Internet Penetration Growth

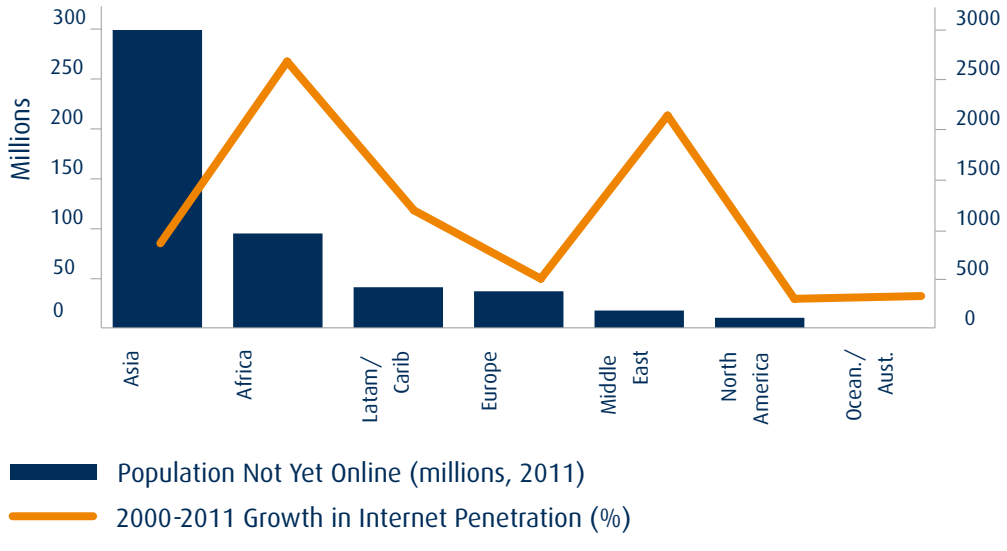

Figure 8: Internet Penetration Growth 2000-2011 and Remaining Non-User Populations (Sources: ITU, HIP Consult analysis)

NEDA – Afghani ISP's Plans for Long-term Growth

Afghanistan is not typically a place to look to for technological advances. Internet use in Afghanistan experienced average year-on-year growth of 33% between 2005 and 2010 (ITU data supplied by the Afghani Ministry of Communications for number of internet users per 100 inhabitants). While some segments of the market will await access for some time to come, business and government capacity needs can be assumed to be rising even more rapidly.

Figure 9: Beam Planning for MEO IP Trunking by O3b in Afghanistan. (Source: O3b Networks)

Due to the current lack of capacity for its national internet infrastructure, and expected growth with particular needs and requirements specific to countries in conflict, a national ISP has selected a shift to O3b's MEO Satellite IP Trunking as a solution. There are a number of reasons driving this decision. Highspeed is an anathema in the current GEO-provisioned Trunking scheme. The new service will provide growth up to 1.2Gbps per beam with a flexible bandwidth allocation that will allow better provisioning and scalability to changing needs.

Moreover, replacing GEO capacity with higher capacity Trunking gives this ISP a more secure (less risk of catastrophic damage than terrestrial options) and rapidly provisioned service. The anticipated new service will enable rollout of a national WiMAX network and extension of services to new regions – increasing market size and share. In a virtual monopoly situation, it may seem as though this ISP sits in the catbird seat. But in today's technology world, wise business people know that no one can claim that position for long without constant innovation. Bringing in this new capacity and speed ensure a longer period of time in which this ISP can hold off competition and generate profit.

Lost on this Island – Mayotte's Struggle with High Latency

On Mayotte (tiny neighbor to Madagascar) uploading pictures to Facebook is likely to be a process of hours, not minutes; one to leave running overnight in hopes it will have completed by the morning. In one instance, an internet user resorted to mailing CDs with files to a European relative for upload to make the process flow more efficiently.

Not only plagued by low bandwidth, this technology-isolated locale suffers from high latency on its only internet service – supplied via traditional satellite – routing through distant hubs even to send the next door neighbour an email. Fiber-like latency would mean this French territory's IP needs would be fulfilled much like they are back in France, impacting financial services, government and even schools and private enterprise.

IP Trunking Coverage in the Cook Islands

The Cook Islands is a collection of 15 islands in the Pacific Ocean scattered over 690,000 sq miles between French Polynesia and American Samoa. Long associated with New Zealand, this self-governing and independent country is far removed from the nearest undersea fiber linkages out of Australia, New Zealand or Chile. In fact, building fiber from any of these locations to Cook is estimated to be a $100m+ project. The overwhelmingly negative ROI on such a project means the islands are unlikely to ever see such a solution come their way in the estimation of local telecoms managers.

But that reality doesn't stop Internet users looking to the mainland and even to other well-connected regional islands and raising their hopes and expectations for highspeed service. Capacity at present is supplied primarily by GEO satellite at a high cost per Mbps; some capacity is delivered by inclined orbit at less cost than GEO but with an unwelcome level of instability. Even as a monopoly provider, the local telecommunications network which supplies what bandwidth it can at present, feels pressure for more efficient pricing and better service.

The vast geographic territory to be covered is also a major challenge for the Cook Islands. The islands cover an area equivalent to a country of the size of Sudan or Libya. Being able to target beams to the relevant coverage areas is something that is clearly easier to deal with via satellite than by submarine cable.

For these reasons and to meet the challenges of a demanding population at pricing that allows the provider to sell service at a profit, the long-term solution of MEO satellite IP Trunking has been chosen. This solution (to be provided by O3b) is slated to come in at 30% lower cost compared to inclined orbit; and when it comes online in 2013, will exceed the current needs, allow for scalable upgrades and future-proof this island nation for 21st century technology needs for the foreseeable future.

Banking on Banking Apps in Nigeria

Nigeria has been one of the greatest beneficiaries of fiber infrastructure in Africa. Despite multiple fiber deployments having been completed over the past few years, several regions in the country remain unconnected or underconnected to fiber networks. In the case of one Nigerian bank, enabling a private network was crucial but impossible on existing satellites due to the high latency.

With the low latency available from O3b, the bank can run its transaction-driven database applications – so the entire bank network can operate on the same platforms and with the same ability to conduct real-time transactions. At O3b*Trunk's* latency levels of 150ms or less, bank branches in remote locations can become more efficient and software driven, like their counterparts in the main cities, enabling better service levels for such well-connected banks so as to reach all their potential customers.

Of course, no amount of fiber infrastructure is relevant to a bank if the connections have not been extended out to the "last mile." Although fiber infrastructure is becoming more prevalent in urban centers in places like Nigeria, it still has quite a ways to go; making O3b's high bandwidth, low latency features highly relevant and very beneficial for at least the next 5-10 years.

Prepared for the Growing Demand

International bandwidth usage continues to see annual growth of 50% (see Figure 10). In some nearly saturated regions such as the US and Europe, growth will continue to slow. However, it is safe to assume the future will bring significant growth in underserved locations and that as more becomes available it will continue to be absorbed into the uses that have come to be expected and which require more bandwidth and speed.

For a growing provider of broadband voice and data services (ISP, BWA, or other) keeping up with and stoking demand is a primary concern. Client businesses expect their mission critical needs to be filled with top-notch service reliability. Consumers who are relatively new to having reliable service quality rapidly acquire a taste for it.

International Bandwidth Usage

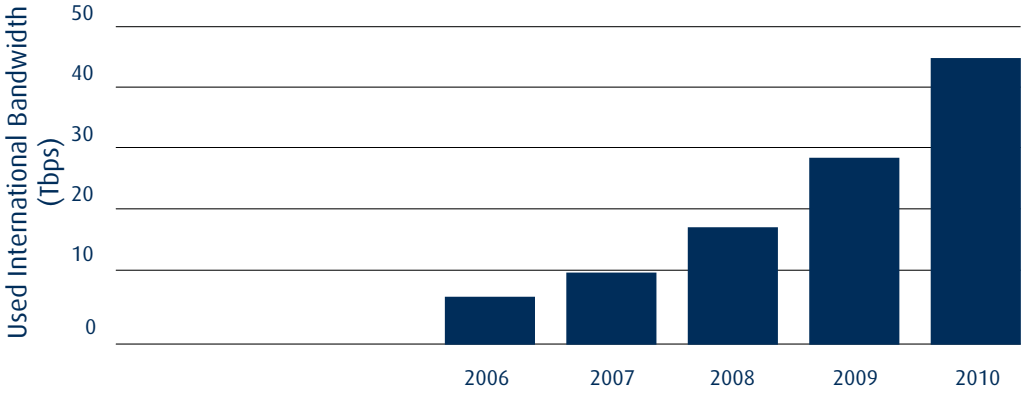

Figure 10: Growth in International Bandwidth Use 2006-2011 (Source: TeleGeography)

Once introduced to fast uploads, video streaming and other "first world" conveniences, everyone wants it: better, faster, cheaper. Take the example of Facebook: Indonesia has the second largest number of Facebook users worldwide, spend more hours per month than the average global user on the site; Vietnam's recent six-month user growth rate was over 100%.

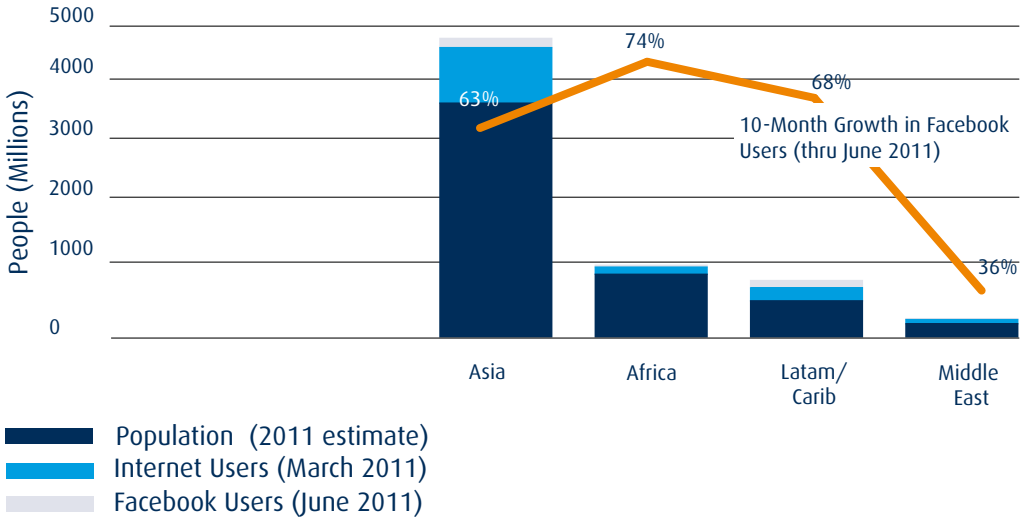

Figure 11: Facebook Growth and Potential Growth (Sources: Internet World Stats, HIP Consult analysis)

Growing with the expansion of digital consumption is advisable; waiting for these markets to mature is equivalent to letting the opportunity slip by. Though clearly adoption of social media is rapid, it has considerable room for growth in its fastest growing regions (See Figure 11).

At this point in time over a billion internet users have yet to access Facebook in these four regions. These estimates only increase as more internet users come online. It is not just users that are growing, but time spent online has been climbing as well. Globally, the average time spent on social media sites went from 2 hours in December 2007, to 3 hours in 2008, 5.5 hours in 2009, and is currently estimated at around 7 hours (Nielsen).

According to comScore's data for September 2011, disproportionately more time is spent on social networking than there are users connecting in the regions of Middle East/Africa and Latin America. These places are exceeding their "share" of use, indicating heavier usage patterns than their connectivity would suggest. The potential for Facebook illustrates the deep pool of use that has yet to be tapped.

While some internet access is via mobile devices, the growth and need for Trunking traffic for computer internet use remains clear and compelling (See Figure 12).

IP Trunking has a critical role to play in service delivery; enabling the expansion of transmission networks, backhaul and IP transit/peering. As a wholesale, end-to-end service, satellite IP Trunking gives providers direct, high-speed Internet backbone access – often the most direct path to a tier-1 IP point of presence. Overall, IP Trunking needs are slated to continue to rise with compounded annual growth of 17% through 2025.

Total International Trunking Traffic ('000 Gbps – 2008 – 2025)

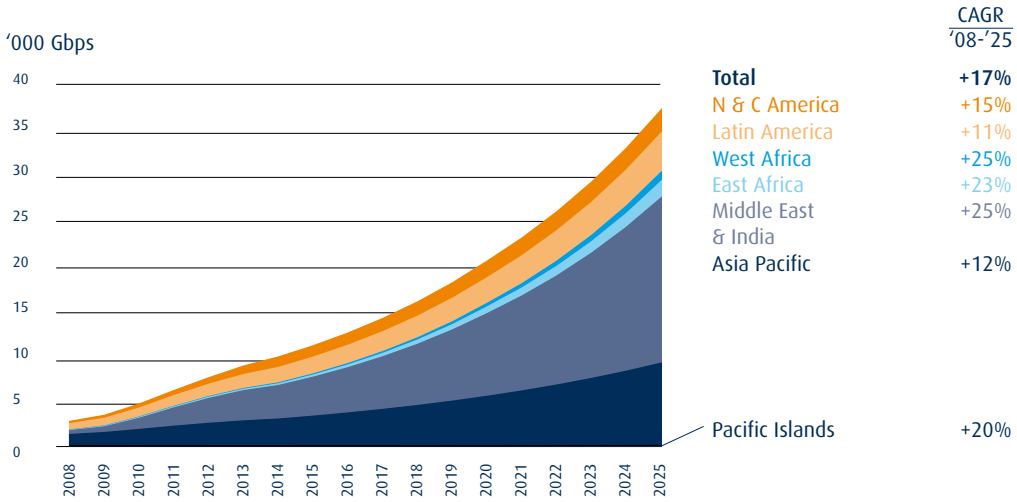

Figure 12: International Trunking Traffic Projections (Source: Booz & Co.)

03b Supports Internet Penetration and Trunking Traffic Growth

Contrary to what might have been assumed, the emerging markets context has already been supporting a broad and deep assortment of online user activities (See Figure 13.) Once internet access is there, the uses multiply. The application of this bandwidth to pent up consumer and business demand, awaits only its activation. With high speed, low latency bandwidth, at better cost structures than other satellite options, 03b*Trunk* supports the growth of internet traffic where it will be most needed. 03b*Trunk* will enable more users in your underserved regions to gain access to the Internet and to have a higher speed more interactive access to consumer, education, health and business applications. This will improve education and the delivery of health care to the populations in these regions and ultimately lead to economic improvement.

Internet User Activities (% of online users)	China	India	Brazil	Indonesia
Instant Messaging	87	67	61	58
Online Music	83	60	49	34
Reading news	80	61	47	47
Online Video	76	53	49	16
Online Gaming	55	54	44	35
Social Networks	33	23	69	58
Online Banking	26	–	–	5

Figure 13: Internet User Activities 2009 (Source: BCG)

Cost Effective Future Proofing

Historically, broadband demand has escalated rapidly when supply and service levels rise. Moreover, as noted, fiber is far from ubiquitous, and numerous locations are unlikely to see viable fiber infrastructure in place for the foreseeable future.

An ISP that is unable to meet the demand of customers for high speed, low latency services risks leaving money on the table and the door open to emergent technologies and competitors. Conversely, understanding how demand will grow enables providers such as ISPs to plan service to profitably meet new and existing customer needs. MEO satellite systems offer the possibility of fiber-like bandwidth and latency in locations that will remain underserved for the foreseeable future.

The need is clear for more reliable, easily implemented, and cost effective options for Trunking service. In simplest terms, more bandwidth at lower cost is what providers seek in their IP Trunking solution set. But as reviewed here, there is more to the story than purely bandwidth. Other needs must be addressed, such as coverage, latency, service restoration timing or total cost of ownership. With O3b*Trunk*, providers with demand for 50Mbps or more can be first movers in their markets, capturing share by offering high caliber highspeed bandwidth with fast implementation; ensuring their longevity for many years to come.