Broadband and the Role of Satellite Services

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Executive Summary

The deployment of broadband access in the US has fundamentally enhanced business productivity over the past decade. However, while such improvements will enable relevant applications at many enterprise sites, the lack of economical access to wired broadband resources at a significant number of facilities will pose a critical hindrance to business operations. Satellite will be essential to enable comprehensive broadband services with the performance required to support the mission-critical applications needed by corporate, SME, and SOHO markets. Next generation satellite platforms can service both competitive and underserved markets due to their ability to supply the substantial bandwidth at a fraction of the cost of current systems. Business cases illustrate the benefits conferred upon service providers and end users by these satellite platforms.

Introduction

There has been much talk about the “Digital Divide” among consumers where segments of society stand to be left out of the gains garnered by access to broadband Internet connectivity. However, little has been mentioned of a similar, more critical, gulf that is developing in the business world. This paper will examine US broadband application requirements, terrestrial broadband penetration, and the number of potentially disenfranchised businesses. Then, we will consider the value proposition of satellite broadband through business cases and economic comparisons. We will show satellite broadband to be essential in competitive and underserved markets. New satellite platforms will enable service providers (RBOCs, IXCs) cost-efficient solutions to service geographically disperse and multi-site markets.

Broadband Evolution and Satellite's Value

The penetration of broadband access and Internet-based applications in the United States over the past decade has fundamentally enhanced business productivity. In almost every sector - ranging from natural resources exploration to finance - reliable access to high-bandwidth services have enabled the timely sharing of critical information.

Private networks, even those considered now as narrowband, have provided communications solutions since the 1970s. Such systems have supplied Fortune 500 companies with the connectivity that is the precursor of today's broadband systems. For corporate America, such networks are indispensable and an expected part of the infrastructure. Large corporations have the means to develop such resources for both core and remote operations in order to maintain competitive position. In retail environments such as gas stations or automotive dealerships, where many sites needed to be networked simultaneously through a common network, satellite has traditionally provided an ideal solution.

Satellite has offered cheaper, more convenient, and more comprehensive solution; thus, it has been competitive in markets even where wired infrastructure had been well established. To illustrate this point, we compare the installed base of frame relay and satellite based networks in the US. In 2003, the number of fractional T1 and 56/64 kbps frame relay ports are estimated to be about 1.1 million[1]. Satellite networks (VSATs) serviced about 230,000 2-way narrowband business sites[2] in the US in the same year (2003). So about 17% of data services is provided through satellite today.

With the proliferation of broadband applications, the need for comprehensive broadband infrastructure becomes critical. As narrowband satellite provided complete solutions in the past, broadband satellite will address those needs and markets in the future. While current generation satellites can support broadband, they cannot supply the capacity at the cost structure required. Next generation (Ka-band) satellites will supply much more bandwidth and flexibility at a lower cost. In fact, since the cost to provide universal broadband coverage via wireline is so exorbitant, Ka-band satellite stands to be competitive in a significant market. Business cases and comparisons in forthcoming sections will support these assertions.

Largely due to economics, smaller businesses (SME and SOHO) have been slower to adopt broadband services. Many companies in the SME and SOHO category have not been able to justify the cost of a T1, full or fractional. For them, there had existed a bandwidth gap that has only recently been closed by DSL in some regions. But DSL is not uniformly available at business quality because the maximum achievable data rate is dependent upon distance from the central office (CO). Hence, many businesses, even those that are "covered" by DSL, stand to be disenfranchised because this broadband gap cannot be economically addressed in the absence of satellite.

Business Applications and Demands

The evolution of broadband has facilitated the immediacy and vastness of information communicated. Having a "bigger pipe" allows a great number of small messages (e-mail, instant messages) to be conveyed simultaneously AND information dense material (databases, video) to be shared. The existence of broadband enables high-bandwidth applications, which foment the need for ubiquitous broadband. This symbiosis enables eCommerce and drives business productivity. However, such productivity gains can only be maintained if network performance is relatively uniform; in short, having a weak link harms not only the businesses that do not have adequate access, but also aggregate productivity. All business will eventually be affected if broadband connectivity is not universal.

Listed below are applications that are commonly utilized in the business environment, along with their requirements. Applications that are most often utilized are not dependant upon rapid response times or symmetry requirements. Broadband, however, is absolutely required and businesses that do not have access to adequate bandwidth will be disadvantaged. Also, with proper latency and jitter management, Voice and video applications can be supported through satellite.

Table 1: Application Requirements

Application	Frequency of Usage	Minimum Bandwidth Requirements	Response Time[3]	Real Time	Symmetry
Email (no attachments)	High	16 kbps	Not real time	N	Y
VPN/Intranet Access	High	512 kbps	5-10 seconds	Y	Y
Internet, Browsing	Med	256 kbps	5-10 seconds	Y	N
File transfer[4]	Med	512 kbps	Not real time	N	N
Instant Messaging	Low	16 kbps	< 5 seconds	Y	N
Videocasting (1-way)	Low	384 kbps	< 1 second	Y	N
VoIP	Low	16 kbps	<200 ms	Y	Y
Videoconferencing	Low	384 kbps	<200 – 500 ms	Y	Y

Source: Frost & Sullivan

The bandwidth requirements for applications listed in Table 1 are sufficient to provide an adequate user experience for a single workstation. Obviously, sites with more employees would require a higher aggregate bandwidth since access is shared and there is internal contention. The ratio is not linear because statistical multiplexing enables adequate performance. The key factors that determine capacity required are burst rate and duty cycle (activity ratio). For small branch offices, SME and SOHO, 512 kbps or higher will provide the desired performance, provided external contention is limited.

For vertical markets, there are certain applications that are considered to be "must-haves." They are summarized below. Common to all sectors is the need to support file transfer, internal network access, and email. Less important is the need to provide video and VoIP, and general Internet access. In our assessment, interlinking with suppliers, distributors, etc. is classified as "Intranet/VPN"

Table 2: Applications by Industry Sector

Vertical	Email	File Transfer	Internet	Intranet/VPN	VoIP	Video
Manufacturing	Y	Y	N	Y	N	Y
Oil/Gas Mining	Y	Y	N	Y	N	Y
Financial	Y	Y	Y	Y	N	N
Medical	Y	Y	Y	Y	N	Y
Government	Y	Y	Y	Y	Y	Y
Military	Y	Y	N	Y	Y	Y
Warehousing	Y	Y	N	Y	N	N
Transportation	Y	Y	N	Y	N	N
Retail	N	Y	N	Y	N	N

Source: Frost & Sullivan

Terrestrial Broadband Penetration

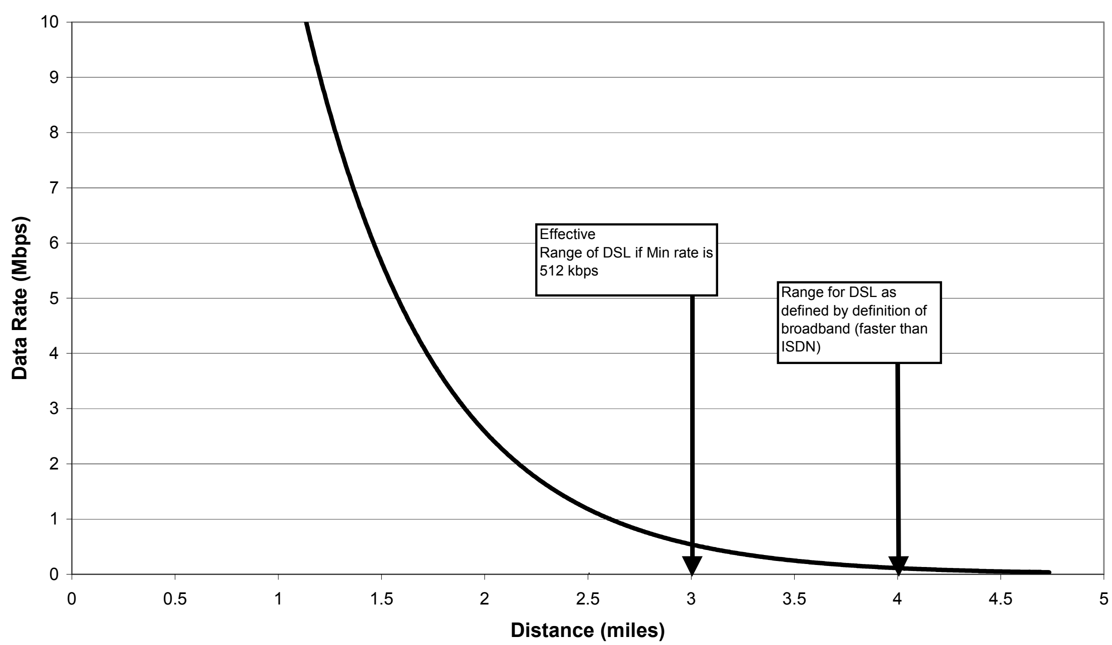
Cable Broadband

Cable Internet coverage in the US approaches 80% of households[5] and has largely reached the limit of economically viable rollout given today's technology. MSO's have spent billions to upgrade outside plant with hybrid fiber coax (HFC) to enable broadband connectivity to locations where the residential population density can support cable Internet revenues. Cable Internet is not typically deployed in business districts. Hence, while 80% of households may have access to cable Internet, coverage of the businesses is much lower. Commercial and residential zones are separated; the overlap is less than 30%[6], especially for lower density areas. For the capital that it would take to bring HFC plant to most businesses, it would be more viable to run optical fiber and provide OC-X bandwidth straight to the curb; but optical connectivity to the business site is exorbitant and inaccessible by all except the most well capitalized firms. While there is an effort to supply tiered service, cable broadband, with its bundled video distribution and relatively high oversubscription, is not presently engineered to serve the business market.

Digital Subscriber Line

Historically, digital subscriber line (DSL) coverage has developed more slowly than cable Internet in the US. But since the operators have focused more on the business markets, DSL is more available to the small business markets than cable broadband. The main motivation of RBOC's drive to provide DSL coverage to business is to capture a share of the market that cannot be captured by T1 based solutions. The cost-benefit for an operator deploying DSL depends on user density and penetration. While DSL can be delivered using a single twisted pair, the peak rate supported is distance dependent. In general DSL coverage area is defined by the lowest common rate (IDSL). But, if business class DSL is defined at a minimum peak rate of 512 kbps, then coverage drops considerably. The chart below illustrates the range vs. data rate relationship for DSL.

Figure 1: Data Rate vs. Distance for DSL

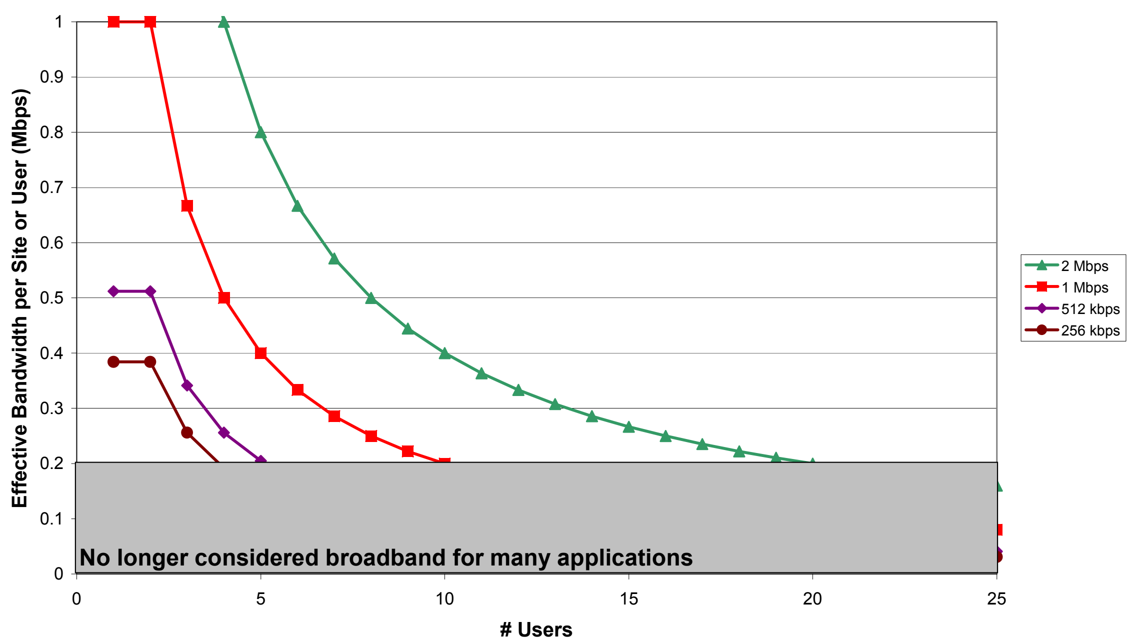


Source: Frost & Sullivan

DSL coverage is defined by the number of sites that can be serviced, not by geography. Sites that are located in lightly populated areas are less likely to be within service area. For example, more than 90% of higher tier markets may be covered, but lower tiered markets only have coverage of 40% to 60%. In general, rural regions have penetration rates of about 4% to 5%, about 10% of covered areas.

While DSL (at all rates) is expected to provide coverage to 70 to 80% of business sites, many of those sites will only receive the minimal rate of 144 kbps, much less than the 512 kbps that is required to service business-class sites. Figure 2 below represents the allocated bandwidth with contention either due to oversubscription or to multiple users, with a 50% chance of usage overlap. If the minimum peak bandwidth is insufficient to support a number of simultaneous users, then the service cannot support crucial business applications. Therefore, to be realistic, we define business class DSL coverage at 512 kbps, which reduces the effective coverage to just over 50%. This means that over 40% of businesses will not have access to useful broadband given the average SME establishment has over 5 employees.

Figure 2: Data Rate vs. Number of Users

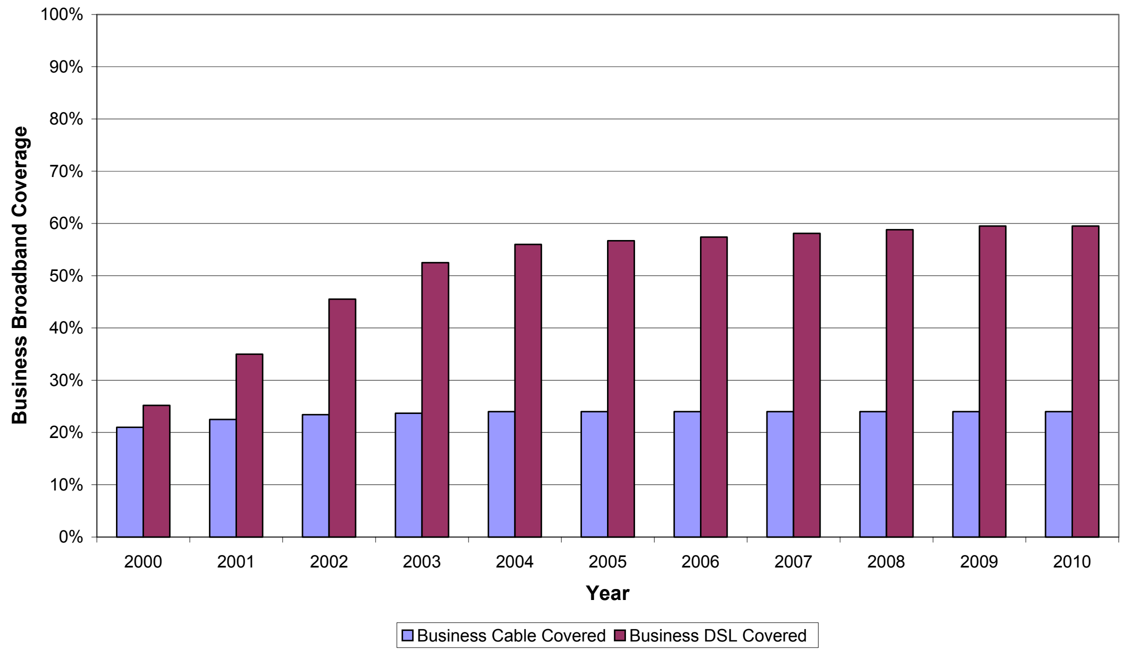


Source: Frost & Sullivan

Communications Gap and Satellite Market Potential

Wireline broadband coverage and penetration is shown in Figures 3 and 4. Of the over 7M business establishments in the US, more than 40% cannot be addressed by terrestrial business grade broadband (defined as 512 kbps or better). This represents a total satellite market potential of about 3 Million in the underserved market. Wireline solutions require certain population density before it pays to establish facilities. Moreover, for DSL it is important for the operator to know where there will be sufficient uptake to justify the cost of upgrade. Thus, lack of supply is largely responsible for this gap.

Figure 3: Cable and DSL Business Coverage

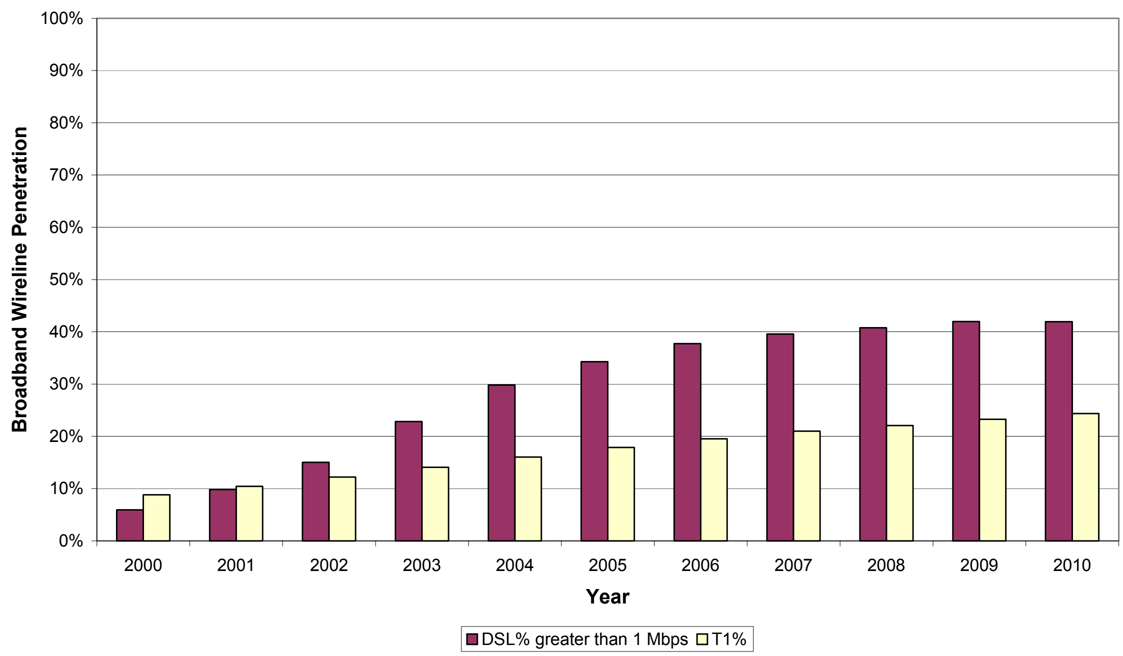


Source: Frost & Sullivan

Of these underserved customers, the adoption will largely be based upon availability and cost. The ability to provide coverage and effectively provide service at a wide range of subscriber density is key to success. It is here that next generation satellite shines in comparison with wireline. Satellite broadband removes much of the uptake distribution risk by economically providing enormous geographical coverage. This will allow operators and service providers to address a large market with relatively little upfront investment, as the business case analysis in the forthcoming section will show.

Of the more than 4 million businesses that have or will have access to wired broadband, there is a segment that will use satellite because of its inherent advantages. These likely customers will number about 250,000, conservatively[7], using the current satellite user base as reference and the rest is upside. As multicast solutions become mainstream, there will be relative shift toward satellite access. Add to that the 30% of the segment (assuming that RDSLAM solutions drop in price and terrestrial wireless becomes competitive) that is not addressed by terrestrial connectivity of 512 kbps or better, and the market is sized at over 1 million for next generation broadband satellite solutions.

Figure 4: DSL and T1 Projections in the US

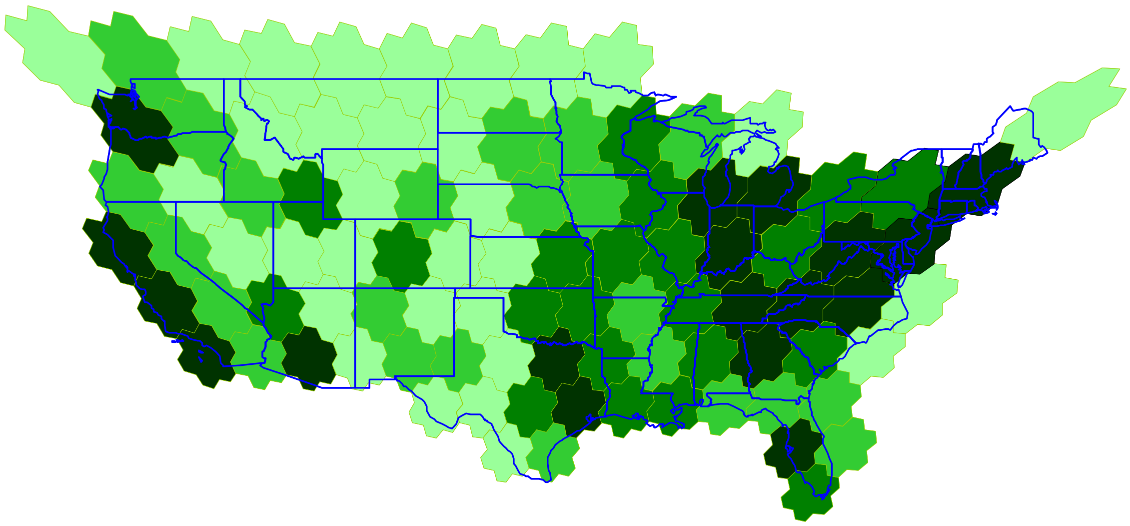


Source: Frost & Sullivan

Satellite Solutions

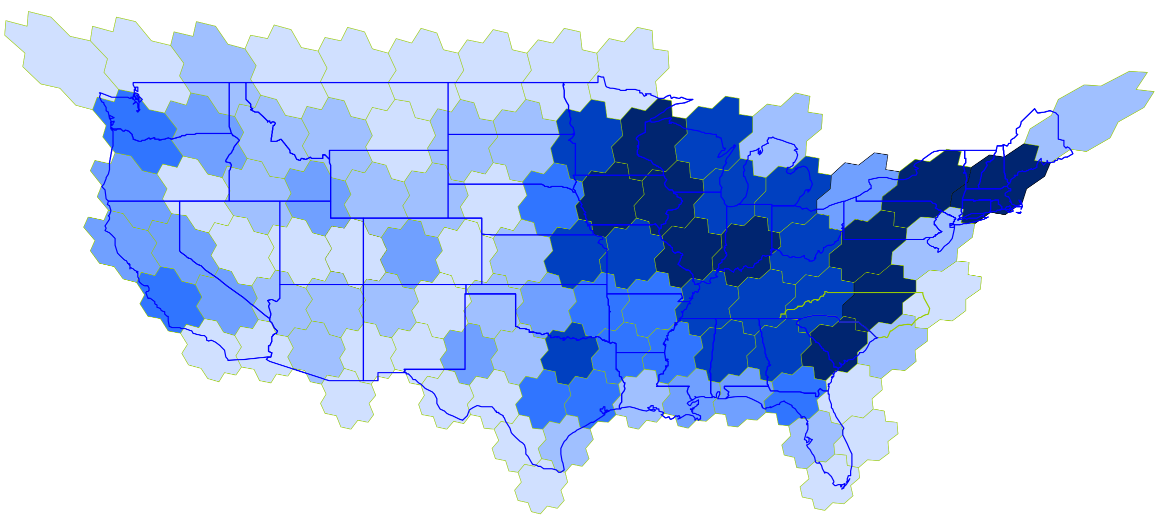
Satellite solutions are competitive with terrestrial services when taking into account applications and coordination of multiple service agreements. Satellite is complementary to landline services in regions with low corporate density. Today's corporate networks, even in areas of high wireline availability, continue to utilize satellite solutions because of ease and cost of acquisition and coordination. Satellite solutions enable connectivity for dispersed sites through a common carrier, eliminating the need for multiple, often disparate, service contracts and bills. More importantly, it supplies a common grade of service that is uniformly available to all sites so that applications run transparently and seamlessly. Shown below in Figures 5 and 6 (where density is represented by color saturation), it is evident that that satellite penetration tracks population (and business) density fairly well in the US. Satellite is not only a solution for the rural business, but an integral part of communications infrastructure for firms in general.

Figure 5: VSAT User Density



Source: Hughes Network Systems

Figure 6 Population Density



Source: Hughes Network Systems

So it is no surprise that broadband services via satellite will be similarly popular for the same reasons. Until recently, the key consideration has been the cost to provide such service. At low usage or penetration, Ku-band solutions are adequate to service the number of sites at a competitive level of service for business applications. Even then, the cost is high and out of reach of smaller businesses. As the need for bandwidth explodes, Ku-band platforms, as they have not been designed to provide service at the bandwidth density required by broadband users, cannot hope to supply the needs of the business community.

Ka-band satellite platforms are fundamentally different. Specific comparisons and technology-related explanations will be presented in the next section. For now, it suffices to say that because of architecture, Ka-band satellite can provide a much more bandwidth for a given geographical area than current platforms. Having a higher capacity allows the operator to provision more sites at a higher bandwidth. More importantly, Ka-band services can be structured to provide broadband packages that can offer virtually the same level of service as popular data networking technologies such as frame relay over landline. This provides both end users and service providers with a solution that is well understood and transparent.

Presented below are economic and performance metrics of business broadband access that are relevant for discussion in the business case analyses. Noteworthy is the fact that satellite bandwidth, contention, and service levels can be tailored to a business' exact requirements at a cost that is competitive.

Table 3: Wireline vs. Satellite Attributes

	T1	DSL	Satellite	Notes
Cost of Coverage	High	High	Low	Cost to enable (but not provision) service
Cost of Provisioning	High	Low	Medium	
Peak BW	1.5 Mbps	> 1 Mbps	> 1 Mbps	Business Class DSL Satellite solutions have various BW offerings
Contention	None	Yes	User Specified	Satellite can be provisioned like DSL or Frame Relay
Cost of Service	High	Low	Medium	Retail Pricing
Load Leveling	Not Required	Not Available	Yes	Landline assets are fixed determined by physical location
Support for Asymmetry	No	Yes	Yes	DSL and Satellite are available in symmetric and asymmetric configurations
Cost to coordinate multiple service contracts	High	High	Low	High for landline since site will each require a contract and SLA
Business Class SLA	Yes	No	Available	MTTR = ~ 4 hrs
Multicast Costs	High	High	Low	

Source: Frost & Sullivan

Metrics

Cost of Coverage – The capital expense that is required to provide potential service to a region. This is higher for landline because of outside plant costs.

Cost of Provisioning – The expenditure that is required to actually provision and establish service to a site. Typically lower for T1 in terms of $/Mbps but higher as a purchased unit because of dedicated bandwidth.

Peak Bandwidth – The peak bandwidth that can be supported under a given condition

Contention – Whether bandwidth is dedicated or allocated among a number of sites

Cost of service – Recurring monthly costs for providing service

Average Allocated Bandwidth – At a given contention, the amount of bandwidth that is available to a user if it were allocated equally

Load Leveling – The ability of a system to service variable traffic from sites by dynamically re-allocating bandwidth resources accordingly

Support for asymmetry – Ability of platform to provide asymmetrical rates since typical usage is asymmetrical. Asymmetry is defined as the ratio of downstream to upstream data bandwidth

Multisite coordination costs – The expense or opportunity cost involved in establishing multiple service contracts for multi-site operations.

Multicast costs – The additional expense of transmitting data to many sites via multicast

Business Cases

Business case for the operator: Broadband Coverage – Satellite vs. Wireline in "low density" regions.

Cost for coverage is low due to satellite's ability to cover a large area. Amortization of enterprise equipment is not relevant in a coverage scenario, since cost is only incurred upon customer acquisition. Satellite will always offer coverage at a lower cost than wireline. The main drawback of current satellite platforms is their inability to provide enough throughput to support high-data density usage. The architecture of Ka-band satellite addresses that issue. Geographical coverage using landline is not only costly, it carries with it an inordinate amount of risk, especially in low-density regions, where marketing campaigns are expensive and may not have the desired effect.

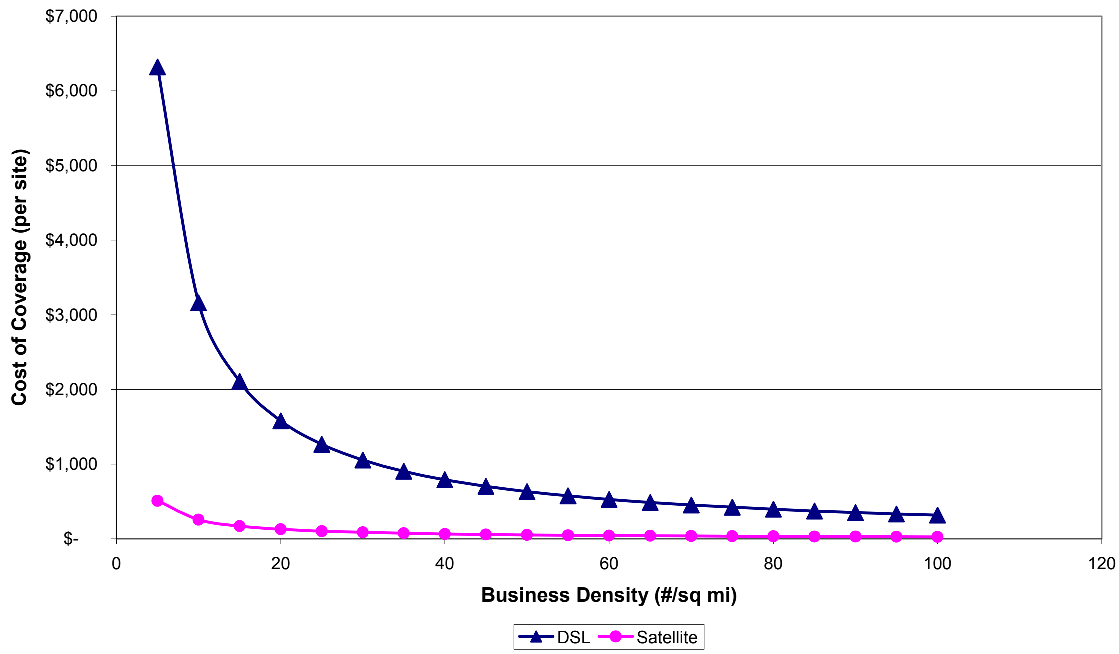
This case study compares Ka-Band satellite with a DSL deployment from an operators' perspective. The scenario involves an area of 1000 square miles of which 10% is populated with any significant business density. This model is in line with the fact that businesses tend to be clustered rather than uniformly distributed in a given area. The carrier faces two prospects: deploy DSL in the region to bring connectivity to the clusters; alternatively, the carrier could acquire satellite bandwidth to cover the same region. We assume that the operator acquires coverage rights at capital cost (per area) plus a 50% premium. In actuality, the bandwidth per region would be leased; however, we made the comparison based upon capital expense in the business case.

Table 4: Parameters for Coverage Cost

Parameter		Notes
Coverage Area`	1000	Square miles
% Occupied	10%	
Range	4	Per Remote DSLAM
Cost for R-DSLAM	$90,000	Per site
Cost for Line Upgrade	$200	Average per line
Cost for Backhaul	$50,000	Per mile
Cost, DSL Customer Premises Equipment	$100	
Satellite Cost	$600,000,000	Satellite + Ground System Cost
Area CONUS	3,537,000	Square miles
Cost per area	$254.45	$ Per Sq mile + 50%
Cost per CPE	$2,000	Satellite
Subscriber Penetration	20%	

Source: Frost & Sullivan

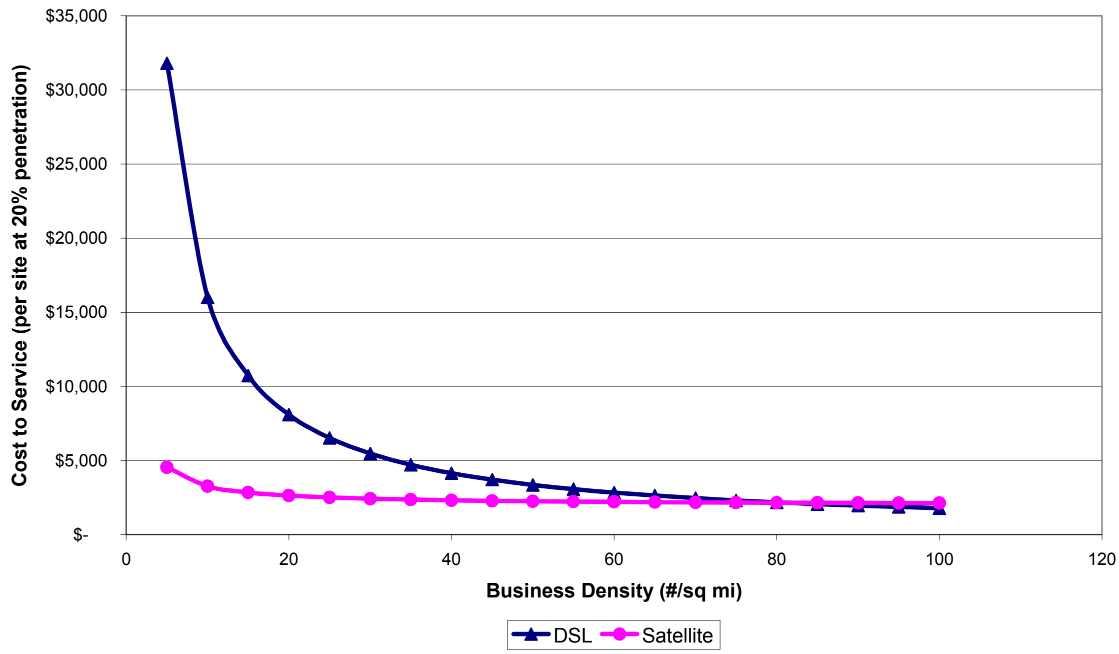
Figure 7: Cost for Coverage, DSL vs. Satellite



Source: Frost & Sullivan

Shown in Figure 7 is the cost of coverage vs. business density in the clusters. It is quite evident that market coverage is much less expensive using satellite. Even if location of demand is known in advance, it may still be more cost effective to provide satellite services if the density is insufficient. Figure 8 illustrates the cost to provision the site and the effective cost per site serviced at a 20% penetration[8]. As penetration rises, the allocated cost per site decreases. Even with an assumed installed satellite CPE price of $2,000, it is still less expensive to provide service in regions that are under a certain business density.

Figure 8: Cost to Provide Service, Wireline vs. Satellite



Source Frost & Sullivan

Business Case for the Enterprise: Multisite Solutions – Satellite vs. Terrestrial

The business case below considers the multisite firm when making a decision on whether to purchase satellite or terrestrial service. The business case assumes that there will be 1 headquarters site and a number of remote sites, 50% of which can get access to DSL and the remainder relying on private line access to a network service such as frame relay or IP-VPN.

The main office will be serviced with T1 level service in both cases. We assume that headquarters will have access to T1 type services at a competitive rate because of proximity to the central office. We are assuming half of the remote offices will have DSL at symmetrical 512 kbps, with the appropriate levels of contention. The other half will receive frame relay through a fractional T1 at 512 kbps peak and a CIR of 256 kbps. In the satellite option, all sites are serviced via a satellite network with symmetrical rates of 512 kbps. Presented below are the comparative costs for service and equipment. Note that the cost for remote offices on frame relay include loop and termination costs that are on the high side because these sites are relatively far from the CO, being outside the range of symmetrical 512 kbps DSL.

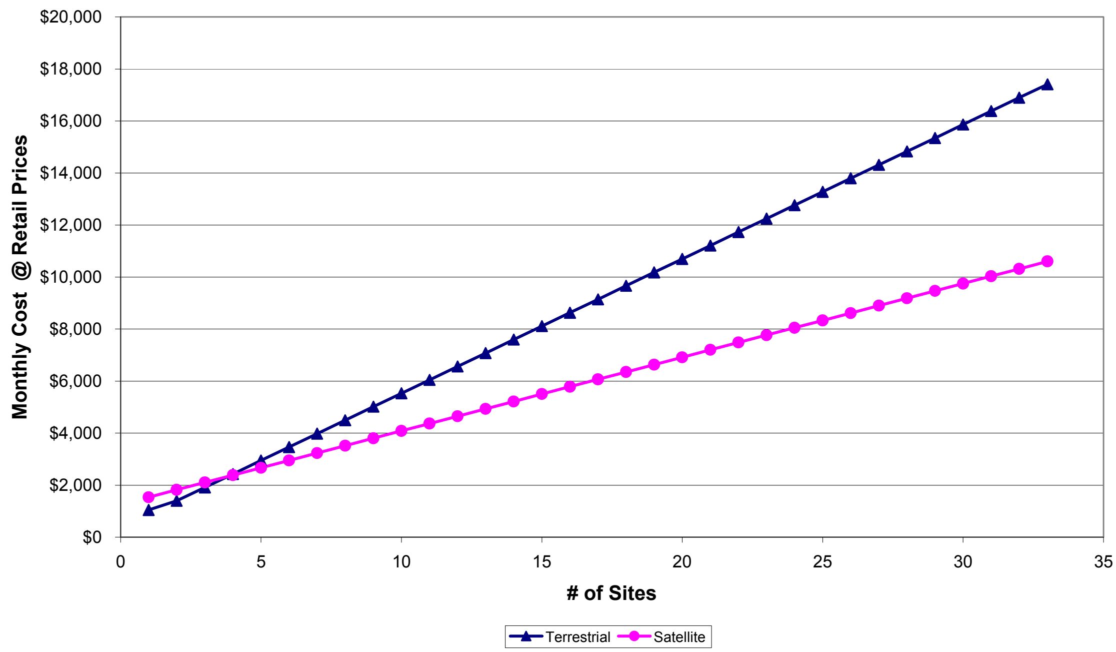
Table 5: Parameters, Multisite Case Study

DSL		
Bandwidth (Mbps)	0.512	Peak
Cost per CPE router	$1,000	
Cost per Month, Service	$175	512 kbps symmetrical service
Amortized Equipment Cost (monthly)	$17	5 yr depreciation
% of Sites	50%	
Frame Relay		
Bandwidth (Mbps)	0.512	Peak, with 256 kbps CIR
Frame Relay Access Equipment	$2,500	
Cost per Month, Service	$800	Estimated price, for remote sites
Cost per Month, Service	$1,000	Estimated price, T1 for HQ
Amortized Equipment Cost (monthly)	$42	
% of Sites	50%	
Satellite		
Bandwidth (Mbps)	0.512	For Remote Offices
Cost per CPE + Install	$2,000	
Cost per Month/Bandwidth	$250	Estimated price, 512 kbps, business grade
Cost per Month	$1,500	Estimated price, T1 Grade Service
Amortized Equipment Cost (monthly)	$33	5 year depreciation

Source: Frost & Sullivan

Satellite becomes significantly competitive at 5 sites and the accrual of benefits increases with the number of sites. This is still not taking into account coordination costs for applications and establishment of service, as well as ongoing maintenance and service support. While these costs may not be easy to substantiate, they do take their toll in terms of productivity and lost opportunity since headcount and hours (IT, purchasing, and legal) are inevitably involved.

Figure 9: Multisite Connectivity Costs, Wireline vs. DSL



Source: Frost & Sullivan

Ku band vs. Ka Band

The primary advantage of Ka over Ku band is not the frequency of operation but the architecture of the system whereby a given amount of bandwidth can be dynamically allocated to a greater number of beams, thereby improving frequency reuse and throughput. Also, because of the higher gain afforded by spot beams, more data can be transmitted in a given amount of frequency allocation. For example, new Ka-band satellites, such as Hughes' SPACEWAY, are being configured with up to 10 Gbps of capacity, which can be allocated among about many spot beams. In contrast, a typical Ku-band satellite may be configured with 20 transponders and 5 beams. Not only does a Ka-band platform have more total capacity, the capacity can be allocated for a higher bandwidth density. Table 6 below illustrates the essential differences between Ku- and Ka-band platforms.

Table 6: Ku-band vs. Ka-band Parameters

	Ku-Band	Ka-Band	Notes
Data Capacity (Mbps)	1,300[9]	10,000[10]	
Maximum Number of Users	25,000	200,000	512 kbps @ OS = 10
Normalized Cost	100%	150%	Satellite Cost Ratio
Normalized cost per Mbps or User	100%	20%	Cost for capacity

Source: Frost & Sullivan

The main point is that a single Ka-band satellite can provide service at a fraction of the cost of Ku-band. Moreover, while the a Ku-band satellite could only handle about 25,000 users with peak bandwidth of 512 kbps and an oversubscription of 10, Ka-band can service 200,000 users at the same rate and oversubscription.

Conclusions

Given that broadband connectivity will be de rigueur for businesses, the obstacles must be overcome reside largely on the supply side. As mentioned before, satellite had already demonstrated value in the enterprise even in regions where wired infrastructure is mature and inexpensive to acquire. Broadband satellite will be adopted for similar reasons. Ka-band satellite satisfies this market by providing bandwidth that can be effectively marketed. In other markets, where wired broadband is deficient in service quality or unavailable due to cost to provision, Ka-band satellite provides a solution that is less expensive and risky to deploy than wireline solutions. Satellite broadband will be an integral part of the telecommunications infrastructure.

Bridges the looming Digital Divide in the business environment

Satellite broadband enhances aggregate productivity by eliminating the weakest link and enabling common application usage among all firms, facilitating interconnectivity. Value of the entire network is enhanced when all players can communicate and exchange information on an equal basis. Next generation satellite can offer bandwidth at a cost that is a fraction of that of current satellites. This allows traditional carriers to address a market that they would not otherwise service and enhances business dynamics to enables alternative distribution models and partnerships. For the business client, operations are no longer beholden to wireline broadband enabled regions; this offers firms the flexibility to do business where resources are more plentiful.

Enhances competition in the marketplace

Satellite broadband is a product that can be offered by local and inter-office exchange carriers to supplement services and enable common connectivity with their corporate clients. As a complement to wireline, satellite enables many applications that cannot be provided as cost efficiently over terrestrial links. In SME and SOHO business markets, where there may be limited choice, next generation satellite broadband offers alternatives. By providing competitive solutions in the broadband market, satellite broadband creates an essential impetus for innovation, spawning new service offerings and value-added applications.

Author Biographies:

Gary Fong is a Telecommunications Industry Analyst with Frost and Sullivan. He has over 15 years of operational experience in the telecommunications, wireless, and semiconductor sectors. He has provided consulting services to business development and operations executives at wireless and chipset companies. Mr. Fong holds an MBA from UC Berkeley and technical graduate and undergraduate degrees from UCLA and USC.

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[1] Vertical Systems Group 2003 for Fractional T1 and 56/64 kbps Frame Relay

[2] Frost and Sullivan, narrowband satellite defined as 128 kbps or lower

[3] Latency has technical implications, response time reflects user expectations for the application

[4] Includes download of pictures, files, video, etc.

[5] NCTA

[6] City zoning maps, e.g. Los Angeles

[7] If narrowband satellite % of FT1/FR is used as proxy then this figure approaches 700,000

[8] As penetration rises, the allocated cost per site drops

[9] e.g., for 20 transponders at 54 MHz with 1.3 bps/Hz and 10% overhead

[10] e.g., for 50 transponders at 125 MHz with 1.8 bps/Hz and 10% overhead