The **comsys** VSAT Report

14th edition

Hughes
Market Summary & Company Profile

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The comsys VSAT Report

14th edition

Version 1.0

Market Summary & Company Profile

HUGHES™

COMSYS LLP
PO Box 65749, London, N13 9BW, England

Telephone: +44-1727-832288
Web: www.comsys.co.uk

"VSAT is Hughes and, in many ways, Hughes is VSAT"

"Market dominance of this magnitude does not come from doing things wrong"

"Hughes' presence casts a shadow over almost every player in the market. Its dominance of the enterprise VSAT industry is remarkable..."

"Hughes has stayed with the pace, generally making the right judgements and reading the market's demand better than its competitors"

"**The company lives and breathes the technology at all levels** from chipsets to installation, not least because it lays claim to have started the industry with its work in the early to late 1980s"

"For the potential purchaser, the fact that buying Hughes is rarely a mistake counts for a great deal."

"Hughes' achievement really has been monumental both on its own account and on behalf of the industry"

"Hughes has managed to achieve the virtually impossible"

"Hughes has managed to walk the tightrope between **innovation and proven reliability** which service providers in the enterprise business require to the exclusion of almost anything else"

"Hughes is the only company to have developed a platform that competes and wins at the highest and most specialised levels of the market as well as in the mass consumer business – this is achieved on a **single, unbelievably flexible operating platform**"

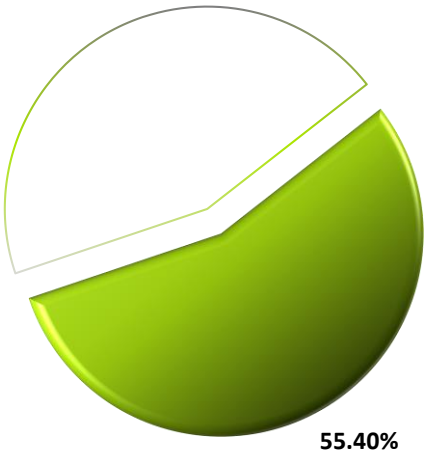
"Wal-Mart's adoption of a VSAT system from Hughes in 1983 was described by Fortune Magazine in June 2005 as one of the 20 "**epic decisions** [which] were breathtakingly smart" and made history"

"the first lesson for all other VSAT system vendors:
never take your eye off Hughes."

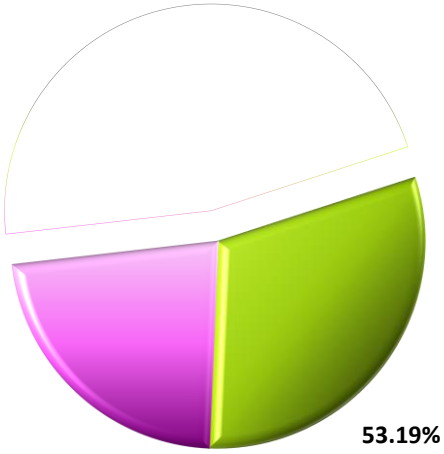
1. Hughes – The Company

1.1. Company Performance

Hughes is the 800 pound gorilla of the VSAT market and even the largest of the company's competitors generally try and work around it rather than go head-to-head. Those companies that let their attention wander or make the mistake that theirs is a segment Hughes has no interest in, get a rude awakening. The fact of the matter is that VSAT is Hughes and, in many ways, Hughes is VSAT. The company lives and breathes the technology at all levels from chipsets to installation not least because it lays claim to have started the industry with its early work in the early to late 1980s. As its positive financial results demonstrated every quarter since it went public in 2007 and until it was swallowed by EchoStar, what sets the company apart today and drives its growth is the service business. Beyond technology and product innovation, over the past several years Hughes has successfully morphed into being the leading broadband satellite service provider in North America, Europe, India and Brazil as well as supplying a growing list of operators and service provider customers in the rest of the world with its broadband technologies and products.

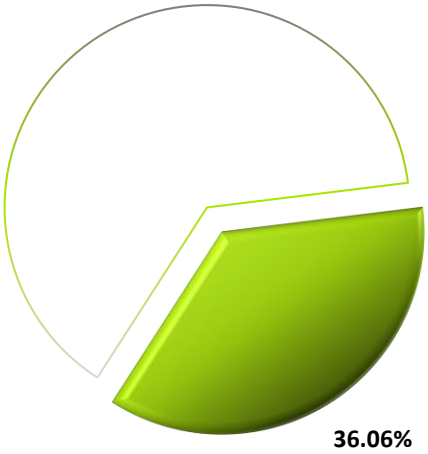


Shipped Enterprise Market Share, Historical

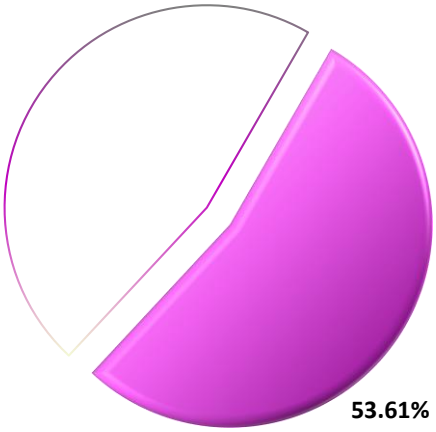


Shipped Consumer & Enterprise Market Share, Historical

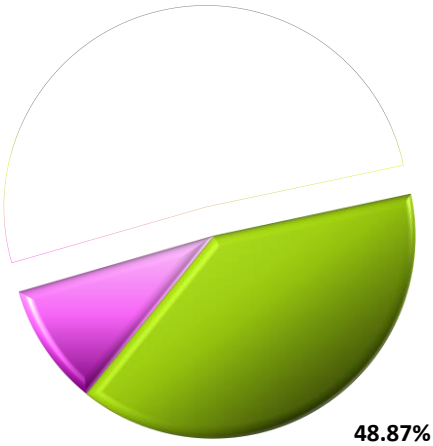
Hughes' presence casts a shadow over almost every player in the market. Its dominance of the enterprise VSAT industry is remarkable in the fact that the company has been able to sustain its lead for over twenty years and that it has rolled with the punches and constantly responded with new developments which has kept it at the forefront of an intensely competitive market. Customers purchase HNS VSAT systems because it is the market leader, understands competitive pricing and has cutting edge products, but also because there is a confidence that the company will always overcome any problems and the system will work reliably. Furthermore, being a leading service provider that uses its own products adds immeasurably to Hughes' advantage when operators are deciding on Hughes technology versus the competition. HNS has managed to walk the tightrope between innovation and proven reliability which service providers in the enterprise business require to the exclusion of almost anything else. The company has consistently beaten its competitors to the punch in terms of the delivery of new breakthroughs in technology – in mid-2016 it released the first DVB-S2X VSAT platform at least six months ahead of every other competitor. A few years ago its customers enjoyed a real head-start in efficiency when



Shipped Enterprise Market Share, 2015



Shipped Consumer Market Share, 2015



Shipped Consumer & Enterprise Market Share, 2015

the company hit the streets with the first DVB-S2 ACM platform, more than a year ahead of anyone else and there are examples of operators who gained a critical advantage in the market as a result.

Hughes is traditionally a very conservative company giving the impression that it simply plods along, but to believe this would be a mistake. It is finely in tune with the market and misses little. Looking back, its product releases either catch the wave or begin it in the first place and the engineering machine which lies at the core of the company is continually advancing the platform and introducing new features. Hughes is the only company which has been able to demonstrate sustained leadership in technology, market share and financial results in the VSAT business. Whereas GE, NEC, AT&T, GTE, Contel, Qualcomm and Scientific-Atlanta have all fallen by the wayside, HNS has powered on through both their successors as well as newcomers. This undoubtedly gives its customers a confidence which cannot be matched by others.

The challenge never abates, competition grows and the industry is of a size to allow innovation to have a substantial impact. This has always been good for Hughes and has led it to strive to develop both new technology and service-related features, reduce cost and move its products on. As a case in point this report covers more than 300 operators around the world and a significant proportion of them still employ one or more Hughes PES systems they acquired a dozen years or more ago. During the research for our last report we interviewed an operator that finally switched its PES platform off after over 20 years of service and, for the past ten years the hub had run flawlessly *without even a re-boot*. It would be all too easy to rely on this kind of longevity, but the success of the HughesNet service business has fuelled the high volume manufacturing and quick succession of new generations up to the current Jupiter System, thereby maintaining the company's 50 per cent historical market share during a time that the market has grown by a factor of four.

Hughes has consolidated its early lead in the satellite broadband Internet access market through its HughesNet service business with over a million consumer subscribers in North America by the end of 2016. Together with its

enterprise business the company has now manufactured and shipped over five million Hughes broadband terminals and, combined with the PES system, over 5.6 million units have been produced. This market is one which feeds on volume and, once again, Hughes stands head and shoulders above its rivals. It alone has highly successful service businesses across four continents that fuel its manufacturing arm and challenges its engineers to improve product performance and quality while driving down cost. The threat from the standards-based DVB-RCS system vendors has evaporated, but iDirect continues to be strong in the small network segment, Gilat remains extremely aggressive in the enterprise market and ViaSat is a focused and a very worthwhile competitor in the consumer market. All are credible competitors and, we would argue, essential to keeping Hughes on its toes, but it is interesting to note that in each different segment of the market, all these companies have the same thing in common – their biggest competitor is Hughes.

HNS has stayed with the pace, generally making the right judgements and reading the market's demands better than its competitors. The past two years have seen Hughes retain its position once more as the leader of the industry in terms of both shipments and orders. It recorded over a third of all enterprise VSAT shipments in 2015 and over half in 2014. Major sales included technology refresh deals, extensions and new networks with GTECH and the Digital Cinema Distribution Coalition in the US, MinTIC in Colombia, Bank of Baroda and the State Bank of India, Primacom in Indonesia, Vodacom in the DRC, Yahsat for AY3 over Africa, KB Iskra in Russia, Dexar in Turkey and many others. 2016 has also seen the company achieve a high degree of success with its latest Jupiter platform selling to the likes of KBZ Gateway and SeaNet in Myanmar, DirecTV and ARSAT in Argentina and PSN in Indonesia. Alongside all these deals, Hughes retains a very strong presence in the growing Ka-band market with the likes of Yahsat, Avanti, MNLA, Xplornet and RSCC.

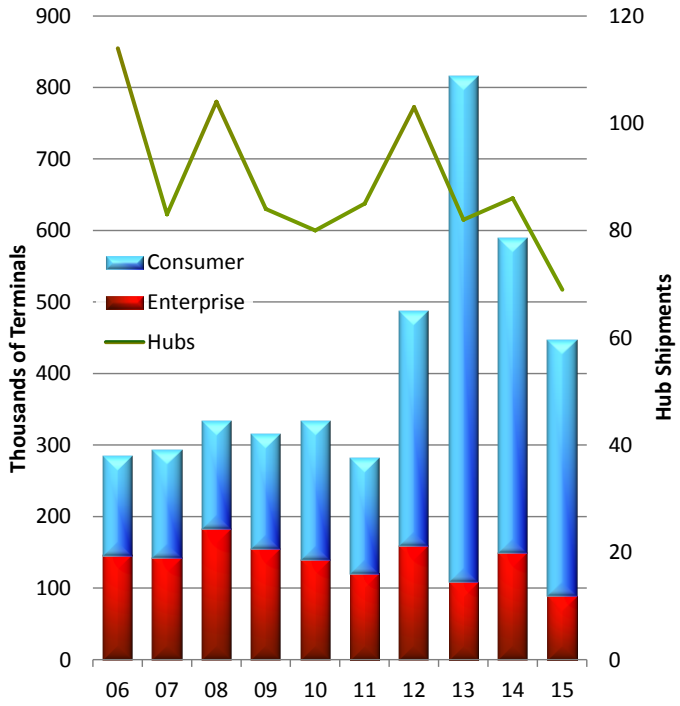


Figure 1 - Hughes Annual Terminal Bookings and Shipments

As the annual booking and shipment chart shows, the past two years have seen a decline in shipments primarily due to the increasing saturation of the Jupiter-1 satellite and the consequent slowdown in consumer sales. A similar situation can be seen in the two years prior to 2012 before Jupiter-1 came online and we are confident that the launch of Jupiter-2 (EchoStar XIX) with its 200 Gbps payload will result in another explosion of demand. Enterprise sales have been affected by increasing consumer sales outside Hughes' own HughesNet service – a few years ago only between 5 and 10 per cent of the company's international terminal shipments were consumer related, but in 2015 this shot up to 30 per cent.

The strongest regions for enterprise sales have been Asia, Europe/Russia and Latin America. Africa has suffered primarily as a result of exchange rate problems. The United States, once the biggest regional market for every vendor, has seen new sales decline slowly but surely as competition from terrestrial services has intensified. Hughes has countered this with its own hybrid enterprise offering and now has more than 50,000 terrestrial sites in service in the United States, but sees its latest Jupiter-2 based service as a strong augmentation solution for the increasing bandwidth demands seen in the enterprise segment and which cannot be met with DSL.

Three years ago, our last report lauded the fact that Hughes' gross monthly subscriber additions were in excess of 20,000 in 2012. Ironically, even with the decline in net subscriber additions since 2013, this number remains the same and in 2013 we believe it rose to an average higher than 50,000 new installations a month. For the VSAT business this is a massive amount – just for its own HughesNet service the company is manufacturing 50 per cent or more VSATs a month than its competitors manufacture in a year! Hughes is undoubtedly able to use this volume to help drive down manufacturing costs. However, the company is primarily focused on subscriber growth and this rose to over a million subscribers in the US by mid-2016 – another first for Hughes.

Hughes is the only vendor with both a strong hardware business and a large service operation with strength at all levels - technical, operational, sales and financial - to make a real difference in the VSAT and the satellite marketplace. It faces competition from many sides, but this is no different from how it has always been and now some of the newcomers need to look over their shoulders to see what's coming up behind them. Hughes is not blind to this and, in 2015, announced a $50 million investment in the OneWeb LEO initiative – a project that most believe is the most likely LEO project to succeed and for which Hughes is designing and building the gateway structure. Expected to work side by side in a complementary way with GEO services, OneWeb is an indication of how Hughes envisions the future and consistently strives to stay at the front of the curve. Over almost 30 years of reporting on Hughes' business, COMSYS has finished the assessment of the company's business with the same statement. Once again, we have no reason to change this because it is quite simply true - it is easy to criticise a market leader, but market dominance of this magnitude does not come from doing things wrong.

1.2. Company Additional Information

Commercial Factors:

HQ/Offices:	Germantown, Maryland	***Revenue:***	US$1.35 billion for hardware and services (2015)
Staff:	~2,250 inclusive of foreign operations and joint ventures	***Growth:***	5.1% in revenues 2014/15

Hughes Network Systems LLC (HNS) is a wholly-owned subsidiary of Hughes Communications Inc. (HCI), itself a wholly-owned subsidiary of EchoStar Corporation. EchoStar acquired Hughes – which had been traded on the NASDAQ, but substantially controlled by the Apollo private equity group – in February 2011 for $2 billion. EchoStar's primary business is the manufacture of digital television set-top boxes and is listed in the NASDAQ under the stock ticker SATS. The company is part of a group, which includes DISH network, controlled by Charlie Ergen. Apollo had acquired HNS through SkyTerra from the DirecTV Group, in a complex series of deals which finalised in November 2005. Since its formation more than 30 years ago, Hughes has had the same management team, virtually unbroken with the exception of a few retirements, even through all of the various transactions the company underwent between 2003 and 2011.

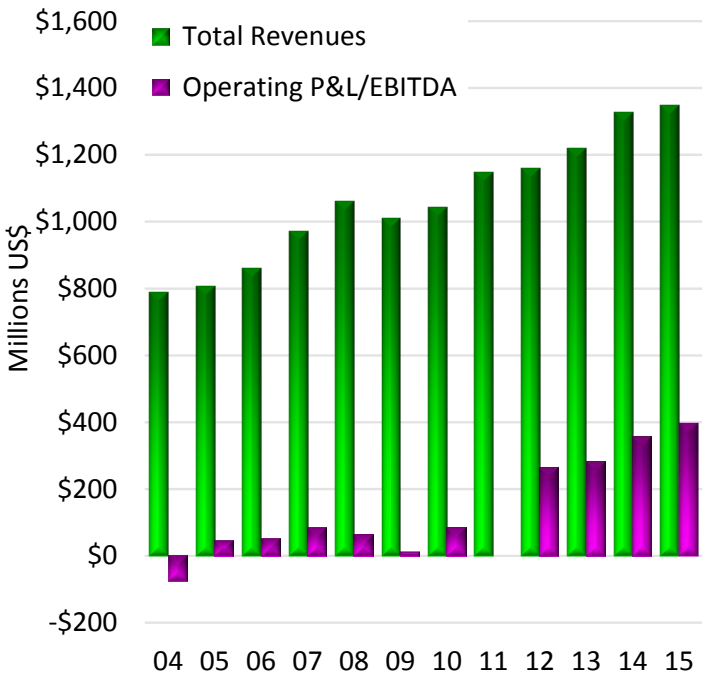


Figure 2 - HNS Annual Revenues and P&L, 2004-2015[1]

HNS describes itself as the world leader in broadband satellite networks and services, bridging the best in satellite and terrestrial technologies. The company has dominated the interactive VSAT business since the early 1980s when it was instrumental in developing the technology which created the industry. In 2002, before the sale of some its businesses, it had revenues of approximately $1.2 billion and employed more than 2,500 staff worldwide. Today, the company is primarily focused on VSAT design, manufacture and service and managed to break the billion dollar mark once again in 2008 and, most recently, recording revenues of $1.35 billion in 2015. In addition to its VSAT product lines, HNS also manufactures a range of carrier-class microwave systems and mobile satellite terminals, undertakes large scale technology development contracts and has interests in other software and services companies. The company is also the largest provider of shared hub

[1] P&L 2004-2010, EBITDA 2012-2015

VSAT services in the world with leading positions in the consumer and enterprise segments in the United States, in Europe through HNS Europe, in Latin America and Brazil through Hughes do Brasil and in Asia through its Hughes Communications India joint venture in India.

As part of General Motors little was known about Hughes' financial performance due to the fact that they were buried deep within its parent's results. As an independent company during the period 2002 to 2010, Hughes published trading results and a detailed breakdown of its business which showed impressive revenue growth from approximately $790 million in 2002 to $1.04 billion in 2010 and moved from an operating loss of $75 million to a profit of over $85 million. Under EchoStar, Hughes' results are no longer broken out in the same detail, but the data that is reported clearly shows that the business continues to grow strongly and the company has essentially become the mainstay of EchoStar's business since the acquisition. The following tables and charts give a breakdown of the company's historical financial results.

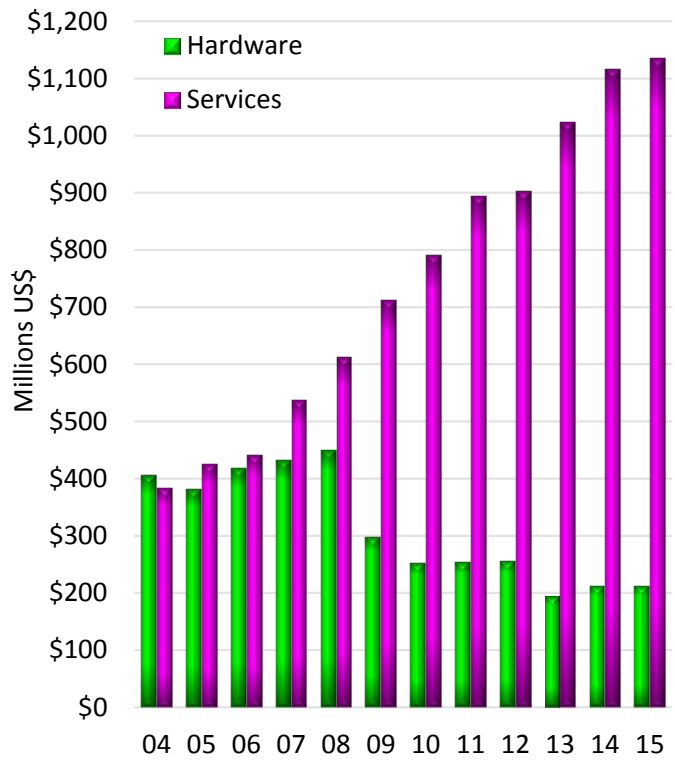


Figure 3 - HNS Hardware/Services Revenue Breakdown. 2004-2015

Since 2002 service versus hardware revenue has grown proportionately from just over 40 per cent to almost 85 per cent of the company's total revenues, reflecting a long term strategy to move the business in this direction.

Hughes quickly became the runaway global market leader of VSAT systems from the industry's inception in the mid-1980s. Its exploitation and dominance of the United States market over its initial growth period then gave it tremendous advantages when recruiting partners and selling systems abroad. Since 1988, all of the VSAT vendors have faced heavy price pressure which contributed to severe losses by several of the manufacturers and the withdrawal of big names including GTE, GE, AT&T, Scientific-Atlanta, Alcatel and NEC. As a result of its high volumes, Hughes has been in a better position than most to meet these price expectations head-on and to fund re-engineering developments which have enabled the company to stay one step ahead of the competition. In the late 1990s HNS began to invest heavily in developing its Spaceway Ka-band enterprise broadband platform. Before it sold HNS, DirecTV took the decision to keep the first two Spaceway satellites which were close to launch and convert them to broadcast platforms. The third spacecraft, then just beginning construction, was included as part of the sale and was successfully launched by Arianespace in August 2007 marking the end of the beginning of a ten year dream. Spaceway 3 was brought into commercial service in April of 2008 and now supports the HughesNet consumer service

business as well as some enterprise accounts. Times have changed and today Spaceway's 10 Gbps of capacity, which once seemed massive, will soon be only equivalent to five per cent of the new Jupiter-2 payload. Nevertheless, Spaceway supports an interesting onboard processing architecture able to shift capacity dynamically between beams and all user terminals are able to communicate directly in mesh configuration with traffic being switched and routed on-board the satellite. Some highly specialised applications continue to leverage Spaceway's capabilities, particularly military and government customers, but its overall role in Hughes' business has diminished substantially as the company's Jupiter strategy has taken hold.

As market leader, Hughes theoretically has greater price latitude than any of its competitors. It led the way by winning the vast majority of networks of more than 1,000 terminals with an aggression which was a major barrier to its competitors building up their market share. Up until the end of 2002, Hughes had won over half of all the contracts greater than 1,000 sites and accounted for eight of the ten largest corporate networks in service. Consistent with this legacy 2015 saw the company win almost half of the enterprise orders greater than 500 terminals in deals amounting to over 100,000 sites. The company has built a momentum in the corporate networking sector which is hard to challenge and in some areas, such as the gas/convenience store business, it almost monopolises the segment. This helps it build specialisation and recognition in a particular industry, gives it an advantage when bidding for that same company's business abroad and gives it a great reference list which inspires confidence in other potential customers.

Over the years the VSAT market has exhibited a domino-effect pattern as one segment of opportunity came to dominate demand for the technology with successive companies or projects following on one after the other. Sometimes this has been due to simple awareness or a lack of alternatives, such is the case with many of the government sponsored broadband networks for schools, but in others the competitive advantage one or more customers gained, forced rivals to adopt the same technology. The best example of this is one of the earliest – Wal-Mart – which deployed a network from Hughes across all of its stores in 1985. The edge that this gave the business was recognised by others in the US retail segment and over the following few years most of the major US chain store retailers also installed VSAT networks. Wal-Mart's innovative decision and the importance of Hughes' VSAT solution in the company's massive growth was recognised in 2005 by Fortune Magazine as one of the 20 key business decisions that made history.

In the ten years following Gilat's entry into the market in 1991, the big battle was between these two companies. Gilat effectively squeezed the other vendors out of the market, but had little effect on Hughes' position. However, there then began a period of upheaval as first Gilat found itself in dire financial straits following the telecom crash and then General Motors sold DirecTV, along with Hughes, to News Corporation. Gilat was forced into painful restructuring and Hughes found itself mired in a protracted sale of its business by News Corp. There was also a great deal of change in the VSAT market itself as first DVB-RCS was pitched as the logical alternative to the proprietary systems, then ViaSat emerged as a major player and then iDirect. IP and the Internet were not just important, they were almost everything and broadband (meaning high speed inroutes in that particular instance) suddenly became absolutely essential. Spaceway had been originally planned for deployment in 2002 and the company had been gearing up for this as the primary focus of

its next stage of business growth. The derailment of the project and the position of its product line left Hughes looking vulnerable, probably because it had been pre-occupied preparing for Spaceway. However, remarkably it managed to turn on a dime and produce the HN7000 less than a year after it lost Spaceway 1 and 2 when the satellites were kept by DirecTV. It was obvious that the next system took the product line to a different level and that its combination of performance, price and functionality was going to be hard to beat.

In the US, the enterprise market for hardware has transformed from a few key deals each year to incremental installations for backup and business continuity as part of a more hybrid solution. Many of the same segments of the market continue to account for the largest sales – gas/convenience, retail, casual dining and hospitality with only a few areas, such as lotteries and utilities, still focusing their use on primary networking. Customers signed or upgraded during the past two years included accounts such as Chevron, Sunoco Pipeline and Sears. The nature of the business has undoubtedly changed in several ways and the demand drive has shifted largely from transactional applications to high availability networking requirements and media applications involving a great deal more hybrid networking. The advent of satellite broadband services targeted at small businesses a few years ago took a while to find traction, but now Hughes makes a reasonable percentage of its sales through various value added resellers to the segment. Some of the larger, more specialised VARs, such as Brothers Media, focus on niche applications and have brought in a few networks which Hughes might not have been able to give enough attention to.

The casual dining industry has been the source of several large deals over the years and many of the largest fast food businesses have used the technology. Historically Hughes has served the likes of McDonalds, Burger King, Taco Bell, Jack-in-the-Box, Denny's and Carl's Jnr and several of these companies remain customers both for VSAT and terrestrial services. The majority are franchise deals with the corporation itself making one decision for its own sites (which are usually a small percentage of the total) and mandating both a DSL and a VSAT solution for the franchises to select themselves. Franchises generally have been a good prospect area for a few years now and have even been described as "the new majors" as parent corporations have moved to sell off their corporate sites. Hughes has performed well in this area, winning many of the largest deals. Once again, the fact that it is able to demonstrate so many reference accounts helps sales significantly.

In 2006 Hughes grasped the nettle and began offering a hybrid service which integrated DSL connectivity into the core VSAT network management and operations expertise which the company had developed over 20 years. Since then it has sold combined terrestrial-satellite services to a large range of customers, incorporating leased lines and wireless cellular services along the way. The company had begun to see many of its customers attracted by the high bandwidth and low cost of DSL solutions, which would often relegate it to the position of sub-contractor to a DSL aggregator, such as Megapath, or larger carrier. Worse still, some accounts would specify DSL providers only in their RFPs, effectively cutting VSAT service providers out of any direct contact with the account and a loss of customer ownership. The Optimized solution not only gave Hughes direct entry to these accounts, but it also gave the company a much better chance of showcasing its latest generation VSAT platform. The side effect of this was that some companies, which had made the decision to deploy an all-DSL solution, eventually revised their view and chose a pure VSAT network based on cost, performance, a consistent unified solution and the reliable deployment

schedule which VSAT brings. Hughes subsequently launched the same service in Europe and won BP's network there as well. In the US, upwards of 65 per cent of BP's sites were expected to qualify for DSL, but during the roll-out it became clear that DSL service of the quality required was not as easily obtainable as had been first thought and we believe that around 90 per cent of BP's 7,000 gas stations in the US are still served by Hughes' VSAT service.

2008 brought several major Optimised accounts, but also for the first time, the company did some all-terrestrial deals. These included a combined DSL/cable/T1 network for Carter Lumber, Carter Retail and an EVDO network to support truck weigh stations. The past two years have seen this continue and customers with VSATs at many locations, such as Body Shop, Burger King, and Rite Aid, signed up for Hughes' managed terrestrial service as well. However, VSAT remains at the core of the North American operation and will be used as a preference where possible, not least because this gives the company the maximum amount of control over the network.

In order to extend its management ability, Hughes also developed a separate device – the latest version being the HR4700 – effectively a VSAT IDU, but with a DSL router embedded. The unit is able to provide all the functionality of the HT VSAT terminal, as well as handle the terrestrial connection, and allows Hughes a consistent and high level view of the network, regardless of the connection used. The company also introduced a technology in its VSAT modem called ActiveQoS, which provides end-to-end QoS over terrestrial broadband for support of different classes of services, such as VoIP. When combined with satellite based Quality of Service, this has allowed Hughes to offer high availability, high quality voice services to enterprises. In 2012 the company added ActiveBonding, a means of bonding and load balancing between different terrestrial connections, and ActiveCompression and then followed this up with ActiveClassifier, which examines the flows into the router and places data into different queues depending on the requirements, and ActivePath, which creates intelligent multiple paths and application level policies and selects the best connection for any particular application, in 2016. These are all part of its suite of solutions which are branded as HughesON and which are designed to enhance its hybrid satellite/terrestrial networking and media services. The strategy behind this came from a desire to assist the company's enterprise customers in developing cloud-based applications and virtualisation systems and now also has a software-defined WAN (SD-WAN) cloud-based service incorporated.

Media centric network opportunities are another area of development for Hughes, not least because this is a value proposition that resonates well with its core retail customers. In early 2008 Hughes announced its acquisition of Helius, a specialist applications provider that focuses on the IP video market. This followed a process of integrating Helius' technology into Hughes' managed service infrastructure to support digital signage and other IP video applications. In 2010 Helius was fully merged into the Hughes organisation, becoming the Hughes Solutions Group and taking responsibility for other related capabilities, such as WiFi solutions and WAN optimisation. The Solutions Group has had some success selling managed content delivery, training and distance learning applications into the enterprise market in a customer penetration strategy that is able to cost justify a VSAT platform, just as a VSAT network sale can open the door to a media service. A good example of this is Cabelas, a small, 35 site retailer that deployed a system both at the back – for upgraded

break-room entertainment for staff – and the front of the store, for digital signage. In 2012 Cintas, a supplier of corporate identity services, also contracted for this service. IPTV networks have increasingly favoured an interactive solution as delivery of content to storage devices at remote sites for later use requires acknowledgements and checks to ensure reliable receipt.

Ironically, the biggest issue Hughes Solutions Group has to face is convincing a customer to adopt VSAT as part of the overall media solution. The simple fact is that so many enterprises are focused on price – and therefore a cheap DSL connection – that VSAT is seen as an unnecessary additional cost despite the fact that it provides extremely cost effective multicast bandwidth delivery and solves the huge reliability problems faced by DSL networks. Not only does VSAT bring reliability to a media network, but it also adds an important redundancy layer to the wider communications services used by any enterprise.

Hughes was the first of any of the VSAT vendors to venture out internationally. It should be borne in mind that it was the US regulatory environment that helped foster the technology and so even foreign manufacturers, such as NEC, were initially wholly based in the US. Due to the size of its business versus others, Hughes was able to take a more forward-looking approach to the markets of Europe, Asia, Latin America and finally Africa. The company now has offices around the world and a well organised and professional sales force often based locally but supported out of its Germantown headquarters. The past two years have seen the company consolidate its position with existing accounts and add new operators to its list of clients. For some years now, HNS' business has stretched across the world and there are few markets it has yet to penetrate in some form or another.

Most recently the company has won significant deals in India, Malaysia, Myanmar, Russia, Mexico, Brazil, Turkey, South Africa, Indonesia, Argentina and Saudi Arabia. In fact, most regions have continued to perform well for the company over the past two years and although the market generally has become tougher, Hughes has been successful with its HTS and enterprise-optimised Jupiter system as VSAT and satellite operators alike have begun to adopt the latest generation systems for their infrastructure. This is evidenced by the fact that the proportion of terminals destined for consumer, as opposed to enterprise, services shipped internationally has steadily increased over the last two years and accounted for around a third of shipments in 2015. The most volatile regions have been the Middle East and Africa due to the political situation in the former and exchange rate issues in the latter – something that all suppliers are experiencing. Other isolated markets like Ukraine, Australia and Pakistan which were identified in our last report continue to be disappointing for everybody. Hughes' big success in Europe was driven by a major deal to provide around 25,000 sites to Camelot in 2008, the UK Lottery, all of which were deployed the same year in a massive effort and which has subsequently expanded to cover over 32,000 VSAT sites. Besides this, the region is a good enough market for sales of systems, but the majority are destined for Africa and the Middle East in one way or another. In Mexico, Hughes continued to sell strongly with a big win to provide a 4,000 site network to the SCT to extend broadband access to the schools in the country extending the 11,000 sites it sold in 2012. Hughes also has strong partnerships with other companies like Pegaso and SSL Digital.

In Russia, Hughes supports a number of operators and through them is part of a number of government programs and USO deployments. The country was perhaps the hardest hit

during the economic downturn which began at the end of 2008, then rebounded dramatically in 2010 only to stagnate again over the last two years. However, whilst new network sales for most manufacturers have been extremely slow due to the fact that the only operators with growing businesses have done so by winning existing customers from competitors, many of the operators with Hughes systems have been at the top of this trend and this has sustained Hughes' sales in the country, with the company notching up sales to KB Iskra, RSCC, AltegroSky, GT&T and Rostelecom amongst others over the last couple of years. The effects of the poor economic environment have been seen across the world, with credit supply tightening and operators reluctant to commit to capital expenditure without first tying up a customer. The retail business that had begun to emerge in Russia, India and Brazil effectively slowed to a halt and the expectation that government and military opportunities would fill the gap has largely come to pass. The company's Indian subsidiary, HCIL, offers an excellent case study of successful adaptation. Moving from a focus on the retail and SME segments, built partly around a managed hybrid network strategy, the company re-oriented to position itself as a satellite solutions outsource carrier's carrier, targeted the rapidly expanding bank ATM networks and focused on selling high value, high margin specialised government and military turn-key networks. The results have been very successful and Hughes India now accounts for over 40 per cent of all the TDMA VSATs in service in the country.

International markets have generally evolved to become far more sophisticated in recent years. Increased fibre availability has undoubtedly supplanted VSATs as a primary connection for many users, but equally it has hooked customers on the bandwidth drug and even backup sites are now demanding far higher data rates than was the case for primary links just a few years ago. These trends, coupled with the move towards more general broadband provision, brought massive price pressure and with escalating satellite capacity costs and increased competition from terrestrial services, especially in the case of Africa, the market was very tough in 2010/11. The past few years have continued to see rapidly falling bandwidth pricing in almost every region of the world. Africa, the Middle East and Central Asia led the way, but the same trends are now being seen in in Asia and Latin America and all this is expected to help re-ignite growth in these regions. Ironically, it has been in the US and Canada where satellite capacity costs have remained relatively high, although Hughes is one of the few that actually controls its own costs in this region.

Hughes engineered a strong position for itself internationally with respect to its product line. The HX continues to offer a low cost entry, the ability to grow incrementally, more flexibility with respect to satellite operation and mesh and multi-star capabilities, but the Jupiter-2 platform is also already enabling new areas of opportunity as a new wave of spot beam satellite launches gathers pace. Outside of this, the largest focus areas for future growth are military and civilian government agencies; all specialised segments that require Comms-on-the-Move (COTM) including aeronautical, maritime, military, emergency response and security; and, media and content delivery. The company already supports a sizeable number of transportable auto-deploy systems on its network, but has been working with Global Eagle (Row44) to establish an in-flight broadband service for US and international airlines and has been working hard to position its products with the US DoD. It formed the Defense and Intelligence Systems Division (DISD) in 2008 with its own team of engineering and programs staff to pursue business in the segment and market all of the company's capabilities both directly and through a range of specialised partners.

As mentioned in the HX section above, Hughes also has a card-based product for the HX which allows specialist integrators to incorporate the system into a variety of custom terminals which can range from lightweight man-packs to UAV deployments. In India, HCIL has been very successful with sales of customised network solutions to the Indian Army and Navy. As is common with these types of contract, very often few terminals are involved and there is no recurring service business other than maintenance and further development, but these are high margin jobs for which few companies are able to qualify. Besides these highly targeted, high value, niche opportunities, the basic enterprise connectivity market is expected to continue to yield opportunities. Whilst sales in the United States have been gradually declining as customers have become more focused on terrestrial solutions, a new trend has begun to emerge based on growing demands for higher bandwidth delivery to enterprise sites. With minimum required rates greater than 10 or 20 Mbps being requested for all sites, DSL connections simply cannot cope and it is Hughes' view that VSAT will have to be integrated into an augmented solution based on the high throughput capabilities of the latest generation of HTS systems. With its new Jupiter-2 satellite and VSAT platform, the company believes that a new era for VSAT in the North American enterprise market is likely to emerge. It is not alone in this view – ViaSat's senior management has similar expectations for its ViaSat-2 system. When last we discussed the fundamental demands from most customers and operators, bandwidth efficiency was probably the single largest requirement, but today our view is that actual IP throughput on a per site basis is becoming the biggest requirement.

All this underlines the fact that international success has not only been about the conventional VSAT business. Hughes managed to create a big splash in the international Ka-band market in 2011 finally bringing a complement its North American operations and countering ViaSat's initiatives in Europe and elsewhere. In particular, after the disappointment of losing out to ViaSat in the bid to provide the ground segment to Yahsat for its YahClick service on Yahsat-1B, it was a stunning turnaround when the contract was pulled and given to Hughes in early 2011. Not only did the initial $27 million award include the provision of gateways and VSAT terminals, Hughes is also contracted to manage the operation and maintenance of the system for the first three years of operation and this arrangement is still in effect. Until the Yahsat deal, Hughes' contract to provide the gateways and terminals for Avanti's HYLAS-1 and HYLAS-2 satellites covering Europe, the Middle East and parts of Central Asia represented the company's only Ka-band success beyond North America. Yahsat's YahClick service was finally launched at the end of 2012 and the company has recently both selected Hughes to supply the African platform for its planned AY3 spacecraft and begun the upgrade of its existing Hughes system to the Jupiter-2 platform.

Hughes' subsidiary in India, HCIL, is known to have been pursuing the possibility of launching a Ka-band satellite over India for the past few years – although this project has to somehow find a way around the extreme bureaucracy and defensive attitude of the indigenous satellite establishment. In Latin America Hughes began by winning the deal to supply the ground segment for Telefónica's Media Networks using its first generation Jupiter technology platform on the Amazonas satellite. More recently it has launched its own consumer service in Brazil through its Hughes do Brasil service company based on the deal it signed with Eutelsat for 24 Gbps of capacity on the 65 West A satellite. This service was

initiated in mid-2016 based on the Jupiter-2 platform and, we understand, is performing well and looks on track to bring on a significant number of subscribers by the end of 2016.

Over the years HNS has moved slowly but surely into the service business internationally, almost always in partnership with a company able to add local expertise and leverage. The standing joke in HNS is that these ventures only do well when they have Hughes in the name - Satelitron and Verinet never did very well, whilst Hughes do Brasil and Hughes Escorts have been successful. The truth is that the defining factor seems to be one of control - HNS is able to build a viable business when it is relatively free to manage the venture and it only ever took a small stake in the ventures which faltered. In 2002, the company invested in service platforms in Brazil and China, the latter being in partnership with a local company, SVA, with which HNS has had a long relationship. Four years on, China got the better of Hughes and like many other foreign and local investors before it, it withdrew from the market. The research for this report has shown that even once strong VSAT service operations in China have gone to the wall and, of the 30 or so operators studied for this report, less than a handful are believed to make money. The picture has been very different in Brazil, where Hughes do Brasil has gone from strength to strength, adding networks both directly and through its partners, like Primesys, Oi and Telefónica and, even during the present economic difficulties the country has been facing for more than three years. On top of its latest consumer offer, it has managed to maintain and grow its installed enterprise customer base.

Before the recent downwards trend in capacity pricing, for many years it was the VSAT hardware vendors who bore the brunt of much of the pressure caused by the economic downturn and the increasing penetration of fibre across almost all markets. International sales have been better over the past five years than between 2008 and 2011, but for several years now sales volumes have been at best flat and at worst volatile and yet VSAT hardware prices continued to fall. Unlike in the US, where direct competition is quite limited, the international business faces intense competition from many different sources with Gilat, iDirect, Newtec and Comtech in particular competing aggressively for business. This has constantly led to intense price pressure, but Hughes has been relatively disciplined and has shown it is prepared to walk away from a deal if it doesn't make financial sense, however big it might be. Some others are not quite so principled, but they have a different strategy from Hughes where product development has become more of a strategic tool to develop higher value service businesses for itself and its partners. This is something that allows the company to compete particularly aggressively on both features and price.

The company continues to exhibit its trademark attributes - aggressive pricing, strong sales, continuous product development and high levels of software and hardware engineering - and this makes Hughes both impressive to the customer and scary to the competitors. As the market leader with a massive installed base, Hughes has come in for its fair share of criticism at different times, but this has dwindled over the past few years. Whilst we continue to hear vague grumblings about the company from time to time, the bulk of Hughes' customer base is largely complimentary about the platform, its support and the comprehensive and honest nature of its proposals. By this we identify the fact that Hughes includes everything necessary to get a new service off the ground and, unlike some others, does not tend to remove some support services as a means of reducing the upfront bid price.

Some criticisms which have been levelled at the company include the fact that HNS is not above moving up the food chain and competing with its own customers - witness its service ventures with Hughes Europe, HCIL (formerly Hughes Escorts) and Hughes do Brasil. Hughes' rationale is that if operators are not selling VSATs, it will take its own chances in the market and show how it should be done. A good example of the company's attitude can be seen in Latin America where the company had an excellent relationship with Impsat (now Level 3) and for many years both companies prospered on this, but when Impsat moved towards a fibre infrastructure and other operators slowed their investments, Hughes introduced its own service which has been highly successful. Funnily enough, all eyes are now on the development of HdB's consumer service – after all, if Hughes cannot make a success of satellite consumer internet outside the US, who can? It is also ironic that some of Hughes' competitors have recently adopted a more intense service strategy and are now seen as much more threatening by many VSAT operators.

Since 2001 Hughes has been organised on the basis of geographic markets. Initially product development was primarily driven from the North American market which formed the core demand. Now however, Hughes informs us that its development activities are driven equally from both the domestic and international parts of its business and that it has found that the two sources of feature demand have strengthened the Jupiter system both internationally and at home and helped bring the HX to life. The growing sophistication of many of the developing markets is also helping this process, allowing Hughes even greater leverage in international markets with the developments spawned from its US businesses.

The competitive environment has changed a great deal in the past few years. In the mainstream enterprise market, Gilat remains a strong player and is now pushing harder into consumer project opportunities alongside Newtec which has managed to establish a credible position helped significantly by the support the company has had from both ESA and SES. In the specialised small networking segment both Comtech and iDirect have strong positions, but this was not an area in which Hughes traditionally had a strong value proposition, and the two companies have tended to create more opportunities than they have taken away share from Hughes. In any case, Hughes began to address this segment of the market with its HX system, which has displaced some competing platforms in some accounts, and the company seems determined to maintain this with the latest Jupiter system.

In the consumer internet market Hughes was one of the pioneers, initially facing Gilat's StarBand service. Hughes prevailed and StarBand consequently withered on the vine, but then ViaSat emerged and, after taking a strategic role as the "arms dealer" partner for the major broadband platforms, it has since pursued a vertically integrated strategy. In addition, ViaSat also supplies Xplornet with capacity on its ViaSat satellites as Hughes does with its Jupiter spacecraft. In the US market, the situation has risen and fallen to the advantage and disadvantage of both companies – both WildBlue and Telesat's growth slowed to a crawl as their initial spacecraft ran out of bandwidth, leaving Hughes and its Spaceway-based service a virtually clear field for two years, but as Hughes experienced capacity constraints towards the end of 2011, so ViaSat-1 came on-stream. As a result Hughes' sales effectively flat-lined during 2012, but showed a major re-bound following the commercial launch of the Gen4 service on Jupiter-1 (EchoStar XVII). Up until mid-2016 Hughes continued to grow its consumer service strongly and now serves over one million subscribers. Now both

companies' satellites are effectively saturated and both are sitting on their hands waiting for their next generation spacecraft to be launched. Thus, competition in the consumer ground segment space is well defined between Hughes and ViaSat, with Gilat and Newtec snapping at their heels, but without a vertically integrated strategy to support the development of their product lines.

We continue to hold the opinion that Hughes has the edge on its competitors because of its organisation, depth of market presence, experience, vertical integration and the fact that if it is ever behind with product features it is never far behind. For the potential purchaser, the fact that buying Hughes is rarely a mistake counts for a great deal. Jupiter is one of the cutting edge systems available in the market today and given all that we know about its extended consumer and enterprise architecture and vastly increased processing capabilities, will be an exciting prospect for many. The HX addresses more capabilities in segments which have never really been in Hughes' sweet spot before and now supports some incredibly powerful networking features that are unlocking new potential demand and taking Hughes deep into segments it only scratched at in the past. It is clear that Hughes' plan is to maintain this strategy with the incorporation of these features into Jupiter-2. Finally, there is also the obvious focus on the opportunities for hybrid networking which COMSYS has identified as possibly the largest influencing trend on the VSAT market today. As evidenced by the continuing development of the Active technologies in the HughesON portfolio, Hughes is investing heavily in hardware and software products that aim to bind satellite and terrestrial infrastructure together in a unified solution and we have no doubt that this is a capability that Hughes will export to its various partners around the world. Given all of this, there is every reason to suppose that Hughes' strength in depth, greater developed services business and increased responsiveness to the market will be more than enough to maintain its leadership of the industry.

Competitive and business challenges, however, do not abate - they only change. The shape of the North American satellite consumer market has changed dramatically, the company's growing focus on high value niches will challenge it to maintain compatibility between platforms and channel engineering resources and development with vision and care whilst price pressure continues to mount. The lower entry point and flexibility of the HX are features that have attracted smaller operators in Africa, Europe and Asia and, whilst a good thing in terms of sales, Hughes has generally focused on larger operators which require a different type of support structure. Its universal modem architecture should also bring high levels of flexibility to any operator which discovers they need to adapt their original service strategy. The company has its own exceptionally strong Ka-band strategy in the United States and with Xplornet in Canada, but the past two to three years have seen it expand this into different areas of the world.

HNS is all the things that we have described it as - conservative, methodical, cautious, stable - but it is not above taking calculated risks and has managed to pull rabbits out of the hat to many people's surprise a number of times. As a case in point, two years ago we were concerned that the company had not countered ViaSat's aggressive chasing of any and all Ka-band opportunities in international markets; Hughes has, once again, turned this situation around and now, arguably, looks to have the stronger position of the two. We see the company's major competitors moving towards very specific product strategies and shedding their involvement elsewhere because they were simply not able to compete at a

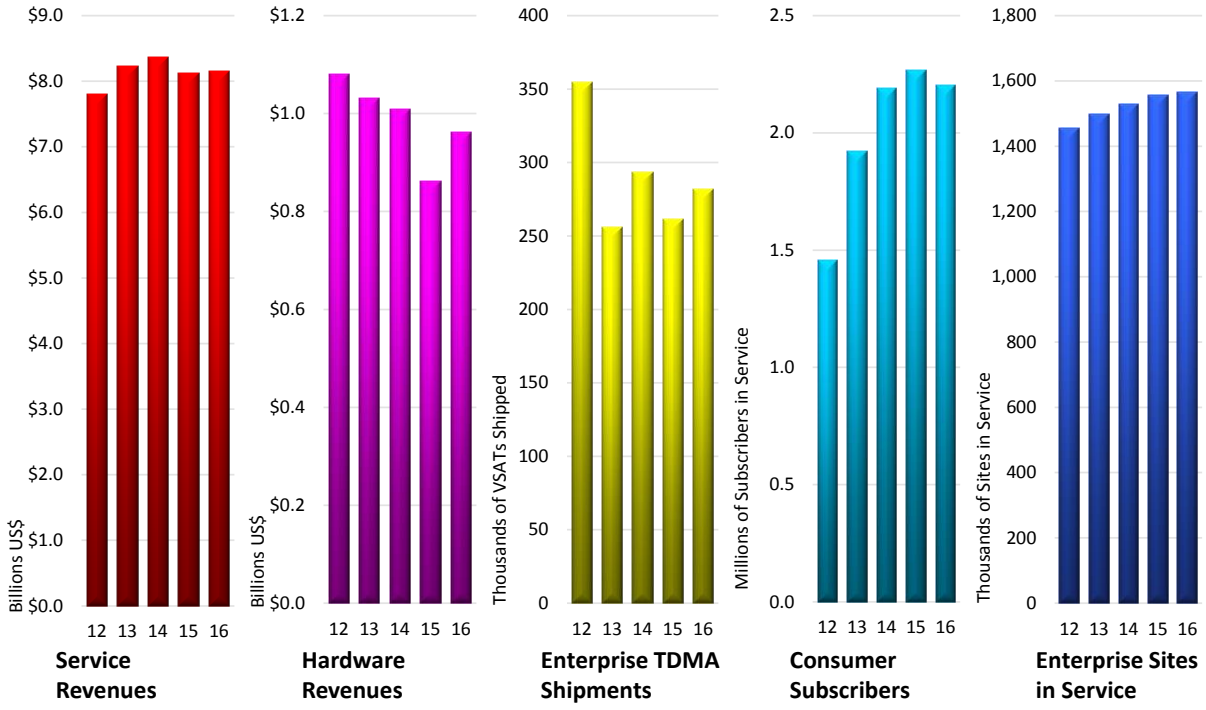
viable level. By contrast, Hughes does exactly that – competing strongly and profitably at almost every level of the VSAT business – from hardware to service and from corporate to consumer – and manages to achieve a leadership position in every one of these areas.

The potential for more rabbits remains with the company as long as it retains its current structure. We commented in 1996 that Hughes Network Systems had managed its VSAT business almost faultlessly since the purchase from M/A-COM. We still believe this to be the case and believe that the painful separation of the business from GM was cathartic for the company. Now Hughes is, once more, part of a larger corporation, although this time the owner really does understand the satellite business and has more than a passing interest in consumer satellite services. EchoStar's plans for Hughes' future are not really visible, but the fact that it has been Hughes that has maintained the growth of the group must be both recognised and lead to a policy of no interference – leave the experts to do what they do. Hughes continues to innovate and lead the industry in terms of technical development and aggressive market approach. It has an astoundingly deep management bench with vast experience in both the enterprise and consumer worlds and an incredible ability to anticipate and adapt its strategy, so the combination with EchoStar coupled with its legendary engineering resources, reputation for reliability and innovation is potentially very powerful and a tough one to beat.

executive summary

To say the satellite and VSAT business has changed over the last three years would be an understatement. To suggest the industry now has a new direction is simply not true. The fact is that the business is in what is best described as a tornado. So much is or could or won't or will change that predictions of the future shape of the market are really little more than wet fingers in the wind – and it's quite a wind.

As an example, just consider flat-panel conformable, electronically steerable phased array systems (what we term a FP-CESPAA) – there's little doubt we will see these products emerge, but questions abound. Exactly when, how efficient, at what price points, what the possible binding configurations for receive and transmit will be, how look angle signal drop-off will affect performance, will multi-frequency operation be possible? Without understanding all of this, the grand promises of the LEO systems suddenly become extremely questionable because a mechanically steered dual antenna arrangement is simply not viable to sustain business on these systems. These systems will need a low-cost terminal, otherwise the link budget might close but the business case will not. However, if all these promises come to pass, then the proposed LEO constellations will enhance GEOs with a latency level that might even challenge fibre. Whatever anyone in the satellite business says, the high latency of GEO links is a killer. Customers hate it, software companies ignore it, applications without some form of intervention can fail, bandwidth delivery can seem slow by comparison with a much lower rate terrestrial service.



The satellite operators are facing what some are describing as their "Kodak Moment". Now that capacity prices have begun their descent this isn't likely to stop – it is simply the same trend seen in the terrestrial business. Most satellite operators still have the major prop of television broadcast, but VSAT has become a bigger part of their business over the years and

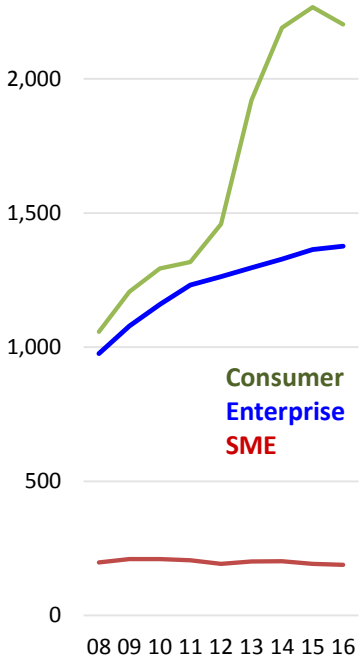
will continue to do so. None of the HTS systems that all satellite operators either currently have in operation or are planning for launch will provide DTH broadcast services of any scale so VSAT will be an absolute necessity. Thus, the move towards verticalisation has started. In many instances this is denied – the satellite company has no intention of competing with its customers – but this is simply not true and some represent the biggest threat to a VSAT operator. We believe that any managed service needs more than the ability to provision bandwidth. Installation, maintenance, application integration, repairs and maintenance - all these things are required and only the VSAT operators have this in place. Therefore, we believe it is inevitable that, sooner or later, an acquisition process will begin.

Mobility has become the number one specialist, high-end area for VSAT that is growing and managing to maintain margins at a better rate than fixed terrestrial networks. We have commented on the maritime, aeronautical, military, DSNG and other mobility areas many times already, but it has to be mentioned that these segments are probably at least five years behind what has been happening in land markets and expansion is becoming fast and furious. Even in the economically challenged commercial shipping market, fleet owners are now seeing the positives in investing more to reduce costs, increase safety and efficiency and improve crew welfare, although the latter is no longer the principal decision driver. In the aeronautical business an acquisition-based consolidation strategy has already begun with Panasonic buying ITC Global and Global Eagle buying EMC. Both companies have ambitions to expand their businesses into the maritime and offshore O&G segments.

In the fixed network market, we have long been seeing evidence that the role VSAT is playing is increasingly dependent on either the lack of alternatives or adding the unique diversity that satellite brings to a network. In some ways it can be argued that this effectively reduces VSAT's role to that of the last resort solution and we would have to agree that this is a potential outcome which risks condemning the technology to an increasingly marginal position. Terrestrial infrastructure is growing faster than might have been expected for both fibre and cellular services and there is a strong, if not always rational, preference on the part of both enterprise and government customers to always favour these solutions over satellite. Large scale enterprise networks are slowly, but surely becoming a thing of the past as requirements boil down to very specific applications or just one role within a total solution. This process has already happened in North America and Europe and is now well underway in the developing regions as well.

However, an alternative argument - and the one that we subscribe to - is that VSAT technology is slowly, but surely, assuming a more embedded role within the total communications solution that a customer requires from their service provider. The plans that Hughes and ViaSat have to make use of their new HTS satellites over North America to provide universal high bandwidth connections of 20 Mbps or more to enterprises that are increasingly demanding this type of connection across all of their sites uniformly, regardless of location, look very positive for VSAT. These services, which we describe as augmentation as opposed to extension, offer real promise for VSAT solutions and will leverage the existing integration with terrestrial connectivity to ensure that latency-sensitive traffic is directed over lower rate, but lower latency terrestrial connections whilst anything else is directed via the VSAT link.

As has always been the case, Hughes and ViaSat look to be well in front of the curve on this and VSAT and satellite operators outside of the US should sit up and take notice. Both companies have managed to make amazing progress with their consumer service platforms and Xplornet has equally leveraged their advances in its Canadian service. Now Hughes is actively feeling out the satellite consumer internet model in Brazil and, if it continues to be as successful as it has been so far, this will be a major step forward for the VSAT business and begin to open up new possibilities for growth in this segment in other regions. For its part, ViaSat is in some ways behind Hughes and in others ahead. Its move into the aero market looks to have been a very smart one and now presents another significant area of growth for the company. Always willing to place massive bets on its belief regarding the importance of minimising the cost of bandwidth beyond anything else, the plans for the ViaSat-3 constellation look likely to bring a radical change to the market. We would not be at all surprised if the company's recently announced JV with Eutelsat turns into a merger or ViaSat actually ends up acquiring Eutelsat. Either way, it is clear that the race has begun and the expansion of the consumer business into international markets by both Hughes and ViaSat marks the beginning of a new era. The recent announcement of the merger between Intelsat, Softbank and OneWeb coupled with Intelsat's service partnership with, and investment in, Kymeta shows integration is accelerating.



VSATs in Service (000s)

Another positive which is also a negative in some ways, is the fact that government sponsored broadband programs under whatever guise – schools, community centres, post offices, hospitals – are coming to dominate the VSAT business in the developing world. This has meant that larger and larger programs are being initiated and, in many instances, this favours the larger operators and disadvantages the small VSAT service provider. The encouraging thing is that we see governments increasingly accepting the fact that connecting the rural population is an important method of enabling more economic growth in a country and that VSAT simply has to be the largest element in this solution.

As part of this there is another very positive element – the growth of the cellular backhaul market. Yes, SCPC is declining as the preferred solution, but TDMA systems are not only replacing, they are extending and expanding the market substantially. In the fixed market (ironically for a mobile technology), cellular backhaul represents the single largest opportunity. Cellular companies in every region are now implementing VSAT-based backhaul networks over hundreds if not thousands of sites, rather than the tens of sites a few years ago. A market that was once completely dominated by Comtech now has strong plays from Hughes, iDirect, Newtec and especially Gilat for which this has become a major focus. The move to 4G is playing a big part in this trend because the solution is based on data rather than voice circuits. With the cost of smartphones having come down and many rural residents now owning one, a combination of cellular and wireless trunked with a VSAT backhaul connection represents the ideal way in which to extend connectivity. Many

governments are now supporting this concept and also pushing their USO policies towards the cellular operators.

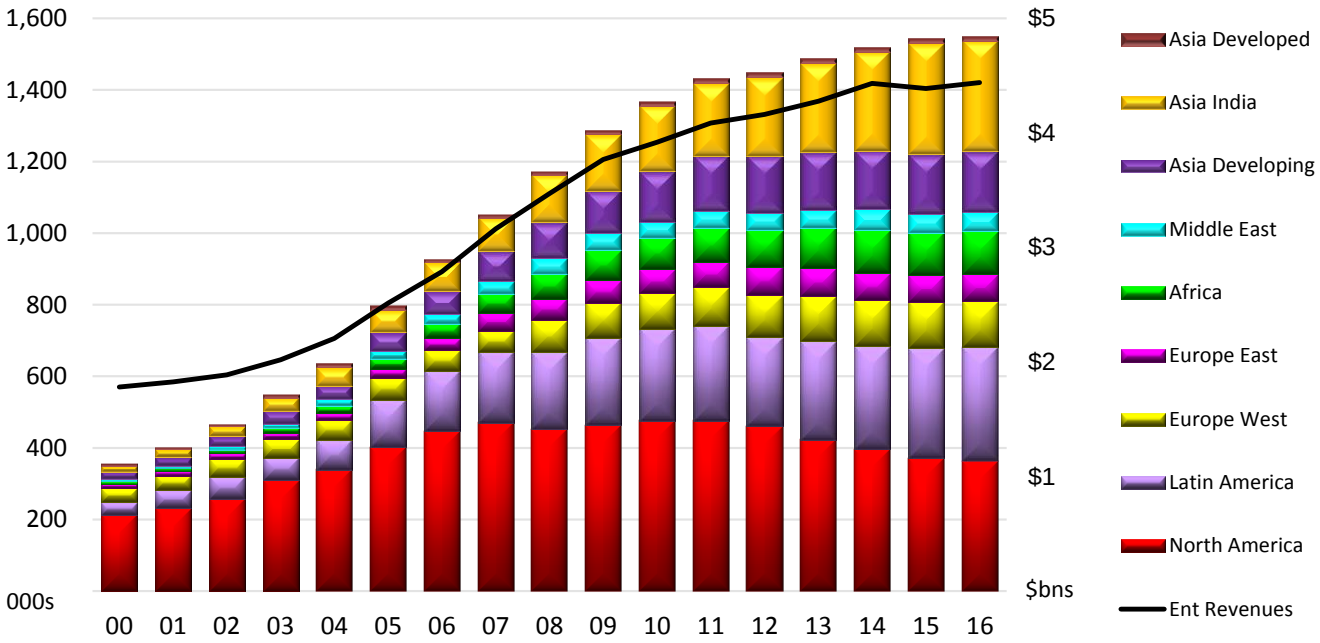
At the corporate level, the global economy remains in a precarious state and this has had a major impact on several once key areas of business for the VSAT industry. The oil price collapse has caused huge damage to many small and large operators supporting land based drilling operations and offshore operations. Service to established and long-term sites such as FPSOs, production platforms and mines continues of course, but these are small niches within niches. The pain has been severe and there will doubtless be some operators that will never fully recover or simply go out of business. However, the oil industry is historically cyclical and the business will recover at some point – the world needs oil. When things begin to change and prices rise to an acceptable level there is no question that there will be a dramatic and very fast resurgence of this segment of the business, but for now all anyone can do is wait and hope for the best.

As mentioned in relation to the potential for use of HTS capacity for terrestrial network augmentation, demand for higher bandwidth services is growing and whilst a few years ago this meant a couple of Mbps of throughput it can now mean 10, 20, 100 Mbps or more – and this can just be for one part of the link, usually the receive side. In this Report we comment on the challenges behind implementing the processing and application support that these levels of throughput require. Three or four years ago the VSAT business had been found lacking as manufacturers were caught napping by the huge increases in throughput requirements by many customers. With the focus having previously been on network capacity as opposed to user throughput, all VSAT platforms were increasingly being challenged to support the level of services required. The response to this was widespread and appropriate with almost all the vendors producing or developing a new generation of system that incorporate memory and processing which is orders of magnitude higher than those in the mainstream in 2012.

Both situations have continued – throughput rates rising and the manufacturers running to ensure their platforms are able to support them. The introduction of Layer 2 OSI support by several vendors offers users and operators the ability to add other third party devices to enable higher processing capabilities to support a link. This is a good thing, but it does not take away the challenge because operators ideally want a fully integrated solution. Handling much higher PPS rates and many more IP sessions as well as optimising items like acceleration, different packet size processing and encryption ideally happens at a board level enabling maximum efficiencies, as opposed to transferring between different devices via an Ethernet connection to perform different functions. Alongside this, every platform now has to have enhanced network management, software defined feature sets, mobility roaming capabilities, dynamic access schemes, greater bandwidth management capabilities and faster and faster beam switching. As mobility takes over and the use of HTS satellite capacity becomes essential, the smaller beams that are offering greater frequency re-use means that beam hopping capabilities are going to have to get much quicker and more efficient.

The major trends and changes of the market are as follows:

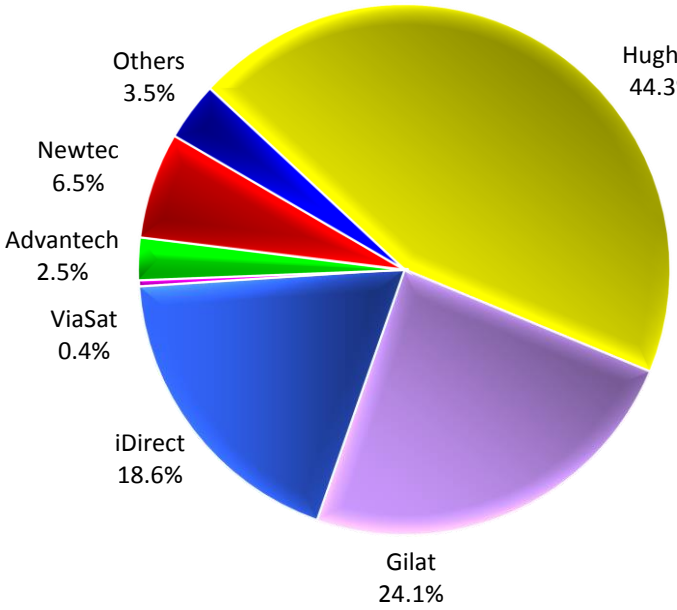
- ***The annual market has become more volatile in terms of hardware sales over the past four years with a flat service site count in almost all.*** Key points include:
  - Increasing hybridisation of services and transition of networks to backup;
  - A trend towards mobility;
  - Domination by larger, government broadband projects;
  - Drop-off of large non-governmental enterprise networks;
  - A pick-up of potential in the international consumer segment.
- ***Overall growth***: The VSAT industry recorded $962 million in hardware sales in 2016, up 11 per cent after a 14 per cent decline in 2015. Combined service revenues were up by 0.4 per cent to $8.15 billion with managed services revenues more robust than dedicated networks and accounting for $5.5 billion, almost 70 per cent of all VSAT service revenues.

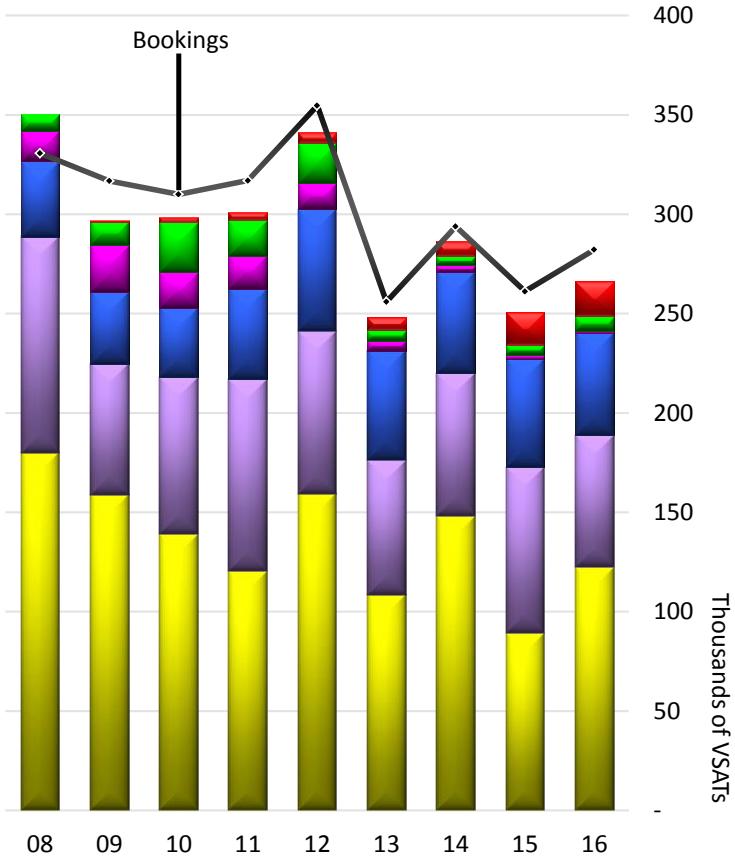


Enterprise VSAT Service

- ***Leading enterprise system vendors***: In the enterprise market Hughes Network Systems retains its position as the market leader followed by Gilat, iDirect and then Newtec which has established a strong position in fourth place. Advantech and UHP Networks both saw good growth and brought in worthwhile sales in 2016 accounting for almost 5 per cent of the market between them.

Shipped Star TDMA Terminals 2016

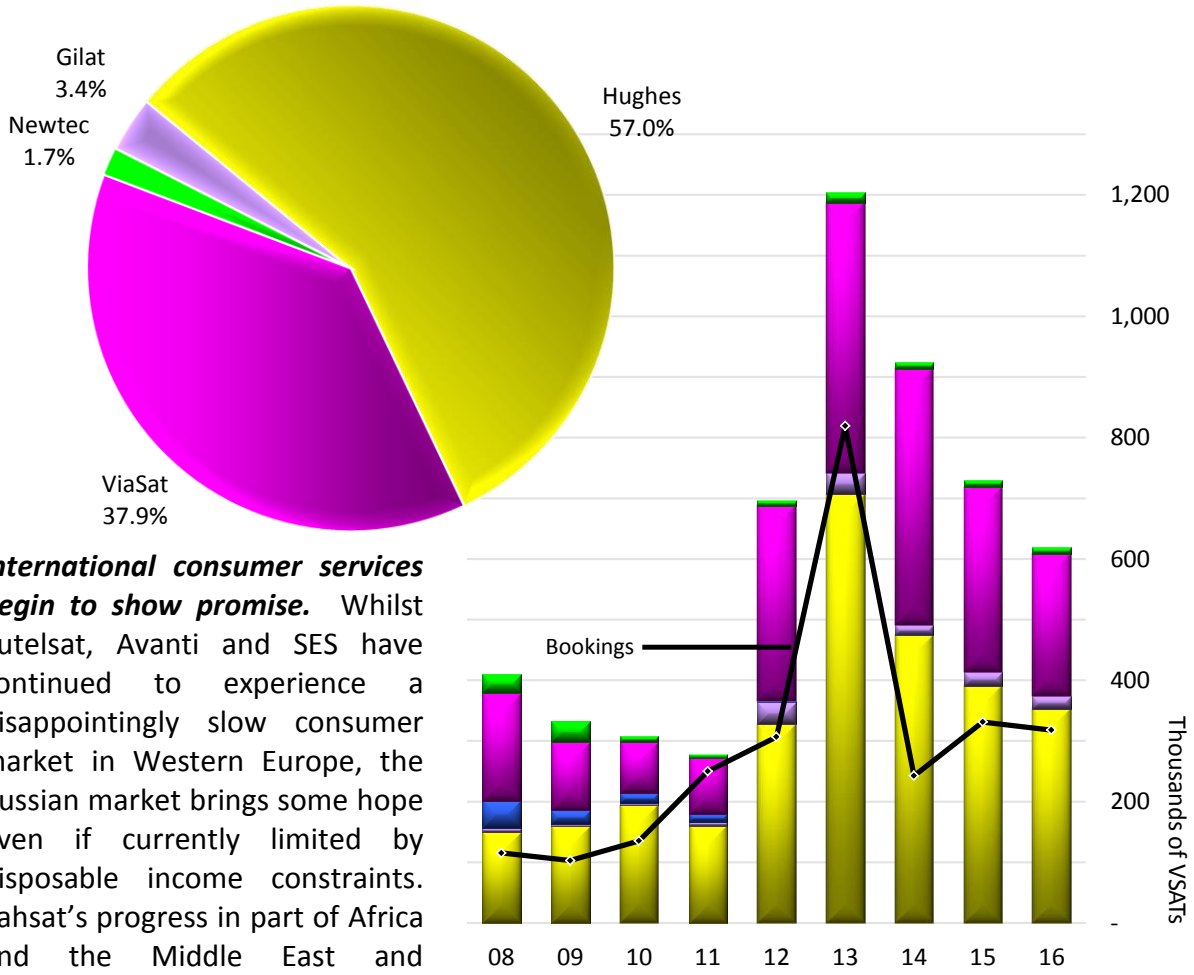




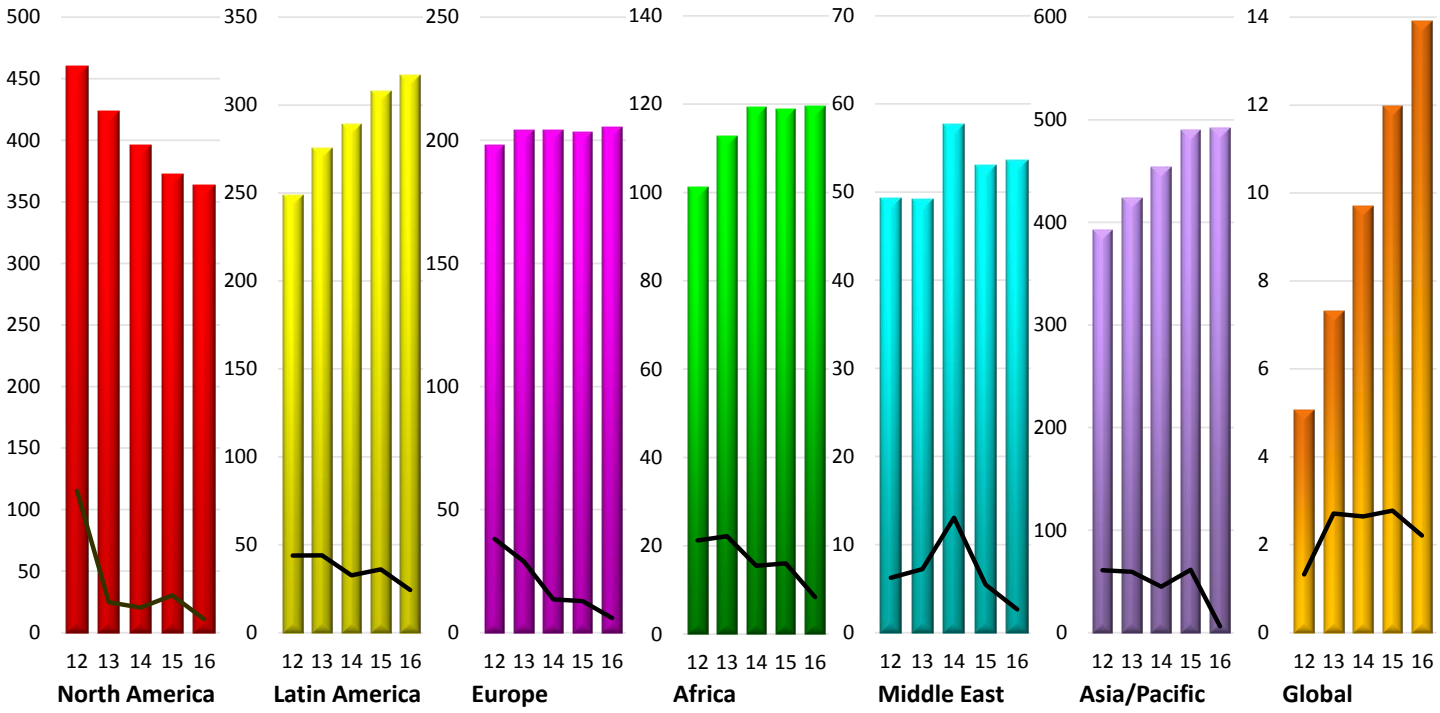
- ***TDMA terminal prices continued to fall,*** following the same consistent trend that has been seen for over ten years. Price levels for volume enterprise and consumer terminals have substantially reduced hardware margins.

- ***Consumer market***: In the consumer market, Hughes retained top spot between 2013 and 2016, delivering more than half of all consumer terminals shipped, whilst ViaSat delivered over 40 per cent. Both Hughes and ViaSat's sales dropped between 2013 and 2015 as their spacecraft capacity became increasingly saturated. Both HughesNet and Exede recorded record subscriber acquisitions during the first half of 2013 on the back of the enhanced services provided on Jupiter-1 and ViaSat-1. In total the industry shipped over 1.3 million consumer terminals in 2015/16.

Shipped Consumer Terminals 2016



- ***International consumer services begin to show promise.*** Whilst Eutelsat, Avanti and SES have continued to experience a disappointingly slow consumer market in Western Europe, the Russian market brings some hope even if currently limited by disposable income constraints. Yahsat's progress in part of Africa and the Middle East and Afghanistan has stuttered with a recent restructure and growing competition from Avanti, but the company has been most successful with higher ARPU SME customers. New consumer platforms are emerging from Arabsat, Eutelsat, SES and Global IP. After a shaky start, Latin America is now seeing Hughes lead the way and proving that experience underlying the right strategy makes a difference. For the first time there is real hope for satellite consumer services of North America and there is more coming down the pipeline as Jupiter-2 and ViaSat-2 extend coverage, Yahsat and other HTS satellites come on stream and DirecTV tests out in Argentina using Spaceway.
- ***Consumer satellite internet services*** now serve over 2.2 million subscribers worldwide, over 80 per cent of which remain in the United States.



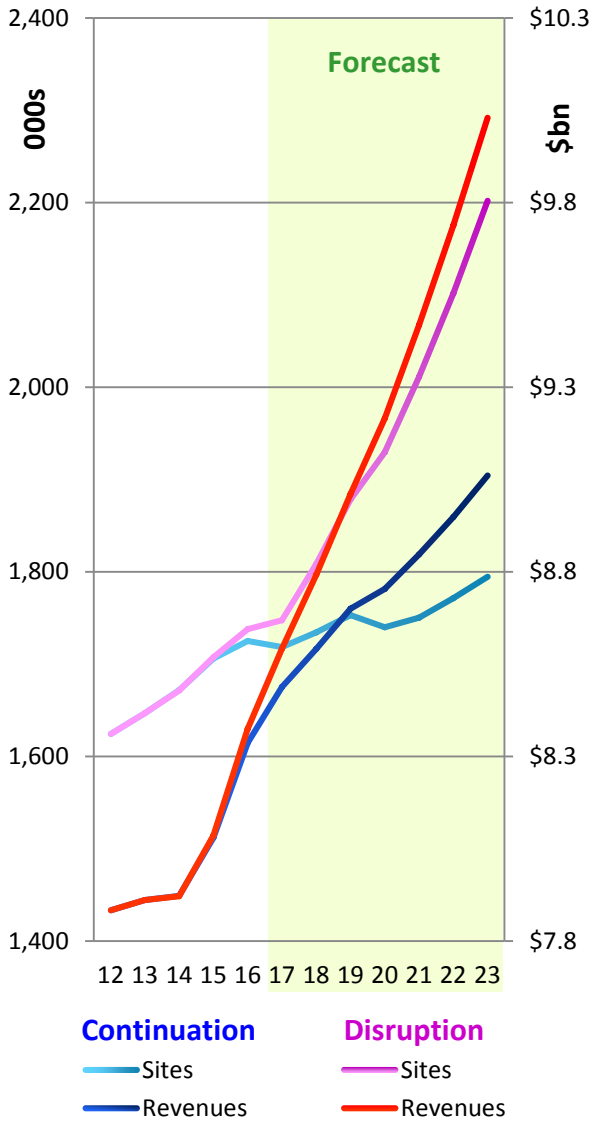
Enterprise VSATs in Service (000s) & New Sites (Line)

- ***Bandwidth consumption continues to grow, but falling satellite capacity costs have undermined service revenue growth*** because lower pricing has not increased demand in the larger volume enterprise segment. The corporate segment of the market flattened primarily due to the reduction of demand in the O&G business, but most other vertical segments report high increases in required data rates.
- ***Verticalisation strategies in the US have been successful*** with ViaSat and Hughes having re-energised the market in North America with their consumer services and achieving good growth, albeit constrained by bandwidth supply. Jupiter-2's successful launch in December 2016 and ViaSat-2's slated Q1-2017 launch will unlock this bottleneck and introduce further growth.
- ***SME broadband access services*** have shown a downward trend across almost all regions, caused largely by the growing capabilities of consumer services. This has forced SME BB-focused operators to diversify and re-structure business strategies.
- ***Satellite capacity pricing, terms and availability*** have all changed substantially. In some cases prices have dropped by as much as 80 per cent over the past three years. Contract terms have either reduced to one year or are now usually tied to annual price reviews. Few markets currently suffer from a constrained supply, following the growing deployment of HTS satellites and a trend towards overcapacity in regions such as Latin America is starting to show.
- ***Ka-band, spot-beam, high-bandwidth spacecraft*** added almost 800 Gbps to global FSS capacity in 2016 and the total is expected to grow to over 4.8 Tbps by 2022. Satellites launched since 2011 have already substantially changed the competitive environment globally and further deployments will continue to change bandwidth pricing as well as the supply and demand economics prevalent today.

The future of VSAT can be divided into two potential scenarios

Continuation or Disruption The VSAT business is now highly dependent on the promises of technology, system and service innovations that can essentially be boiled down to FP-CESPAAs, LEOs and HAPS. VSAT manufacturers have a strong history of adapting to technology changes and so we have confidence that the ground segment platforms will meet the challenges and support these solutions. The traditional satellite and VSAT market is evolving, but only with incremental changes to the same model. Satellites are becoming larger and more flexible; space segment prices have dropped and will continue to do so, probably at an even faster pace; VSAT platforms are becoming much more powerful, efficient and sophisticated; spacecraft production, HTS to XTS designs, in-orbit renewal and lower cost launchers all promise a rescue (but not a resurgence) of the GEO market. All of this will ensure a continuation of the market as it is today, maintain growth in the unique mobility segments and soften the trend of decline in the wider enterprise sector.

Enterprise VSAT Service Forecasts



However, if the planned technology initiatives fulfil their promise, the market will be disruptive – both internally and within the telecoms market as a whole. LEOs will re-energise GEOs, HAPS will boost local capacity coverage and FP-CESPAAs will bring flexibility and simplicity to the ground segment. VSAT will be able to provide a ubiquitous, uniform, high bandwidth, low latency, consistent service and fast deployment solution to the market which will give satellite networking a major competitive advantage over any form of terrestrial alternative. Fibre will continue to offer higher and cheaper bandwidth, but only to limited coverage areas; DSL will be cheaper, but with inconsistent performance and limited bandwidth; cellular will mix all of these attributes and limitations and become the extension rather than the primary.

VSAT will be on the ascendancy again.

2. Market Information

2.1. Evolution

VSAT technology offers one major unique selling point (USP) - direct connection. When VSAT was first commercialised, not only did this form the primary marketing focus of the VSAT service provider, it became the principal justification for the adoption by customers of VSAT systems. This remains a strong part of the attraction and almost every operator of VSAT services provides end-to-end service level agreements in comparison to many of the VSAT terrestrial competitors whose offerings often excluded the last mile for a long time. VSAT networks in the early days were established based on some extraordinary reason that VSAT could uniquely support. Some of the important initial networks came as a result of:

- A centralised management with visionary leadership as was the case with Sam Walton and Wal-Mart stores which contracted for 1,600 units from Hughes (then M/A-Com Telecommunications Division); or,
- A company which had funded a start-up VSAT venture and which adopted the system to prove its own commitment such as Prudential Bache, one of the initial backers of Tridom which contracted for 1,500 terminals; or,
- A company which had suffered a catastrophic failure of the terrestrial system and had sought a way to avoid future disasters, such as McKesson which contracted with Contel ASC for 110 terminals, or Walgreen Drugs, which accelerated the switch to a VSAT network from Hughes after the Hinsdale telephone exchange fire in Chicago. Impressively, Walgreen is still a Hughes VSAT customer today after 30 years.

Many of the early decisions were inevitably made at board level rather than by the communications manager. In addition, as users began to adopt the technology, it became clear that there was a domino effect occurring in segments of the market. For example Wal-Mart was followed by K-Mart and 7-11 Stores in the retail sector; Days Inn was followed by Holiday Corporation and Hilton; and Chrysler was followed by Toyota and Nissan. By 1987, VSAT systems were able to offer:

- Higher reliability;
- Independent networks;
- Greater flexibility;
- Proven systems;
- Additional facilities, such as voice and one-way video;
- Single source suppliers;
- Stable and predictable prices; and,
- Cost savings on terrestrial systems.

As a result, many entrepreneurial businesses were founded on the technology and the number of companies involved in VSAT system development and managed services grew substantially, first in North America and then the rest of the world.

2.2. Enterprise Developments

Service and manufacturing consolidation has been an ongoing trend. For a while in 2000 and 2001 it was virtually mayhem with so many companies changing hands, but this settled down as many owners decided they were simply not prepared to sell at the prices buyers were prepared to pay. Many of the telcos which disposed of their satellite or VSAT assets did so to concentrate on their core businesses and Deutsche Telekom, Telia and BT were prime examples. Since that time, both DT and BT have re-entered the business in a low-key way, but the process of retrenching and restructuring has gone on unabated at all levels and in all segments. The past five years have seen major consolidations and acquisitions across the industry, most of which have related to service providers. In this SpeedCast is clearly the king, having completed 13 acquisitions in less than four years.

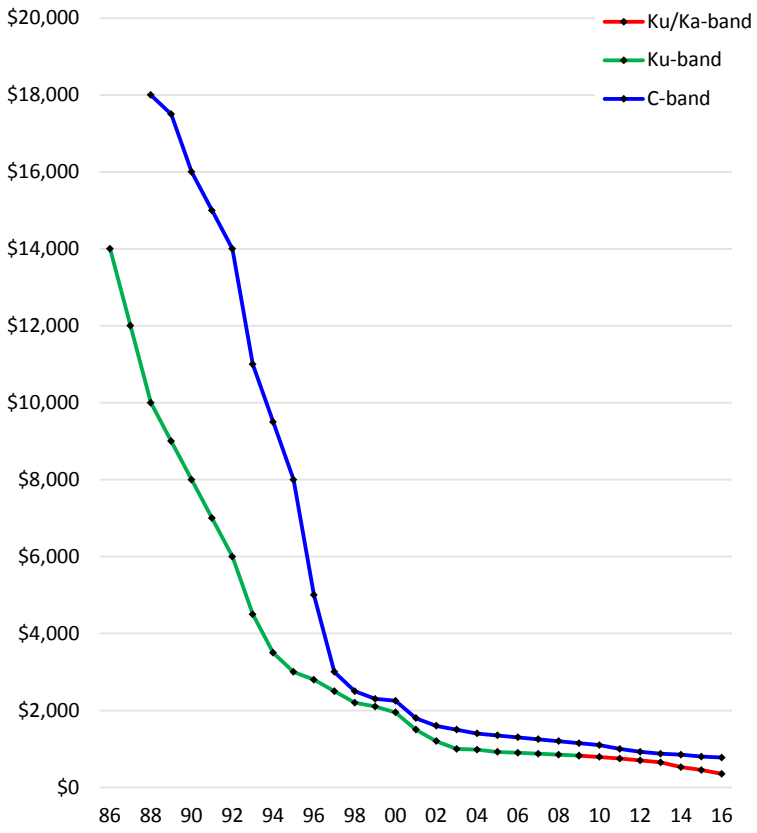


Figure 4 - VSAT Terminal Prices 86-16

It was Hughes which first started the ball rolling towards a low cost product line with the launch of its PES6000 model in 1991. 1996 saw the beginnings of a real cost reduction in the price of C-band as well as Ku-band terminals. From average prices of $14,000-$12,000 in 1994 - almost twice that of a Ku-band system - C-band terminals are now virtually equal in price. In general, a good rule of thumb is to add $100 to $200 to the cost of a Ku-band terminal due primarily to a larger 1.2m antenna, although the addition of a 1.8 metre antenna can add several hundred dollars more to the total. When considering recent price changes, the temptation is to remember only the hype of previous years and compare it with the reality of today. In fact, in 1998 a Ku-band VSAT, in quantity, sold for between $2,500 and $2,200. During 2000, COMSYS saw several bids at or below $2,000 and by 2002 we routinely saw bids at little more than $1,000 and sometimes considerably less. Whilst very large requirements of 5,000 units or more prompt price bids which can be lower than $500 per terminal - which shows that prices have and will continue to fall - in general the pricing we saw in 2002 is almost half what we see today in mainstream network deployments. For extreme opportunities, such as the SCT project in Mexico and the Correios network in Brazil which demanded many thousands of VSATs from the vendors, prices are likely to be closer to $350 or even below, however this is exceptional. Figure 4 offers a picture of what we believe has happened to

VSAT terminal prices when sold in quantities of greater than 1,000 units. The simple fact is that none of the manufacturers make any margin of worth on these types of VSAT and it is the top modem models giving higher throughput, processing and functionality selling at levels of $3,000 to $10,000 that make the money.

The dramatic fall in the cost of VSAT hardware shown in Figure 4 has been passed directly on to the end user through lower service costs. Over time, VSAT service charges have fallen both in real terms and in relation to competitive alternatives of the time, such as ISDN, dial-up lines, Frame Relay, MPLS and DSL-based IP/VPNs. VSAT services offer the unique feature of supporting every site with exactly the same capabilities and functionality regardless of location. This is not the case for terrestrial services where even the same platform, such as DSL, may vary quite significantly in some way between sites depending on the location and what quality and rate local access lines can support. This positions VSATs as a unifying technology where a new application can be tested at a single location and then deployed across a network in comparison to multiple tests and tweaks which might be required by a terrestrial solution. In addition, VSAT operators provide end-to-end guarantees on the networks - again, a feature which many terrestrial providers do not offer.

All this has brought waves of new users to the service with different applications driving demand at different times. In 1997 we reported on the progress in the gas station market in the US and Europe and in 1999 we forecast that mergers between the major oil companies would result in new networks and this was indeed the case. Other markets which have emerged and peaked include the quick serve restaurant (QSR) business in North America, brokerage and exchange networks in India and lottery networks in several regions. Today competition is tougher than ever before, but there remain some bright spots in enterprise markets across the world, common areas being banking ATMs, SCADA, cellular backhaul, business continuity, government rural broadband inclusion programs, military networks, aeronautical and maritime services. A more specific breakdown is given in Table 1 below.

Value in the distributed network: A point which has always distinguished the VSAT service business from mainstream telecommunications services is the fact that there is a major hardware element which has to be accounted for in some way. In the terrestrial environment, the operators build infrastructure in the sure knowledge that the investment will pay back over many years and that only a small installation fee for immediate costs is required. In a market which is experiencing unpredictable price rises the VSAT model works well - commit for a five or three year term which will cover the cost of the hardware and guarantee stable, if not lower, prices for that term. In a market where prices are falling on a year to year basis, this model does not hold up so well and the service providers and manufacturers have had to sell on other features as customers have consistently backed away from even one year deals in some instances. Unfortunately, a large part of the business has become dependent on selling connectivity and internet access in areas of poor infrastructure and the opportunities in this area are fast declining. In our opinion the market will favour those operators who can deliver value over and above the utility of connection that VSAT brings.

Hot: ▲ / Good: ▲ / Ongoing: △ / Problems: ▽	North America	Europe	FSR	Latin America	Asia/ Pacific	Central Asia	Africa	Middle East
Agriculture				△	▲			
Aeronautical	▲	▲			▲		▲	▲
Offshore Oil & Gas	△	△	△	△	△	△	△	△
O&G Land based drilling	△		△	△		△	△	△
Mining	△		△	▲	△		▲	
Fast Food/QSR	△							
Financial		▽	△	△	▲	△	▽	▽
Gas/Convenience	△	▽			△			
General Franchises	▲							
Government BB Access Programs	△	△	▲	▲	▲	△	▲	△
USO	▽	▲	▲	▲	▲	△	△	
Government/Military	▲	▲	▲	△	▲	△	△	▲
SCADA/Utility	▲	▲		▲	△			▲
Lottery/Gaming	△	△	△	▲	△		△	
Retail	△	▽	△	▲			△	
IPTV/Digital Cinema	▲	△		▲				
Maritime	▲	▲	▲	▲	▲		▲	▲
Cellular Backhaul			▲	▲	▲	▲	▲	▲
Carrier Extension	△	△	△	▲	△		△	
Business Continuity	▲	▲	△	▲			▲	
SME Broadband Access	△	△	△	▽	▽		▲	▽

Table 1 - Enterprise Customer Segment Market Opportunities by Region

MPLS competition: The terrestrial competition has, in some parts of the market, settled on DSL as the primary means of delivery. Initially bolstered by VPNs and now with MPLS providing greater levels of quality of service and network recovery services, the threat has grown over time. Enterprise customers have been comforted by the assurances that MPLS brings, but cables still run out of buildings along the same routes, join up in common switching stations or run under the same bridge so VSAT can sell on its true route diversity amongst other things. DSL services are not only limited to the developed markets of the world either, with IPStar experiencing significant churn in Thailand as TOT has aggressively extended its services as a case in point. In almost every market, decent terrestrial infrastructure serves the major cities and the trunk routes in between, with only the occasional drawback of extended lead times in some instances. Where DSL has lagged, VSAT has prospered, but this is a limited window of opportunity – examples can clearly be seen in Nigeria and Kenya where the largest proportion of satellite broadband subscribers have come from the major cities and, as international and local fibre has been deployed, operators have been pushing out with cellular and WiFi services providing a better, cheaper, faster service and the satellite subscribers have followed.

Cellular backhaul: The growth of cellular services everywhere has brought both opportunity and threat. Cellular providers have made huge demands on satellite backhaul links to extend their network of base stations in the search for the next billion customers. Our research suggests that whilst some operators have benefited, many backhaul links are simply operated as part of the existing network structure by the cellular provider itself, so in

many countries some VSAT operators simply do not see this segment as a revenue opportunity. In addition, if the service is based on SCPC links, in many instances these will go away in time, either replaced by fibre or microwave or just shifted between providers. With a VSAT operation relying on this revenue stream, the loss can and has been catastrophic for a business. Having said this, growth now lies in the desire to reach more rural areas with lower population densities – something that is only really feasible with more cost effective, flexible and bandwidth efficient TDMA systems. This is beginning to offer an opportunity for more operators only mitigated by the fact that many cellular operators have taken their network provision in house. Several operators and vendors have been working on business models for an MNO to think differently when pushing into more rural areas by offering revenue sharing proposals. We now see new business models from the likes of Ericsson, Eutelsat, AMN and ViaSat that have packaged up an integrated solution of VSAT, tower, power and cell transmitter to sell to a MNO in a revenue share arrangement.

Cellular competitive threat: Cellular services also represent a significant competitive threat in many markets. GPRS and now just simple cellular data services have long been considered as an alternative to some transactional VSAT services. Up until a couple of years ago the lack of guaranteed delivery and patchy performance put off customers running mission critical services, such as lottery or credit verification. However, during 2006 a GPRS solution was selected for the South African lottery network, replacing a VSAT service. We have since been told that, as result of the lower availability of the GPRS service, lottery receipts fell significantly (50-60 per cent was mentioned) as did the weekly jackpot, but this did not result in any replacement. Whilst the desire to use cellular for lottery applications is nowhere near universal, there are now many instances where competition between the franchise bidders and a licensing authority's demand for the lowest cost solution has ushered cellular to the fore – the GTECH network in Poland and several state networks in the US with Scientific Games are examples.

The second area of threat is a potential one which has yet to truly emerge and may never do. In Africa, booming cellular services drove massive expansion of cellular base stations. As we mention above, the operators are extending fibre and microwave to connect BTS' wherever possible, but there is a huge wasted resource as competing providers build their own, independent infrastructures. Were governments in the region to start insisting that these trunk network resources be shared, even opened up to allow terrestrial carriers to purchase bandwidth to extend their own services, the impact on VSAT services, especially SCPC links, could be even greater than it is today. As it is, there is already growing evidence that SCPC links are being rapidly replaced in some key markets, such as Nigeria where one operator suggested to us that the amount of bandwidth used for this application dropped by over 60 per cent between 2008 and 2010. The same operator confidently predicted that the demand for bandwidth would half again in the next two years, although the number of VSAT sites would probably double – the push towards more marginal sites with TDMA is now in process.

WiMAX more bark than bite: Finally, in the competitive arena there has also been the growing threat of competition from WiMAX as licensed bands are opened up and standards ratified. WiFi has not proved to be the problem which some suggested it might be, but WiMAX was supposed to be a different animal. There was never any question in our mind that its deployment would drive SME broadband VSATs from the major cities of Africa and

this has indeed happened. The longer term threat was expected to come as operators of WiMAX systems sought to expand their coverage in the same way that cellular operators have – even potentially using the same backbone infrastructure. In addition, the attempts by the WiMAX industry to obtain the rights over some C-band frequencies that are currently reserved for satellite were a worrying development which the satellite industry, mobilised through the Global VSAT Forum, fought aggressively and with good success. The gains that WiMAX made with C-band frequency rights served to prove just how debilitating the resulting interference could be and probably helped the satellite industry in the last series of negotiations at the WRC.

Considering the hype and expectations that WiMAX generated a few years ago, the results have been pretty impressive in their disappointing levels of performance and penetration. Wireless systems might seem cheap at first blush, but over large areas with a low density of potential subscribers the joy quickly turns to pain. In so many instances, we can cite grand plans to deploy wireless systems in rural broadband networks which have spectacularly failed to deliver. WiMAX almost seems like a spent force as a major competitive threat to VSAT outside large metropolitan areas, but as always with wireless technology, another iteration of the same tired mantra has arisen in the form of 4G/LTE. Just whether this could be the technology that finally manages to pull off what so many of its forebears could not, remains to be seen.

Other satellite alternatives: There is always the question as to whether an alternative satellite solution is part of the opportunity or a competitive threat. In the case of Ka-band spot-beam satellites we believe that it is clear that these initiatives expand the potential market and represent an opportunity. By contrast, Inmarsat's L-band services are now viewed as wholly complementary and the days of considering L-band MSS as the major competition by the maritime VSAT providers are now finished because it simply cannot deliver the bandwidth which is now a standard requirement. Equally, services from Iridium and others can be considered complementary, especially as Iridium has been pushing its maritime product offering – OpenPort – since March 2008. This 128 kbps data service designed for vessels took Iridium head-to-head with Inmarsat's Fleet Broadband product, with OpenPort offering a truly global service and Inmarsat's FBB able to run up to 400 kbps. However, both of these satellite systems are extremely bandwidth constrained and, as we have long been saying, it is the VSAT business – whether this be via conventional Ku and C-band services or the growing Ka-band systems – that meets the needs and therefore the value from the maritime market.

O3b (Other 3 billion) drew considerable interest when it was first announced in 2008. The system design is based on a MEO constellation that can be incrementally upgraded to add more capacity over time, unlike Iridium and Globalstar that were fixed at birth. However, in the O3b design, the terminal is required to track the satellite, handing off from one satellite to the next as they pass overhead. There is a great deal of compelling attributes to the design, but the tracking antenna system and its ability to work reliably in hostile environments for an affordable hardware cost is not one of them. Initially there was talk about O3b having three types of terminal, the smallest of which might even be applicable for individual broadband access. This has simply not happened and the system has found its market in the IP trunking, cellular backhaul, network extension and terrestrial back-up segments. For some time, despite the initial backing of Liberty Media and Google, O3b

looked destined to become another one of the satellite industry's white elephants. However, the guarantee of France's Coface export-credit agency for a $465 million loan and the buy-in of SES gave the project new life. Since then SES has gone on to acquire the whole company.

Possibly the greatest asset that O3b offers is the fibre-like latency of the system – even with a double hop through the system the delay is only 90ms. The system also offers the major benefit of being able to be reconfigured to meet demand as a result of its steerable beams, but this strength is effectively lost once a contract is accepted for just one terminal in an area. This means that the company has to select its coverage and the contracts it accepts very carefully, but does not preclude it from being successful. The onward march of fibre might also be in O3b's favour in the long term as some areas will be simply too hard or too dangerous to reach for many, many years, yet will still want the connectivity, speeds and latency that O3b enables. We never believed that the service would be competitive with VSAT services and in fact the reverse scenario that we predicted – that it would be a complement – has emerged to be true. Our one lingering problem with O3b is the cost, reliability and operational difficulties associated with two large tracking antennas and it no doubt prays every day for a cost effective and efficient FP-CESPAA product to be released.

Despite this avalanche of competitive threats to VSAT services, there remain many areas of opportunity, some that can be considered to be extremely hot and may well grow in potential as more HTS satellites come into service and are increasingly use to augment rather than extend or backup a terrestrial service. All of the segments of current and future business have been covered in various parts of our report, but the major areas include:

Retail and corporate video: retains good potential and will definitely be catalysed with the advent of augmentation provided by ViaSat-2 and Jupiter-2. There has been a growing interest as a result of the inexorable advance of IPTV technology. Moving beyond the old TV screen in the corner of a store with a fuzzy picture of a pink bunny (perhaps), the latest projects use multiple LCD and plasma screens around the store promoting products in the same space. With the ability to link these systems into a retailer's EFTPOS system and directly track results, sales uplift and marketing effectiveness, these new concepts enabled by IP video have brought interest in the retail segment in the United States and some developing markets, but we have yet to see this promise manifest itself in anything other than small reference customers. There are however, new areas of application that in some instances hark back to the past whilst in others the latest trends are driving demand. Senior management interactive communication with staff is an example of the former with "Omnichannel" in-store systems extending a customer's online experience to the shop floor is an example of the latter.

Managed hybrid network services: DSL, fibre, cellular, wireless and VSAT services have long been sold as a unified product offering in the US, Canada and Europe. This is now becoming increasingly common in other regions as the VSAT operators under pressure realise that they simply have to diversify their businesses. At one level, VSAT extends the reach of a primarily DSL-based network – simple in concept and quite common for several years. The adoption of the unified managed approach by operators has however, been successful in winning back the ground lost to aggregators who had increasingly supplanted VSAT service providers as the prime bidders, relegating them to sub-contractors of commodity services. The business

model behind this has, however, moved on over the past two years and operators that have committed to this area are increasingly focused on the terrestrial component with VSAT assuming a supporting as opposed to primary position within the product portfolio.

Hybrid business continuity: The VSAT operators have also been selling the concept of complete overlay systems – with a DSL connection and a VSAT at each site. Hughes terms this as high availability networking and has designed its network edge devices to integrate high quality QoS to support VOIP failover. Other devices, such as Spacenet's Prysm Pro also support similar functionality and allow for instant switchover of applications when either link fails. One potential problem with this solution is that satellite bandwidth is sometimes simply too expensive to keep in reserve for use in an occasional emergency, so operators need to sell a non-mission critical application which can be kicked off when other important applications need to be kept alive. This means that VSAT operators effectively have to sell a solution twice. One would think that with Wal-Mart reportedly losing around $100,000 per day whenever a store loses its credit verification ability, this would be an easy sell, but unfortunately this is not the case. Nevertheless, there are indications that the recognition and need for high availability networking is growing – both Hughes and SageNet have converted older customers to this service and Hughes has informed us that it also sees demand for tertiary networks. This use of VSAT will undoubtedly continue in the future, not just in the United States, but also in less developed markets. However, it often spells a marked drop in MRR of between 70 and 90 per cent, but then maintaining part of the revenue and holding a backup capability that competitors with only terrestrial facilities cannot match is a good thing.

Carrier extension: Outsourcing a satellite service to provide service for sites in an existing network has become much more common in recent years. The vast majority of carriers and large telcos abandoned their VSAT services some time ago and only a few still retain this capability – Orange, Telefónica, BT and Verizon are the ones that spring to mind. AT&T outsources its European requirements to Global Eagle (EMC) and other companies, like ITC Global, Talia and CeTel often provide service in combination with a major carrier. The most activity takes place in Latin America where Servicio Satelital in Argentina, Axesat in Colombia, Elara in Mexico and SpeedCast/Newcom across the region all rely on relationships with carriers for a large part of their business. Unintuitively, just because a telco has its own service doesn't mean that it won't decide to outsource to another company for some business. For example, Telefónica was once a large customer of Servicio Satelital, yet it had its own hubs and VSAT service. Then finally, a few years ago, it moved all its connections to its own hubs. COMSYS believes that carrier extension will grow as an area of business for many operators as VSAT technology increasingly becomes an integrated part of the total solution offered to a customer.

Digital inclusion: Government sponsored digital inclusion programs – bridging the digital divide – include broadband access for schools; connectivity for remote communities; government agency services for tax, land ownership and pensions; broadband kiosks; and agricultural commodity price and market information. The segment has been extremely active over the past ten years – accounting for around 25 per cent of the global terminal market during that time. Worryingly, the first part of 2011 saw several large government projects reconsider their use of satellite – Compartel in Colombia and Enciclomedia in Mexico both seemed to be moving away from satellite as a preferred option. However, by

the end of the year new initiatives were adopted to take the place of these programs and projects of this type have continued to grow and many other projects are currently being considered, bid or deployed in every region of the world.

Primary producers: In Latin America, the strength of basic commodity prices – oil, wheat, soya and sugar cane – between 2005 and 2007 gave rise to a more powerful agricultural business community. Again, the need to be in touch and online is now considered critical by many of these businesses who now come into the "medium" rather than the "small" classification of SME. In India ITC's eChopal program to empower farmers with commodity prices through local kiosks connected via VSAT has been a major and much admired success. This segment was amongst the worst hit by the economic downturn and demand tailed off from 2009 onwards in Brazil, but it has been an area of continued growth in Argentina. In the longer term, we would expect these businesses to recover, but we would also hope that government initiatives would help encourage this. In Asia, the palm oil plantations in Malaysia and Indonesia have long provided a good source of business for the local operators.

Mobility: has become increasingly important to many operators as they concentrate their service sales on the military, government, emergency services, land-based drilling and disaster recovery markets. With companies like C-Com, AVL, Winegard and QinetiQ offering much more robust auto-deploy systems these days, sales have also been seen for mobile cellular cells as part of a service restoration capability. The take-up from land-based drilling oil & gas service providers, stalled again from 2015 onwards as a result of the collapse in energy prices having recovered in 2010 after the last crunch on the O&G industry. Prospects in land-based drilling will pick up quickly when the cycle returns to recovery. At an even more specialised level, the military's requirement for comms-on-the-move has spawned many initiatives in both the hardware and service sides of the business. The integration of specialised, very expensive antennas with high end TDMA mesh and star systems became a big business and whilst it remains so, growth is not quite what it was. More has been seen in the provision of these types of systems for emergency services, DSNG, mobile banking, rural healthcare and other sub-segments.

Our full report discusses the issues and trends behind the maritime and aeronautical segments – the two biggest areas of the market – in greater detail in the international and global sections. The O&G segment is also a big portion of the mobility side both of the land side with COTP auto-deploy antennas and with stabilised systems on rigs, OSVs and various other types of stabilised platforms. The number of VSAT terminals deployed for all of these mobility types and the revenues generated are illustrated in Figure 5 and Figure 6 below, but there are three areas that need to be noted. The first is that the COTP numbers have fallen dramatically over the past two years due to the withdrawal of land based drilling rigs across all areas of the world, but particularly so in the US and Canada. The second is that the US military's roll-out of 2,800 SCPC terminals for the Soldier Network Extension (SNE) is installed on select vehicles under the WIN-T program and this happened primarily in 2013/2014. This caused quite a jump in COTM terminals and revenues, although the latter is hard to calculate because this is a dedicated network which probably has different percentages of the equipped vehicles switched on and off over different period. Finally, there is also the issue of DSNG for which many television channels may take one or two terminals, obviously only used occasionally and mostly operated in-house. For this reason, this is one of the minor sub-segments of the market that is hard to track.

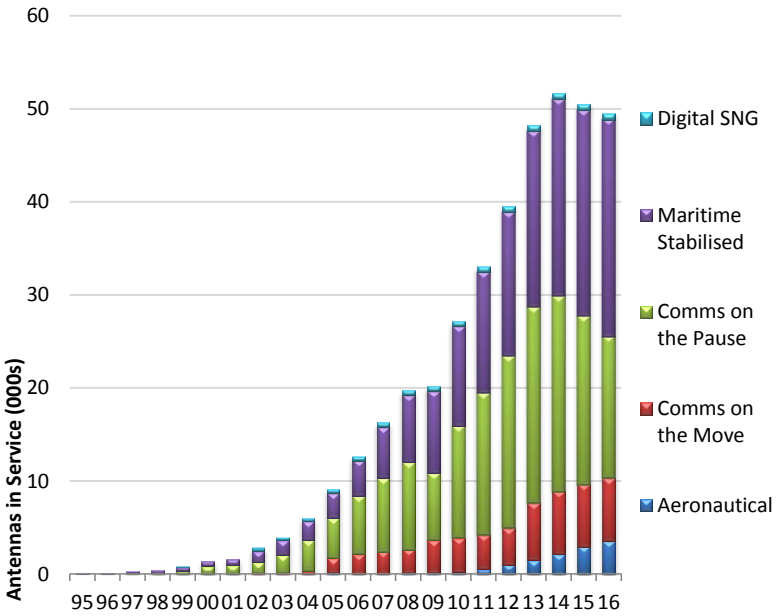


Figure 5 - Mobility VSAT Antenna Service Growth, 1995-2016

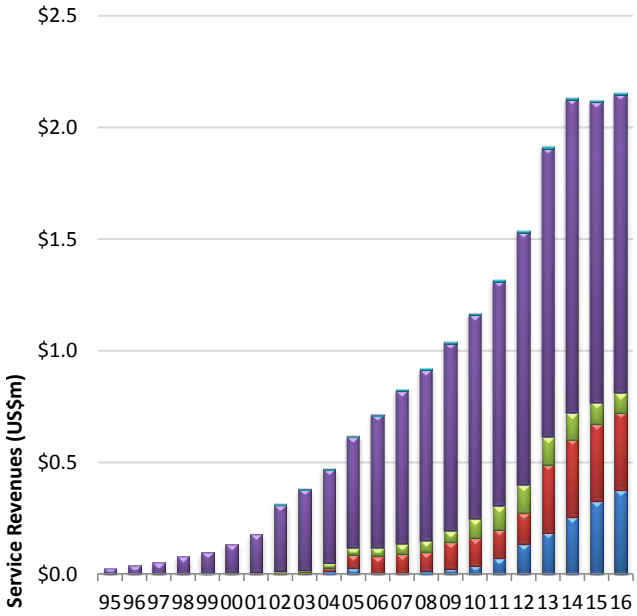


Figure 6 - Mobility VSAT Revenue Growth, 1995-2016

Mining: The mining industry is a small sub-set of the overall resource segment, but it has yielded good business for a few key players. Plenty of operators everywhere mention that they have a few sites with mining companies and that this is a good margin business. The industry does suffer from the same economic ups and downs as the O&G business, although mines generally don't get "cold-stacked" like rigs do and service continues regardless of commodity prices, but growth tails off and price pressures rise. This will always be an important segment for VSAT despite the fact that roads and railways have to be put in place to ensure the mine can deliver its production and if you are building a rail track or a road to the site, laying fibre alongside goes with the territory. Unfortunately, much as some wish to believe differently, mining is never likely to rival the size and overall value of the oil & gas business.

With hardware revenues less robust, the reason for a manufacturer to also provide services now looks more important than it did three years ago. Service brings in a more predictable recurring revenue stream and can bring worthwhile insights to the business of building products. As an operator, there is also something comforting in knowing that your manufacturer is using the same system to support their own business, but then there's also the concern that your supplier might suddenly also be your competitor. For example, Yahsat chose Hughes for its first satellite Y1B and also decided to use Hughes for the African coverage of its second Ka-band HTS, AY3. However, it couldn't bring itself to make the same choice for AY3's coverage of Brazil because Hughes was already a strong service provider in the country and planned its own consumer service which it launched in mid-2016, probably a year earlier that AY3. Gilat also faces this same situation in some markets where it has begun to move its business model from a pure systems supplier to a full integrated and managed solution. This has several of its long term customers concerned that they may find themselves competing head to head with their system supplier.

We have long held that the name of the game for some time now has been service and we believe that any manufacturer without this string to their bow is going to find life increasingly difficult. Margins on hardware are thin and companies must look to supplementary value added services to grow their businesses. We believe that Hughes has done an exceptionally good job in this area and has been tactically smart in determining which markets to enter as a service provider and at what time. Now Gilat is taking a similar approach - one that won't perhaps give it the same margins or longevity, but which carries less risk.

Mixed fortunes: The increase in the number of new operators was pretty impressive between 1997 and 2005 with the latter increases largely driven by iDirect's phenomenal growth which effectively drew in IT businesses, system integrators, dealers and teleports into the business of service provision as a result of its cost effective, easy to manage, highly functional range of hubs with a very flexible and scalable architecture. However, the market has recorded a significant drop in the number of new operators since 2008 and the total number of operators has also shown a net decline following a rash of mergers and acquisitions in the middle to small tier of the market since 2010, so the strategy for all vendors probably has to change from new sales to focusing on ensuring that existing accounts are successful.

Generally, it seems it is harder to sustain a VSAT service business in Europe or North America than it is in the developing regions because the drop off has generally been more extreme. It is also significant that a high proportion of VSAT service providers in Europe and the US are dependent on business done in Africa, Latin America, Asia and the Middle East, in that order. Until relatively recently we could report that the operators which did exit the business often did so through apathy and a failure to invest in new and upgraded systems, rather than a true lack of business opportunities, but this is no longer the case. In Central Europe, Russia and Africa business has been much tougher and several companies have simply not been able to maintain existing customers let alone sign new accounts. The same has been true in other countries around the world where business has become much harder, although these domestic markets have not been as concentrated in one region.

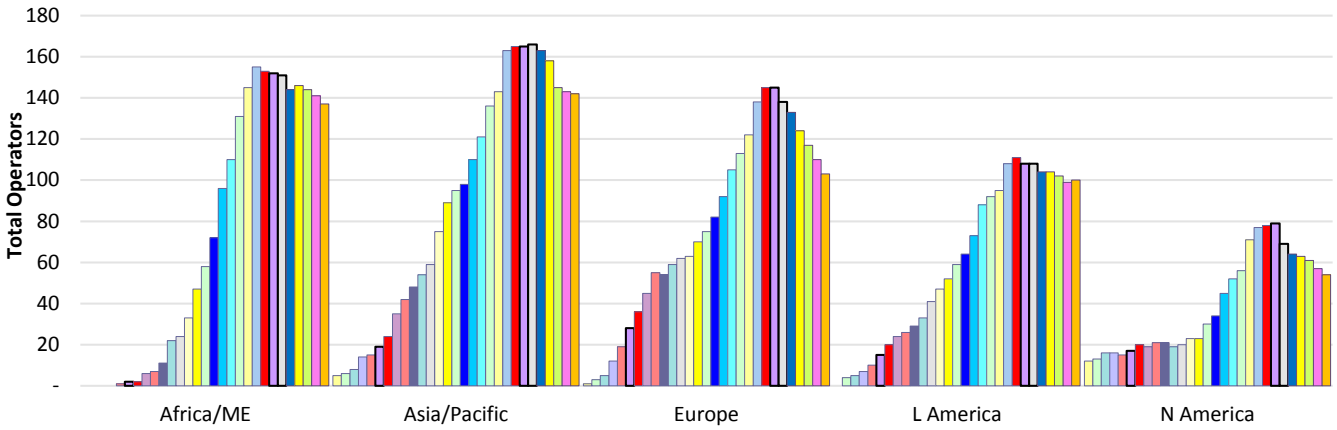


Figure 7 - Operators by Region 88-16

Natural selection is not surprising because, as a leading edge, relatively inexpensive technology, VSAT systems are frequently purchased by small, entrepreneurial companies which often appear to believe that an investment of $2 million to $3 million will be

sufficient. This is rarely the case. For example, Impsat (now GCLA) initially budgeted for an investment of approximately $20 million over three years, but even exceeded that by at least 25 per cent – and that was in 1989. The plain fact is that many new operators completely underestimate the cost of providing an effective VSAT service and it was only the rise in vanilla SME broadband services which required less on-ground support from operators that relied heavily on local VARs that has changed this dynamic. Even so, where financial strength does not exist the effect can be pretty dramatic - as witnessed by Visicom in the UK which only managed to purchase a hub and run its operations for less than a year before it went bankrupt. Now that the SME broadband market is not what it once was, those operators focusing only on SMEs have either had to change tactics or get out. Some of those that have survived and managed to prosper are very good evidence of this – good examples being Talia and Global TT.

Operator consolidation: Our expectation for some time now has been is that a consolidation of operators is inevitable. There are simply too many companies fighting for the same customers and now the market has begun to flatten, space segment pricing has plummeted, there is dwindling differentiation as new hubs are continually brought into operation and, probably worst of all, the advance of HTS will increasingly force VSAT operators to transition to the systems the satellite operators are integrating into their own gateways. Not only will this fuel the satellite operators' move down the value chain and take margin away from the VSAT operator, it will steadily make teleports more of a liability than an asset.

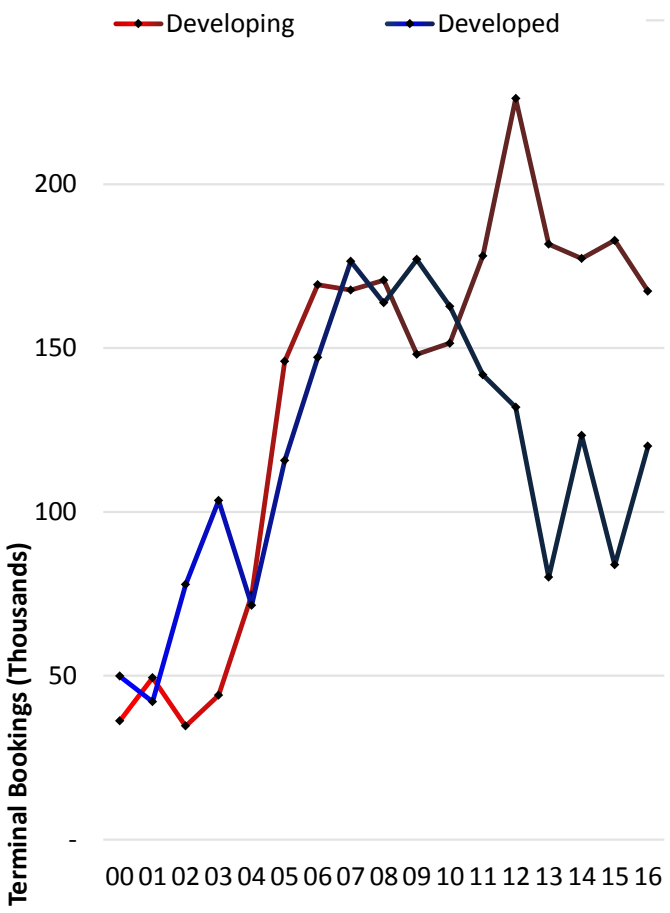


Figure 8 - Terminal Sales - Developed vs Developing Regions 99-16

The expectation of high valuations presented a barrier to several attempts to pursue a strategy of consolidation on the part of some leading operators, but owners found that the kind of offers they could attract, yet turned down, in 2005 and 2006 look impossibly good today, but are now long gone. Many held out only to see valuations for smaller businesses solidify rather than climb back to previous levels. They then divided into two paths – either they began to decline or they found a niche that could sustain and even grow their business. In the Middle East an example of the former is DigitalSkys and the latter is SkyStream, in the US we can take NPL Telecom as one example and DTS as the other. As this process worked its course and consolidation amongst the largest operators was finalised, so a new round of consolidation

began at the mid-level of the industry as typified by the activities of SpeedCast, ITC Global/Panasonic and EMC/Global Eagle with others also harbouring ambitions. However, our point about the liability of teleports is well illustrated by the fact that several potential acquirers that we have spoken to over the past year have made it clear that an operator without a teleport is a far more attractive proposition and, if there is a teleport, they would rather buy the contracts than the assets.

The days of terrestrial replacement by VSAT networks supporting voice and some basic data services in the developing world are now long gone. However, the trend towards more sophisticated solutions provided as part of an applications orientated network has been countered by the growth of IP broadband access. This has happened worldwide – developed and developing; North America and the rest of the world; country by country – so there is no longer a great differentiation between any region or type of economy. Where we can see significant differences they are usually a direct result of local conditions, such as a dominant operator's terrestrial products or a lack of development in a particular segment. Even in these instances, we see demand developing from business segments as they emerge within a country. Good examples have been the rise in interest from retailers in Russia, "Brown Label" ATM networks in India and cellular extension in Myanmar.

The developing world enterprise VSAT markets clearly grew faster than those of the developed world during the 1990s. Ten years ago the markets of North America, Europe and parts of Asia were twice as big as those of SE Asia, India, China, Latin America, the Middle East and Africa, but this changed when the North American business had to re-set itself against the DSL explosion and the changing buying habits of the major enterprise customers. There ensued a bumpy period during which Latin America's government sector pushed much higher growth rates before falling back in 2007 and North America and Europe saw some large account wins in 2007 before the business tailed off in 2008, especially in the west. However, since then, the divergent trend away from the developed regions and towards the developing world has become very clear.

In the past it was true to say that whilst sales lead times were longer and service and support costs more, international contracts generally commanded greater margins for the operators and the manufacturers. However, the large government awards of the last few years coupled with bigger deals as operators have been taking the plunge and ordering significant quantities to bring the cost of the terminal down have changed this situation. There was a point when there was a valid argument that the scale of businesses, chains and franchises was much larger than in the developed world than it was Asia, Latin America, Africa and elsewhere, but this is no longer the case and banks, gas convenience stores and other chains now proliferate everywhere.

2.3. Consumer Developments

The experience of the satellite consumer services in the US, Canada and Australia validates that a large market really does exist and whilst some might argue that this market is a limited window of opportunity, it is worth pointing out that areas of the Australian outback are unlikely ever to see fibre and, even with some of the most sophisticated and well-funded services in the world, four million US farms do not have access to DSL or cable broadband. In Europe it is estimated that there are as many as 13 million disenfranchised customers. The biggest competitive alternative however, is LTE/4G and this is already seen as the largest source of erosion of the consumer customer base in Australia.

COMSYS continues to expect the near term future of broadband satellite access in the developing economies is more likely to lie with small businesses than the consumer and that this has largely been proven out by Yahsat and Avanti in Africa. However, what once was a definable segment in terms of the service delivered, is now hard to distinguish from simple consumer internet just because rates and volumes have risen so fast on the consumer side. Thus, we believe that SME broadband as a defined and separate market will soon be a thing of the past.

Satellite consumer internet services are now beginning to be seen in more regions of the world, but there has yet to be a proven profitable commercial service outside North America. Without question, Hughes and ViaSat have done an outstanding job and achieved some remarkable milestones as well as providing the basis for Xplornet's success in Canada. However, internet connectivity is more expensive in the US than it is in Europe and this appears to be one of the primary reasons behind the slow rate of progress seen by SES and Eutelsat. It may well be that less sophisticated marketing and partnership arrangements have contributed to this situation, in which case the emergence of ViaSat as a partner with a controlling interest of the retail side of the business will make a difference.

Hughes, on the other hand, initiated its own consumer service in Brazil in mid-2016 and its subsidiary, Hughes do Brasil, informed us that it worked very hard to ensure that its service combined the consumer experience of its US parent with its own local knowledge. The company announced in early 2017 that it had reached 40,000 subscribers, an extremely successful achievement versus what has been achieved by other players in Latin America and other developing regions.

All of this brings greater hope that VSAT can establish a presence in the consumer marketplace in regions other than North America. The biggest issue for markets in developing regions is that of the cost of the terminal and there is a spreading belief that the only really credible way for VSAT to penetrate these markets will be by combining a terminal with a local wireless or cellular system to enable smartphone connectivity and low cost PAYG packages. ViaSat has already initiated a trial system in Mexico based on its ViaSat-1 satellite and informs us that the take up and acceptance has been very strong. When it brings ViaSat-2 into service with greater coverage of the country it plans to expand this offering. OneWeb has a similar strategy and has already talked about the fact that it plans to work primarily with cellular service providers to licence a local service which will be connected via its VSAT terminal which will have small-cell BTS functionality built into it. With the growing

acceptance of VSAT as a cellular backhaul solution for rural areas and the adoption by many governments of the concept of using this strategy to extend broadband to the unconnected rural population, this looks like the future for satellite-enabled consumer internet.

2.4. Current Summary

The VSAT industry faces some huge challenges today in terms of both competition and future growth. Substantial opportunities lie with all types of mobility services, increasing acceptance of TDMA VSAT technology as a means of extending 4G cellular coverage, expansion of the satellite consumer internet internationally and the enablement of rural broadband connectivity with government support in both developed and developing markets. However, whilst a segment sales opportunity, cellular has also emerged as VSAT's single largest technology competitor for both transactional, low rate networking as well as broadband. In addition, many customers already have the means to connect via smartphones. Thus, we believe that VSAT is undergoing a step change that underlies an unpredictable market and is the reason behind a disappointingly flat performance over the past three years.

In terms of the current market status, regionally the primary points of note are as follows:

- ***North America:***
  - ***Enterprise TDMA services*** are declining, but backup applications are holding some networks to VSAT. Augmentation through HTS services is expected to re-start new growth. The major area of enterprise business revolves around managed hybrid solutions for a similar sub-set of traditional VSAT customers including retailers and restaurant chains. Video and media-related applications in addition to the diversity brought by a satellite connection provide value. Lottery networks remain amongst the last stand-alone large scale network users, but are experiencing erosion and strong competition from cellular data.
  - ***Corporate networking*** endured major declines in the offshore oil & gas and land-based drilling segments. Mining, maritime and state government disaster/emergency segments remain strong.
  - ***SME Broadband services*** are also declining as consumer service packages improve.
  - ***Consumer*** internet services are influencing many aspects of the VSAT market with high volume sales, proof that satellite consumer internet can be a viable business and development of marketing, sales and delivery expertise.
  - ***Space segment*** prices are now amongst the highest seen in the world, especially in Canada. The reasons and support for this situation in the US are unclear, but Canada remains almost a Telesat monopoly.
- ***Western Europe:***
  - ***Enterprise TDMA services*** are overly reliant on just a few key accounts. Hybrid service platforms are growing, but not as fast or on the same track as the US market, possibly due to national differences. Demand for SCADA networks continues to grow, but cellular data services are becoming more competitive and

eroding transactional networks. Emergency services and replacement of legacy TETRA networks look set to grow.

- ***Corporate networking*** is dominated by the maritime segment which is growing well with good potential. Other corporate customers are mostly served from Europe as a hub.
- ***SME Broadband services*** have entered a decline.
- ***Consumer*** services face disappointing performance, but have been bolstered by government subsidy schemes in some countries.
- ***Space segment*** for VSAT is now dominated by Ka-band HTS, low price capacity.

- ***Eastern Europe/FSR***:
  - ***Enterprise TDMA services*** in Russia have flattened and one operator's growth is dependent on another's decline. Market defined by the large and strong operators pursuing acquisition and consolidation strategies which will result in stronger players with more clear cut strategies. Most other countries showing sharp declines as fibre pushes further into the frame.
  - ***Corporate networking*** has suffered from the oil crisis, but the government, cellular and maritime segments continue to hold up. On the government side, expect RTComm to dominate this area in the future.
  - ***SME Broadband services*** have entered a decline, not helped by the financial issues affecting the economy.
  - ***Consumer*** services have only been launched relatively recently in Russia and still remain at the initial stage of development; however, they show more initial promise than Western Europe. Competition between AltegroSky, Raduga-Internet and RuSat looks fierce and, in some cases, irrational and lack of disposable income is hampering service take-up. Most other Eastern European countries have little or no demand, aside from Ukraine with Datagroup pushing over the 10,000 mark and focused on further gains.
  - ***Space segment*** pricing and availability, the bane of the region for many years, have both turned the corner. Prices for many are dropping and capacity supply, thanks in no small part to RSCC's investment injections to build out its fleet, is no longer a problem with growing Ka-band and currently plentiful sources.

- ***Latin America:***
  - ***Enterprise TDMA services*** largely based on government programs, telco extension and cellular backhaul. Large contracts leave operators with potentially volatile businesses in some countries and a trend away from primary and towards backup is mirroring the US. However, most operators continue to look healthy.
  - ***Corporate networking*** has had to endure the oil price crisis, but maritime is a growing vertical, mining remains strong and military demand continues. SCPC services have continued the steady decline we have recorded for several years, now largely as a result of the move of cellular backhaul to star TDMA systems.
  - ***SME Broadband*** service growth picked up in 2015 and 2016, but economic conditions remain challenging.

- ***Consumer*** service growth has been patchy for MNLA in a few countries, but the HughesNet Brazil service and incoming Yahsat services look to be opening the door to future growth.
- ***Space segment*** availability has improved and whilst price declines are not as significant as seen in Africa and Asia, they are beginning to happen. As more Ka-band is deployed, so prices will drop as capacity enters oversupply.

- ***Asia/Pacific:***
  - ***Enterprise TDMA networks*** are growing, but under heavy price pressure in the largest market, Indonesia, making it hard for operators to maintain margins. Government, banks and agriculture are the primary sources of demand, but ATM services have faced heavy price pressure. Government sponsored cellular backhaul networks are a growing opportunity as well as Softbank's deployments in Japan.
  - ***Corporate networks*** for oil & gas exploration are weaker, but maritime services are growing in Indonesia, Singapore and China. Maritime, mining and telco extension are the corporate segments with the most robust growth, although services to the resource industry in Australia have ceased to grow. Mobility has become a recurring theme ranging from disaster recovery in Japan and China to mobile post and banking services in Malaysia.
  - ***SME Broadband*** services are dominated by IPStar's service in Thailand and some providers in Indonesia and the Philippines. Subscriber numbers have been growing since the decline seen in 2012.
  - ***Consumer*** subscriber counts declined in Australia as the older subsidy customers were converted to the NBN Co.'s new service and LTE/4G services began to eat into satellite's territories. New Zealand saw growth, but its subscriber base is an order of magnitude lower than Australia and there are no other major operations in the region.
  - ***Space segment*** pricing is dropping except for some markets like Indonesia where DTH services are still growing. General expectations are that SE Asia will lead the market in price reductions along with Africa.

- ***India:***
  - ***Enterprise TDMA services*** continue to do well in India driven by government projects for ministries, schools and rural broadband. ATM service growth has declined after the finalisation of the government subsidy program. Banks continue to roll out networks, but on a smaller scale.
  - ***SME Broadband*** services have tapered off in India and operators do not see potential in this area of the business.
  - ***Corporate networks*** for oil/gas are the only segment open to operators. Military networks are a good business, but are dedicated integration projects. Mobility licences are restricted, but many companies are working on obtaining licences and entering the maritime and aeronautical segments.
  - ***Space segment*** availability is about to improve with the launch of the first GSAT HTS Ku-band satellite. Foreign capacity licences are being closed down and all operators are required to move to domestic satellites by 2018.

- ***Africa:***
  - ***Enterprise TDMA services*** saw flat growth in the in the number of sites and declining revenues from 2014. Banking networks continue to grow slowly and, similarly to other regions, government networks are growing in importance.
  - ***SME Broadband*** subscribers saw a sudden decline in 2015 due to the political situation in Libya. Africa has generally taken advantage of Ka-band satellite capacity from Yahsat, Eutelsat and Avanti. Yahsat restructured its service models and saw subscriber drop off in sub-Saharan markets.
  - ***Corporate network*** growth was subdued by the pull-back in O&G segment. Cellular backhaul services continue to show potential, but many networks remain in-house. Demand from NGOs remained robust. SCPC links remained in decline undermined by rapidly falling fibre prices.
  - ***Space segment*** availability has continued to improve and capacity pricing is now amongst the lowest in the world.
- ***Middle East:***
  - ***Enterprise TDMA services*** have advanced in the smaller countries like Qatar, Kuwait and Oman. Iraq has experienced rapid expansion of fibre and terrestrial wireless systems. Demand for banking, utility and O&G networks has held up in Saudi Arabia, but political changes have seen a more depressed government market. Iranian banking services continue to exhibit a slow decline.
  - ***SME Broadband*** subscribers have been declining since 2008 and saw a further reduction of 25 per cent between 2014 and 2016.
  - ***Corporate networks*** declined in revenues, largely due to less regional presence from military organisations. The O&G segment remained relatively strong versus most other regions. Cellular backhaul networks expanded. SCPC links, once buoyant due to the military, have not grown since 2009 and between 2013 and 2015 annual reductions jumped from around five per cent to over 15 per cent. Dedicated domestic military networks are still being contracted as integration contracts, but rarely as a service.
  - ***Consumer services*** are currently almost wholly reliant on the success of Yahsat's strategy for YahClick, but success in the Middle East has been severely compromised by the company's lack of access to the key markets of Saudi Arabia and Iran.
  - ***Space segment is less of a problem*** than it once was with availability and pricing now considered reasonable.
- ***Global Services:***
  - ***Corporate networks*** saw strong growth in the maritime and aeronautical markets with significant potential for ongoing future expansion. Other global services for the government segment primarily Ministry of Foreign Affairs/Embassies, military organisations, NGOs and telecom extension also grew. Only the offshore oil & gas segment declined.
  - ***Space segment*** prices are being pushed down by the aggressive and powerful players in the aeronautical market. Current aims are said to be MHz pricing below $200.

3. The Future

The changes already seen in the VSAT and satellite business over the past five years cannot be considered as indicative of what the industry will look like five years from now. Some of the technological and system innovations that are now in process have the potential to radically change everything and can be compared with something as massive as the emergence of cellular systems in the terrestrial world. From a top down perspective we believe that the structure and business models behind the satellite operators will have to be completely changed and, as the most powerful and profitable companies in the business, this is going to bring a major impact to every other level of the industry.

The one word descriptions which essentially summarise these impacts are:

- Consolidation
- Verticalisation
- Commoditisation

Hughes and ViaSat have already proven the business model – build your own VSAT system, operate your own satellites and run your own service. The problem for the satellite operators is that they will have to redefine their current business expectations in terms of margins, cash generation and investment and learn how to focus on managed services as opposed to the sale of capacity if they are to succeed. It is entirely possible that some will crash during this journey whilst alternative competitive approaches will come from other angles moving the satellite operators from being the centre of change to just a part of it. It is not beyond the realms of possibility that the impetus will come from the largest service providers like Hughes, ViaSat and Panasonic and they will ultimately look to acquire or merge with a satellite operator.

A mixed result is probably more likely with some of the major satellite operators taking this course and acquiring both a systems manufacturer and one or more major managed service operators, whilst ViaSat might end up merging with or buying Eutelsat (or the other way round). As the owner of its own satellites and part of EchoStar, Hughes is also already on the first step of this process. Panasonic has started down the space segment track with its hosted payloads, now has a more diversified service business since buying ITC Global, could potentially acquire Newtec now that it has adopted the Dialog platform and certainly has the financial muscle to pull something like this off - provided it also has the corporate determination to do it. This verticalisation strategy within the industry has already begun, but it is possible it will progress in fits and starts as the full requirement is understood by investors and management of these companies.

Then there is the question of alternative satellite systems including LEOs and HAPS and just how these projects will change the market. In many ways they represent the brightest spot for the future of VSAT services, finally bringing the unique attributes of satellite connectivity together with performance that can match and even challenge fibre systems. The wider LEO constellation projects will face some issues regarding the universal capacity coverage most will deliver and the inability to focus more bandwidth where it is actually needed. However, latency at - or below fibre rates on some routes - will undoubtedly be a game changer and

this, coupled with the ability to augment bandwidth hotspots with integrated GEO services will have even more impact.

4. VSAT Market Shares

4.1. TDMA System Vendor Market Shares

The primary market share calculation for this report is the number of shipped terminals for each of the interactive VSAT system vendors. Hughes Network Systems established an early lead in the industry and has maintained it ever since through a combination of market strategy, product innovation, application support and, ironically, market share. In its simplest form, the sheer volume of numbers which Hughes commands has enabled it to build and order larger volumes of equipment and therefore, we believe, a lower cost of manufacturing than its primary competitors. In part, this is undoubtedly the case, but it seems also true that higher volumes generally have benefited all of the system vendors, particularly in terms of antennas and RF systems. One of the other differentiators, however, is the fact that the larger suppliers, primarily Hughes, Gilat and ViaSat, are able to more accurately predict their likely requirements and can therefore gain benefits by placing advanced bulk orders with component suppliers.

Manufacturer	System	Terminals Shipped	Market Share
Hughes	**Jupiter/HN/HX & PES**	**2,140,873**	**46.8%**
Gilat	SkyEdge II/II-c & Legacy	1,171,345	25.6%
iDirect	Velocity/Evolution/iNFINITI	521,467	11.4%
ViaSat	SurfBeam/LinkStar & Legacy	269,689	5.9%
Newtec	Dialog/Sat3Play & Legacy	67,873	1.5%
Others		325,826	7.1%
Discontinued Systems		81,869	1.8%
Total		**4,578,942**	**100.0%**

Table 2 - Shipped VSAT Market Share by Vendor - Historical Enterprise/BB to end-2016

Hughes' early success and volume manufacture allowed it to enter long-term markets in advance of any of its competitors – it was the first to begin marketing in Europe, the Middle East and Africa. In addition, many of the company's partners, operators and customers were wooed by its market share and signed up in the belief that when US customers expanded internationally, they would take advantage of their system. In some instances, this has almost certainly been the case. Whilst undoubtedly having to win a contract on its merits, Telesat Canada did not suffer from the fact that the large parents of several Canadian subsidiaries had already signed up to Hughes. Operators also buy Hughes because they know it works - perhaps a trivial way to say this and something which also applies to other systems, but customers find comfort in the fact that the technology risk is minimal. In addition, the company has been able to build up application support for its product platform based on a strong order flow from its customers whereas some of its competitors have been forced to develop their own products without an established demand simply in order to stay level with Hughes. Whilst some companies frequently demand payment to develop new features, Hughes is one of those that simply incorporates these requests into its existing R&D plan.

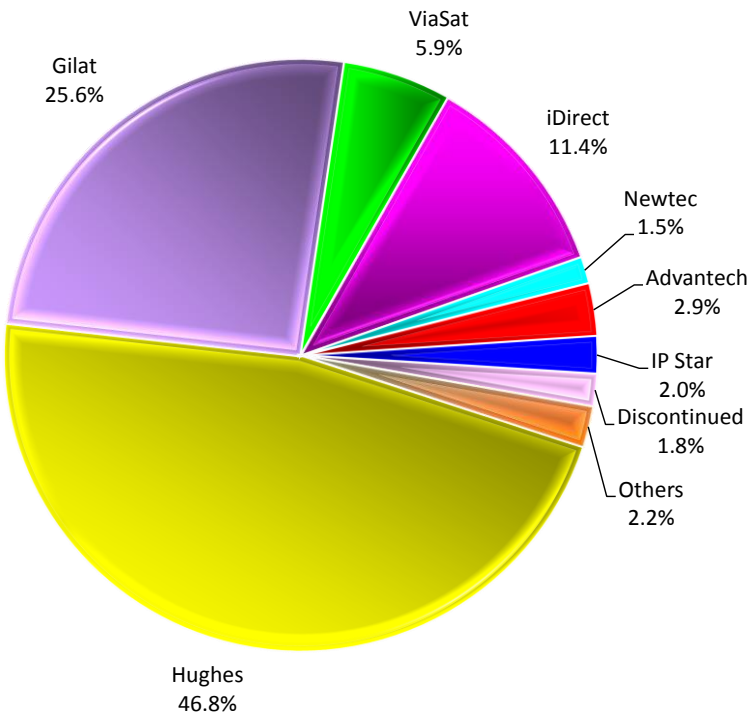


Figure 9 - Interactive VSATs - Vendor Historical Enterprise Shipped Market Share

This is not to say that Hughes has not been careful and managed its business well because it certainly has. Almost invariably its partners and operators have been strong, well connected and have sold well. It is no coincidence that operators of Hughes hubs have, on average, many more billing VSATs on their systems than their competitors or that the company's ship to service ratio is the highest of any of the major vendors. Another advantage of being number one in the market and often the first into new regions has been that it has had the pick of the partners on offer. However, Hughes has also proved itself to be perfectly capable of managing foreign business on its own and in many of its ventures it has either bought out its original partner or assumed complete management control of the business. The only times when it has had an obvious problem have been almost exclusively when it had a minority position - and in most cases it has exited from these ventures. In terms of simply running its VSAT business from a basic value perspective, the company has managed the two parts - international and North America - almost flawlessly. Of course, there have been times when Hughes has slipped and opened itself up to criticism for losing focus on customer support or taking its foot off the development pedal in one area due to focus in another, but all these issues have largely been temporary and the company continues to march forward seemingly inexorably.

Hughes' DNA is in engineering and this has formed the basis for a solid, functional and flexible product platform that has been the foundation of its long-term success in the market. However, its hardware platform has increasingly become the main tool in the company's primary objective to build a strong service business rather than the sole source of revenues. Hughes carries this message into those customers that purchase its products – that its own strength and experience in enterprise and consumer VSAT services gives both its products and, as a consequence, its operator customers an edge that other vendors cannot offer.

Nevertheless, the huge advantage which Hughes enjoyed through its dominance of the market and the refinement of its VSAT platform was tested by the advent of IP as the *de facto* standard, wiping out many of the legacy-based advantages of the ISBN/PES platform. Hughes responded with its own products which have since evolved into the Jupiter and HX systems. The company was the first entrant into the consumer Internet business with its

DirecPC service and believes that, as painful as the venture was initially, it taught it some useful lessons about the nature of the customer, traffic patterns, sales channels and consumer management - all things in which an enterprise-led company was not necessarily well versed. Gilat beat it to the punch in the launch of a true interactive consumer Internet access service, but only by tweaking existing platforms and the two companies largely hit the market with their pure consumer platforms (the DW4000 and the SkyBlaster 360) at around the same time.

Manufacturer	System	Consumer		Consumer/ Enterprise	
		Terminal Shipments	Market Share	Terminal Shipments	Market Share
Hughes	**HughesNet**	**3,660,316**	**52.4%**	**5,801,189**	**50.2%**
ViaSat	SurfBeam	2,757,964	39.5%	3,027,653	26.2%
Gilat	SkyEdge II-c	251,568	3.6%	1,422,913	12.3%
IPStar	Generation 2	160,450	2.3%	251,309	2.2%
Newtec	Sat3Play	156,503	2.2%	224,376	1.9%
iDirect	Evolution/Velocity			521,467	4.5%
Other Enterprise				316,836	2.7%
		6,986,801	**100.0%**	**11,565,743**	**100.0%**

Table 3 - Shipped VSAT Market Share by Vendor - Historical Consumer/Enterprise

Hughes' long term strength then showed through as Gilat's business started to unravel and StarBand was forced into Chapter 11. A combination of HNS' stability and Gilat's problems allowed HNS to once again build a significant lead over its nearest competitor in the consumer market. As Gilat restructured and then successfully re-built its business almost from the ground up: regaining financial stability, maintaining existing accounts, consolidating its hardware and service assets and then, in 2004, releasing its SkyEdge platform, it had to let go of its ambitions for the consumer business. Nevertheless, from facing what seemed to be almost certain bankruptcy in 2002, Gilat came back firmly as the second largest VSAT manufacturer in the enterprise market and a force to be reckoned with again.

With the launch of Telesat's Anik F2 Ka-band spot beam satellite, Hughes had to face up to the challenge from WildBlue on the service side of the consumer business and from ViaSat as a manufacturer. WildBlue took about a year to achieve real scale, but by the end of 2006 it was matching Hughes' monthly sales. Telesat also began to ramp up its service delivery in Canada and the market for consumer broadband services really began to reach mass market volumes. Ever since then there has been a see-saw act going on in both the United States and Canada as satellites and beams have been filled up and stalled growth before sales can begin again as new capacity is introduced. ViaSat's acquisition of WildBlue saw the company pitched head to head with Hughes as a fully vertically integrated provider of service and hardware and both companies have a strong relationship with Xplornet in Canada which now accounts for the majority of the consumer sales in the country. As a result of all this, the new era of consumer satellite internet access services in North America that we predicted in the 12th Edition of our report truly kicked off and sales have been extremely buoyant in North America ever since mitigated only by the periodic saturation of capacity.

In the meantime, Hughes has simply continued its command of the enterprise VSAT market. Not only has it sold close to half the total enterprise VSATs globally over the past two years with average annual shipments to the enterprise market running at more than 120,000 units

between 2012 and 2016. With a product line that uses the same basic architecture to deliver internet access to over one million subscribers and yet is also powerful enough to deliver multi-megabit, high QoS meshed links to a specialist application, Hughes has managed to achieve the virtually impossible. Others can potentially match the company in different segments, but none can claim the flexibility and sheer application power across so many potential markets as Hughes can with its Jupiter/HT/HN/HX family and, we believe, this one of the main reasons that Hughes ultimately prevailed with accounts like Yahsat and Telefónica's Media Networks.

In Asia, IPStar's arrival in the market with a Ku-band, spot beam satellite saw most of its success outside its native Thailand in the Australian consumer market, quickly matching the monthly run rates of the pace-setter Optus. Along with lower volume sales in the New Zealand market, IPStar gained a toe-hold in the global market for consumer VSAT terminals, albeit only on its own satellite. However, now that Australia's NBN Co. has launched its own service on its own satellites using the SurfBeam2 ground segment system from ViaSat for its Ka-band satellite service this source of sales has dried up and the number of terminals in service has almost withered away. In addition, with the decision to adopt an open system policy a few years ago that has seen Hughes, Gilat, iDirect and Comtech systems deployed on IPStar's previously restricted platform, it's almost certain that the system has now essentially reached end-of-life and that Thaicom/IPStar will cease its system hardware business. Manufacturing VSAT terminals was never really the smartest thing for a satellite operator to involve itself with and IPStar's initial business strategy to demand a long-term bundled capacity/hardware deal for each of its national beams was neither very practical or flexible.

However, it is notable that the company has really shone the light on the future of the business in many ways. Whilst it was almost certainly too early, it was the first to design and build an HTS satellite and was the first satellite operator to pursue a vertically integrated strategy involving a spacecraft, VSAT platform and managed services business. Hughes and ViaSat have since proved that this concept can work extremely successfully and as the major satellite operators increasingly struggle with their businesses and consider some form of verticalisation, they may well end up moving down the path that IPStar lit up many years ago. A move into managed services is already on the cards and one or more may even decide to acquire one of the VSAT vendors in order to emulate what Hughes and ViaSat have achieved.

The European consumer market was kicked off by SES Astra with the announcement of its Astra2Connect service (now named SES Broadband Services or SBBS) in September 2006 using a new product from Newtec. The first shipments of this system were made in 2007, but it was not until the first part of 2008 that the service began to be sold in volume. By the first quarter of 2011 SBBS reported 80,000 units in service, making Newtec the fifth competitor in the development and supply of consumer VSAT terminals. SES has subsequently added a series of Ka-band payloads to its broadband service portfolio and, during 2011, ran a process that endorsed Newtec's Sat3Play as one of its Ka-band suppliers, but also added Gilat's SkyEdge II-c system.

The consumer market internationally then took another turn with Eutelsat's Tooway service, which finally opened up full commercial service in July 2011 following the launch of Eutelsat's 70 Gbps KA-SAT spacecraft, although a low-level interim service on conventional

capacity was running for three years prior to this on ViaSat's original SurfBeam platform. The company then went on to use the second generation SurfBeam system as its principal platform for the KA-SAT Tooway service. Both Eutelsat and SES have been a little coy on the release of information on subscriber numbers for their services – most suspect this has been because progress has been disappointing. From the data we have been able to gather SES' service appeared to peak at around 80,000 subscribers in the early part of 2013 and has subsequently declined to between 50,000 and 60,000. Tooway appears to be travelling down a similar path. The service overtook SBBS in 2013 and then grew to 190,000 subscribers by the end of 2015. However, towards the end of 2016 Eutelsat reported that this number had fallen to 179,000. Avanti has also launched consumer Ka-band services on its HYLAS 1 and 2 satellites using the Hughes platform, but we believe that most of the company's subscribers have come from SMEs rather than consumer sales.

ViaSat looked like it was pulling away from Hughes in the international Ka-band market when, in October 2009, it announced that the same platform had been selected as the ground segment for Yahsat's YahClick service. However, in a dramatic turnaround, Yahsat decided to swap allegiance to Hughes. The reasons behind this were complex, but we believe much hinged on the fact that Hughes' platform was able to demonstrate a proven enterprise feature set whereas this was something ViaSat was going to have to integrate from other, older, products or develop from scratch. YahClick launched on Yahsat-1B's Ka-band spot-beam capacity in late 2012 with coverage of the Middle East and parts of Africa, but has seen most of its sales to date in Africa and Afghanistan. The number of subscribers remains in the low thousands not least because, as mentioned elsewhere in this report, Yahsat has been unable to penetrate the two largest markets in the Middle East – Saudi Arabia and Iran and has seen most of its business from small businesses rather than consumers.

Several operators in Russia began selling consumer services based on capacity from Eutelsat and Russian satellite operators from 2012 onwards. ViaSat's SurfBeam 2, Gilat's SkyEdge IIc, Newtec's Sat3Play and Hughes' Jupiter system have all been deployed, but the number of subscribers in service remain quite modest at around 30,000. In Australia NBN Co. finally launched its Ka-band service in 2016 using SurfBeam 2, but has primarily been converting subscribers from its interim service which was supported by Optus with Gilat and IPStar. Australia had around 70,000 households connected as of the end of 2016 and most expect the service to peak at around 150,000 to 200,000. However, this is a government subsidised program and so cannot really be compared with most other satellite consumer markets.

In Latin America, Telefónica's Media Networks initiative on the Amazonas satellite, for which it selected Hughes' Jupiter platform, began in 2013. Again, it has modest success in some countries like Chile and experienced disasters in others like Brazil – coverage is also very patchy across several countries in the continent. In mid-2016 Hughes do Brazil launched its own consumer service, leveraging off its local operational knowledge and history as well as its parent's long established and successful consumer experience in the US. It remains early days and the company has been very quiet about its progress, but we understand from various local sources that it has been very successful to date. This is something that should begin to encourage other operators with ambitions in the satellite consumer internet space because up until now there has been little evidence of worthwhile business outside of North America. No doubt Yahsat, who has teamed up with Newtec for the Brazilian coverage of

AY3, will be far more optimistic about its prospects, although it will face a formidable competitor who has some real advantages and a considerable head start. With more Ka-band projects being considered in several other areas of the world and no shortage of potential and eager ground segment suppliers, yet with the market still dominated by the United States, the consumer business remains a relatively open race, albeit dominated by Hughes and ViaSat.

Part of Hughes' stability, even throughout the Internet bubble, was a direct result of its conservative approach to its VSAT business. The company generally managed to avoid risky investments in the dotcoms (or network dependent businesses, NDBs, as Gilat termed them) and we are aware of several deals from which Hughes walked away when the risk profile simply looked too bad. It took the same approach with rural telephony, avoiding service ventures and risky financing deals in a sector of the market which suffers from onerous regulation, tariff restrictions and currency fluctuations. The same has been true for the consumer deals that have been bid. Hughes has resisted the lure of huge potential volumes with extremely low price tags attached to the terminal and, for a while, this did appear to run the risk of being left behind in the international Ka-band VSAT market. However, the company persisted – illustrating the first lesson for all other VSAT system vendors: never take your eye off Hughes – and recovered the situation in spectacular form. As a consequence, Hughes' customer base in all of its product lines is solid and bankable and has no nasty surprises of a scale which Gilat was forced to reveal from 2001 onwards. The acquisition of Hughes by EchoStar was a very smart move and today, Hughes pretty much accounts for all of EchoStar's growth.

In 2008 Gilat looked to have been largely left behind in the consumer business, but we commented that it has always been a tough competitor. The company has always led with its chin, has never been scared to push the envelope on prices and continually built features into its platform for which others would otherwise have charged extra. The company's competitive spirit and determination to find a place in the consumer business was illustrated when first it won the deal to provide the interim solution for NBN Co. in Australia, which subsequently yielded sales of around 50,000 terminals, and then it found a place in Ka-band with its contract to provide the ground segment for SES' follow on for Astra2Connect. These wins were important stakes in the ground for the company and give it far greater assurance for the future. The company continues to aggressively push its SkyEdge IIc platform which it managed to release into commercial service extremely quickly following the award from SES. SkyEdge IIc is now the primary technology platform for both its consumer and enterprise offerings and has been widely adopted by many operators.

Gilat's presence in the market undoubtedly galvanised Hughes and, its commitment to increasing functionality and lowering prices, pushed its primary competitor into advancing the market at a speed that might not otherwise have happened. This has been good for both Hughes and the market as a whole. Gilat established itself as a fierce competitor from its entry into the market with its sale at Rite Aid and went on to refine its product and then expand its business with its acquisition of GE Americom's Spacenet business in 1998. This gave the company a service presence in both Europe and the United States and, whilst we never believed that this represented the company's chosen strategy (having had its hand somewhat forced by the GE decision to sell Spacenet) it did an admirable job of restructuring the US business and focusing it on building an organisation which could hold its own with

Hughes. However, bearing in mind our view that the service business was never a great attraction for Gilat, it was not a surprise when the company announced that it had sold Spacenet to SageNet at the end of 2013.

Gilat pursued a momentum strategy which was a great fit for the dot-com years, but ultimately proved to be its downfall when many of its risky deals turned sour. Some of the large deals it had done with "new economy" businesses as well as its ambitious consumer strategy were ultimately so bad that subsequent write-offs in 2001 destroyed all of the profit the company had made in the previous ten years. Yes, the company finally achieved its dream of booking more units than Hughes, but the bookings themselves were a dream and Hughes was always ahead in the real business of shipping product for money. For several years after 2001, Gilat underwent rounds of restructuring and write-offs until its financial fundamentals finally made sense. After some solid financial leadership which righted the ship, new management composed of former founders of the company brought a passion back into the business and the company used its strong technical capabilities and a robust and flexible product line in the SkyEdge, to support a value-added strategy, mining more value from its customers by integrating and managing complex projects, in addition to supplying the hardware itself. The company's engineering expertise is recognised across the industry, its product suite, now bolstered with the SkyEdge II-c consumer platform, is fundamentally strong and has proved itself to be very flexible. Gilat's customers buy its systems because the company keeps them at the forefront of the market in terms of both technology and price.

Along with Hughes, Gilat's systems have earned themselves a reputation as extremely reliable and functional platforms, able to support the major demands of a demanding corporate customer base. As a consequence, since 2004 we have seen Gilat and Hughes often fight head-to-head as they always have done and Gilat now competes on a level playing field without having to face fundamental business stability issues.

Two big management changes at Gilat over the past five have resulted in a series of strategy re-orientations which have begun to change the general perception of the company in the wider marketplace. At first the focus was on moving the business away from service and towards, what was at the time, the attractive specialised military market. The company recognised that increased mobility capabilities were an essential part of this and this drove its acquisitions of RaySat and its COTM antennas and WaveStream and its integrated RF product line that had seen a lot of business flow from military customers. The attempt to establish a strong position in the military segment was not a success because it coincided with the military pull-back from the Middle East and Afghanistan and every satcom-related company very quickly began to feel the pinch. Fortunately for Gilat, it was around the same time that all areas of the mobility market started to become of more interest. The largest of these was aeronautical services and Wavestream's compact, powerful and light product was a popular choice amongst the aero service providers. As the military business stuttered the decision was made to widen focus on mobility applications. Then a second management change suddenly reversed the move away from the business of managed services.

Leaving aside its foray in the US with Spacenet, Gilat really began its service history in its home country, Israel, and then a few years later with its creation of a service company in Chile in 1997 to catalyse the adoption of its rural telephony product, DialAway. The new

owners and managers of the company consequently took hold of this and decided to build upon this approach in other regions of the world and have subsequently cut deals with Telstra in Australia and Telesat in Canada. Other possible arrangements with Softbank in Japan and its subsidiary, Sprint, in the US are also on the cards. For Gilat this potentially opens a new source of revenues, allows it to leverage and sell its product platform and diversifies its avenues of growth. On the negative side, some customers are beginning to feel concerned that their supplier might also now be their competitor and, faced with a similar threat from the satellite operators, this is not considered to be a healthy situation.

As already mentioned, Hughes began this transition many years ago and it has proven to be an important mainstay for its business. In fact, its service operations now represent the core of its revenue and growth. It did have to face a rejection from some hardware customers as a consequence, but was very adept at limiting this to specific markets where it saw significant opportunities, but with operators unwilling to really attack the market's potential. A case in point is Brazil, where it now has a large enterprise service business and possibly the most successful satellite consumer service outside of North America. The price it paid for this was Yahsat's unwillingness to extend the Jupiter platform it has implemented and upgraded for its Africa and Middle East coverage into Brazil. In hindsight though, this might prove to be another advantage for Hughes. Either way, the challenge for Gilat will be to manage this potential area of conflict and ensure that it doesn't lose more business than it gains with its turnkey managed solution strategy.

However, ViaSat's real passion and long term strategy lies with the consumer business and this has had an undoubted effect on its performance in the enterprise segment where sales are now only pursued in highly specialised segments. ViaSat sold only 13,000 units into the enterprise market in 2012 in comparison to Hughes which sold almost 160,000, Gilat almost 82,000 and iDirect 61,000. ViaSat saw both Hughes and Gilat taking an integrated service and hardware approach and chose instead to position itself as the technology provider behind several broadband, Ka-band spot beam satellite projects. At one time, it looked as though all of its bets would fail, but when WildBlue burst out of the box, sealing support from Telesat and Liberty, the game was afoot. ViaSat began selling the system developed for WildBlue as the SurfBeam into the enterprise market in small numbers, but when WildBlue and Telesat really began to market their services in 2006 its production began to hit volume levels only previously seen by Hughes.

ViaSat is passionately committed to the idea that the consumer business has heralded the beginning of a bandwidth arms race in the satellite world and it backed this with a pursuit of every independent Ka-band spot-beam satellite initiative it could find, leaving little room for anyone else. The launch of its own huge 120 Gbps spacecraft for North America, ViaSat-1, finally took place successfully in October 2011 alongside its second generation SurfBeam 2 ground segment platform for its re-branded Exede service in the US. It also includes Xplornet in Canada, Eutelsat's Tooway service in Europe and NBN Co.'s service in Australia as its customers. Just to prove its absolute belief in the market, in October 2009 ViaSat agreed to acquire WildBlue's business which now operates under the Exede brand name on the ViaSat-1 satellite.

Whilst the WildBlue acquisition took the company to exactly the position it said it had no intention of being in – a vertically integrated VSAT company – we believe that it really had

little choice but to safeguard the future for ViaSat-1. However, there can be no doubting the company's commitment to its consumer service now that it is in the game and with its subscriber count hitting almost 690,000 in 2015 Exede is now trading blow-for-blow with HughesNet. With Exede running at full tilt, ViaSat is believed to have shipped around 300,000 terminals in 2015 and achieved production volumes only previously seen by Hughes. ViaSat has been the most aggressive and absolute in its conviction that the future for VSAT services is in Ka-band spot-beam satellites and this has resulted in a very strong strategic position, both in the United States and internationally.

The company did once have an enterprise VSAT service in the US called Immeon, but it sold this some years ago as pretty much part of its abandonment of the mainstream enterprise segment. However, the company's strategy on this has begun to swing around again, kicked off by its aggressive move into the aeronautical business by leveraging the bandwidth and throughput of its ViaSat-1 satellite and its long term technology experience with its ArcLight-based global Yonder service. It began its Exede-in-the-Air service in 2013 and has definitely caused a major upset to many of the established players with its service levels and successful deals with many high profile airlines. The company is also now well on track to launch a second, even larger, more flexible satellite later into 2017 which will also significantly extend coverage for its aeronautical service into Mexico and across the North Atlantic. It then shocked the market again with its announcement of plans for a global constellation of three HTS satellites with 1 Tbps of capacity and the ability to switch power and bandwidth between beams and regions. It doesn't take too much imagination to understand that, all of a sudden, this growing capability coupled with its very successful Exede-in-the-Air service is about to catapult ViaSat back into the enterprise managed services business. Whilst initially we expect to see the company move into the high-end segments of O&G, cruise, ferries and large yachts, we also believe that it will re-join Hughes in the provision of high-bandwidth augmentation of terrestrial services across the United States and, with the launch ViaSat-3 satellites in 2020, perhaps other countries as well.

iDirect is probably the first company since Hughes which has essentially created a market on its own and without any leg-up. Gilat teamed with GTE Spacenet and ViaSat bought Comsat Labs and Scientific-Atlanta, but iDirect had none of these advantages. To put the company's success into perspective, it has been outselling the DVB-RCS vendors – Advantech, STM, ND SatCom, Newtec, Thales, Alcatel and NanoTronix – two to one since 2002. The company grew from revenues of $1.5 million in 2001 to $200 million in 2015 and was sold to Singapore Technologies Engineering in August 2005 for $165 million. Its combination of flexibility of platform, richness of IP features, continuous development, market strategy and professional and pervasive sales and marketing has maintained the company's momentum and taken it from an also-ran to the third largest supplier in the market and the second largest by revenues. In 2014 and 2015, iDirect accounted for 17 and 21 per cent of the enterprise market shipments respectively and is calculated to have generated more revenues from the enterprise side of the VSAT business than any other company.

With such a strong position within the enterprise and corporate segments of the market and with terminals that typically sold at a premium against the larger vendors, it was quite a jump to imagine iDirect establishing itself in the consumer Ka-band HTS business. When Inmarsat began planning for its Global Xpress system, however, iDirect's platform was a natural fit and despite paying lip service to considering other vendors, it was clear to

COMSYS and many others that iDirect had been marked out as the chosen ground segment supplier for the program some time before the award was actually made. In any event, iDirect's leadership position in the maritime, military and other mobility-driven segments of the market marked it out as the best solution for Global Xpress. Equally, iDirect needed a Ka-band play and Inmarsat's decision to go with its next generation product line, effectively underpinning development of the Velocity platform, was seen as a major boost for the company.

Over the past two years the development of Velocity has brought some highs and lows. Whilst having Global Xpress as the foundation for the Velocity system gave iDirect momentum and opened up some major prospects, this was first and foremost an engineering project with a strictly defined timescale and a set of specific criteria. Handling project deals is not the same as managing an internal development program and iDirect was forced to dramatically ramp up and restructure its engineering team. The company began with the vision that Velocity would be a backwards compatible next generation version of the Evolution, but quickly discovered that the defined parameters and timescales for the project precluded this approach. Then, as pressure mounted to ensure that the GX platform was completed on time, development of the Evolution platform began to fall behind and frustration grew within the company's customer base as it looked almost as if it had decided to abandon Evolution. Shocked with the sudden realisation of all this, iDirect began turning its attention back to a co-development plan only to discover that some elements of the two systems would plainly be incompatible.

To the company's credit, it honestly and openly admitted these problems, completely contrary to how many vendors in the past have reacted with absolute denial. For a while the company became stuck between its contract to complete and refine Velocity versus its commitment and desire to sustain and support Evolution and its diverse customer base. The first suggested solution was to attempt to try and link the two platforms through a common NMS, but this also proved to be impractical – a big frustration for iDirect that has been truly committed to maintaining existing Evolution progress whilst ensuring the future path for its customers. Finally, the company understood that it was being overly ambitious and had to accept that Velocity was its fourth generation platform that would be introduced to existing Evolution network operators in the same way as Evolution was introduced to Infiniti users (and Gilat, Hughes, ViaSat and almost everyone else has done with new system introductions) – the system represents a non-backwards compatible step-change. The company has ensured that a seamless and easy upgrade is possible by designing a new range of universal remote terminals and hub line cards that can easily and simply be converted from Evolution to Velocity with upgraded software and a different NMS. Velocity itself can then be upgraded from a maximum of 100 beams to support several hundred with a global bandwidth management feature for intense HTS and XTS satellite systems. There is little doubt that it has been a long and hard road for iDirect over recent years, but it finally looks like the traffic has cleared and the direction is settled.

The iDirect Evolution product remains the number one platform in the high-end corporate networking segments of the market. The system is installed on more vessels, more aircraft, more tactical military and more drilling rigs than any other. However, success brings attention and now the likes of Newtec, Gilat and UHP Networks have specifically begun to target the same operators and segments that have been iDirect's foundation. Cellular

backhaul is a particular application that iDirect essentially opened up to the TDMA business and now that Comtech understands its lucrative SCPC business which relies heavily on cellular backhaul is in inexorable decline, it too has shifted direction with its latest Heights platform which brings it head to head with iDirect. With high throughput and efficient dynamic, automatically switching SCPC, Comtech believes Heights will revitalise its business and it has already begun upgrading some of its largest SCPC cellular customers to the new platform.

Of course, dynamic SCPC – an access method that automatically reconfigures the carrier size based on traffic flow from a terminal taking account of demand and prioritisation from all terminals in a network – has become a major area of interest. Despite having been around for some time, it was Newtec's launch of its Dialog platform that really set a spark to the fire. Newtec claims the highest levels of efficiency because its MxDMA access scheme is able to move VSAT traffic from TDMA to dynamic SCPC or dedicated SCPC with the dynamic scheme changing rate every second. This all becomes exceeding complex to really understand and evaluate because some claim that TDMA is more efficient because although it carries a higher overhead, all the bandwidth is constantly allocated between all of the terminals whereas any SCPC scheme, whether dynamic or not, requires some bandwidth be set aside so if there isn't any high enough traffic to instigate the scheme, this bandwidth is wasted. Additionally, TDMA allocations happen in milliseconds, not seconds and although this doesn't sound a huge difference, there is no doubt that some bandwidth will be lost in between longer switches.

Nevertheless, Newtec's Dialog system has really launched it into the enterprise space big time. The company has played in the SCPC space for quite a while and its Sat3Play system established itself competitively in the consumer market, but Dialog has proven to have a much wider appeal. Operators and customers generally love dedicated SCPC for its fast response and high throughput, but hate it because of its "use it or lose it" architecture. Dialog opens up the possibility of both worlds in one and this has been proven out with Newtec increasing its revenues by 28 per cent in 2016 and sales to the likes of Claro (taking out Comtech), Panasonic (taking out iDirect) and Sentech (taking out ViaSat). The company is now firmly established in many operator portfolios, something which would probably have been a pipe-dream just two years ago.

The other company that has emerged in the last few years is UHP Networks. Initially the company managed to get its foot in the door with many very credible and successful operators including Newcom, Galaxy, ITC Global, BT, ABS, X2nSat and CeTel as well as several Russian service providers. In most instances these operators have used the product as a cost-effective high performance SCPC alternative to Comtech or Paradise modems, but X2nSat for one successfully rolled out many hundreds of TDMA sites for one of its enterprise customers. More recently the company has gone on to achieve major growth in 2016 – its terminal sales jumped by more than 150 per cent – and the UHP system is now used extensively in the media, maritime, government and SCADA segments of the business.

Also of interest has been real change within the DVB-RCS part of the industry. Advantech, which acquired the DVB-RCS platform developed by EMS Technologies in 2006, bought the Shiron InterSky business from Elbit in 2015 and has gone on to enhance its own product (which has been renamed ASAT) with the most recent RCS2 generation of the standard as

well adding further features and beginning the integration of the dynamic SCPC scheme that came with the InterSky. Ironically, the Korean DVB-RCS company Pentamedia, which started life as Nano-Tronix, went bankrupt and the founders of the OpenRCS system formed a new company called … ASAT. ASAT informs us that it is working with hundreds of engineers with ETRI (the state-owned technology company) to develop the next generation of its system.

Thales Alenia Space (previously part of Alcatel) has also been working on a new version of its Space Gate platform in partnership with the European Space Agency's ARTES program. The company has traditionally limited its targets markets to the military and government segments, but this has now changed and the latest release of Space Gate is based on the DVB-RCS2 standard and is designed to address the advanced HTS/XTS spacecraft currently being built by TAS. The platform will service the enterprise and consumer segments with a low cost and high performance VSAT along with a professional grade of terminals. TAS is also part of a new consultation group which has brought together both satellite and cellular system manufacturers with the aim of designing a universal chip which would enable a system neutral, extremely low cost VSAT terminal able to be configured by loading proprietary software. With none of the system vendors making any really worthwhile margin on consumer VSAT terminals these days, this does not sound as crazy as it once did and Thales certainly believes that it heralds the future for VSAT terminal manufacturing.

With the increasing competition from DSL and MPLS services, it is worth reviewing some of the key reasons an enterprise chooses to use VSAT over the terrestrial network. We have quoted specific examples of customers in the past, but the value proposition and the reasons behind a purchase decision remain valid for many companies.

■ Unifying technology - a VSAT service covers every location with the same level of service, the same data rates and the same response times. That said, some spotty HTS systems have changed this situation in some areas.	There are many sites which DSL does not, and is unlikely to ever reach. Each different type of connection means a new problem as network parameters vary. Even when VSAT is not the primary solution, it invariably plays a role filling in for a lack of terrestrial coverage.
■ The ability to build and deploy new applications quickly and efficiently.	With a terrestrial network, different levels of services and coverage of the physical network mean that applications have to be tested and troubleshot on each type of connection - even every site.
■ The ability to upgrade the capacity of the network in a scalable and flexible way. VSATs can marginally increase their transmission rate, but can receive at almost any rate which can be increased (or decreased) as required.	The upgrade of a terrestrial circuit often requires step-function changes in the underlying infrastructure. This can be render an upgrade very expensive and time consuming to scale. In addition, once the link is in, it will not be taken away so the cost is almost always there.
■ New applications can be added as a download to the remote site. There is	Any form of broadcast does not lend itself to a terrestrial network, whatever

	huge potential to add applications such as distance learning, multicasting or digital displays in addition to the core application needs.	the technology employed.
■	Back-up and disaster recovery. Some companies also install VSATs on their primary terrestrial sites to both unify the network and provide emergency back-up services. Satellite offers a completely diverse connection and with increased concerns over security and business continuity, this has become a major selling point.	Terrestrial services often do not guarantee end-to-end link-availability – and with multiple local connection suppliers for DSL networks a single point of responsibility with a provider which owns the infrastructure is not an option. VSAT services are truly end-to-end. Terrestrial services often struggle to ensure a diverse connection - one which does not exit at the same point of a facility or join up with the primary connection, either on the same fibre or switch or cable duct.
■	Longevity - some VSAT networks are still operating twenty years after they were first deployed. The pain of a new network deployment is something of which all IT managers are aware. Many customers value a technology which can last ten years or more in terms of reliability and upgradeability.	No terrestrial technology is able to claim the same levels of longevity and reliability that VSAT can. X.25 and leased lines gave way to Frame Relay which, in turn, was replaced by IP/VPNs and MPLS networks.

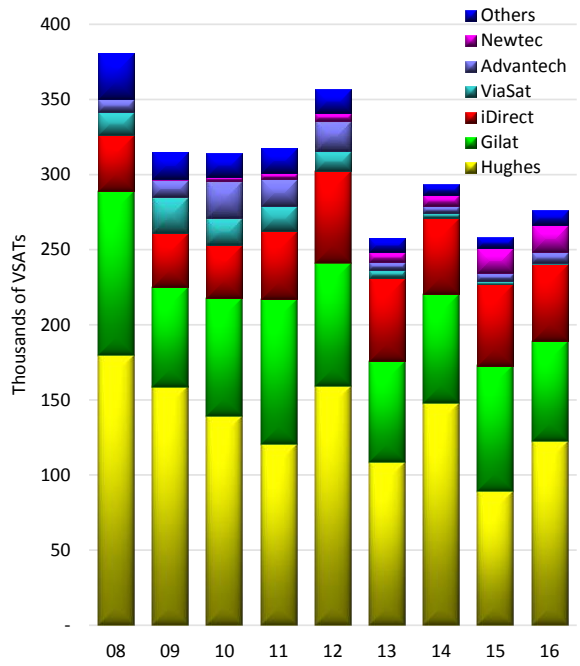


Figure 10 - Vendor Enterprise VSAT World Unit Shipments by Year (2008-2016)

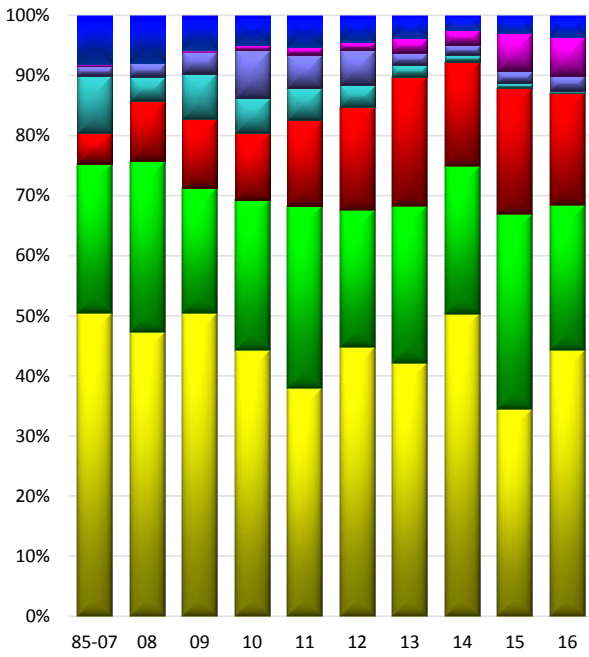


Figure 11 - Vendor Enterprise VSAT World Market Share by Year - Shipments (2008-2016)

From year to year, Hughes has maintained a share which has rarely falls much below 40 per cent of the market, despite relentless competition from Gilat, iDirect and, more recently, Newtec. It has been a combination of engineering capabilities, competitive pricing, market strategy and product functionality from Hughes that has brought its consistent performance year on year. Gilat did very well to first establish its product and then consolidate its position and maintain its growth. Revenues show a slightly different picture because the smaller manufacturers, whilst signing fewer terminals, have probably maintained higher prices on smaller volumes and as a result of operating in niche markets. iDirect is the primary example of this and really the only manufacturer to have been able to consistently grow its revenues to a level that places it on an equal footing with those companies focused on volume. It was only in 2002 that we began to see ViaSat and others begin to make some small dent in the Hughes and Gilat duopoly, but once the wedge was in, ViaSat clearly hammered it home. However, almost as quickly as it grew, it declined as its focus on the consumer potential has drawn attention away from the enterprise business, but as we commented earlier, we expect to see another turnaround in this. iDirect's entry became evident in 2004 and even DVB-RCS systems found themselves in the line-up.

Manufacturer	08	09	10	11	12	13	14	15	16	To Date
Hughes	**47.3%**	**50.4%**	**44.3%**	**37.9%**	**44.7%**	**42.2%**	**50.4%**	**34.5%**	**44.3%**	**46.7%**
Gilat	28.5%	20.9%	25.1%	30.3%	22.9%	26.2%	24.6%	32.4%	24.1%	**25.6%**
iDirect	10.0%	11.5%	11.1%	14.3%	17.2%	21.4%	17.4%	21.1%	18.6%	**11.4%**
ViaSat	4.0%	7.5%	5.7%	5.2%	3.7%	2.0%	1.1%	0.7%	0.4%	**5.9%**
Newtec	0.1%	0.3%	0.8%	1.3%	1.5%	2.5%	2.5%	6.4%	6.5%	**1.5%**
Others	10.1%	9.4%	13.0%	10.9%	10.1%	5.7%	4.1%	4.9%	6.1%	**7.0%**
Discontinued	0.0%	-	-	-	-	-	-	-	-	**2.0%**
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 4 - Vendor Enterprise VSAT World Market Share by Year – Shipments (2008-2016)

Over time, the strength of Hughes, Gilat and iDirect simply squeezed almost all other players down to scraps that accounted for only 10 per cent of the market. The past two years have seen Newtec push back with its Dialog system and it is impressive that the company has moved its position from little more than one per cent to over six per cent in 2015 and even more in 2016. Hughes, ViaSat, Gilat, iDirect and Newtec are all now established in the HTS segment of the market. In Hughes' and ViaSat's case they have their own satellites as well as deals with other satellite operators including Eutelsat, SES, IPStar, Yahsat and NBN. On a mainline basis Gilat is in with SES, Inmarsat and Eutelsat; iDirect with Inmarsat, SES and Intelsat; and Newtec with Intelsat, SES, Eutelsat and Yahsat. The smaller vendors are actively seeking potential deals with many taking the view that without an entry into the Ka-band HTS area, the pressure will rise and they may be pushed to the wall. On a more generic basis, DVB-RCS generally has not done that well considering the fact that the principal players seem to be diversifying the functionality of their systems, which is pulling them away from the baseline standard, and sales of hubs and VSATs are not particularly significant in the overall market. This may change if some of the strategies to get into the HTS/XTS market are successful, but this is something that has yet to be proven out.

The market has clearly had its ups and downs over the past five years, but it's interesting to note that market shares have remained consistent throughout. As Table 4 above shows, Gilat is now back to full fighting strength as its new strategy bites and its share of the market

in 2015 took quite a big jump. What is as equally remarkable is that Hughes has managed to maintain such a large market share despite the advent of so many new competitors and the massive disruption the market has been experiencing. Looking back over the past few years, it's interesting to see that upticks in sales are often a result of Hughes shipments jumping.

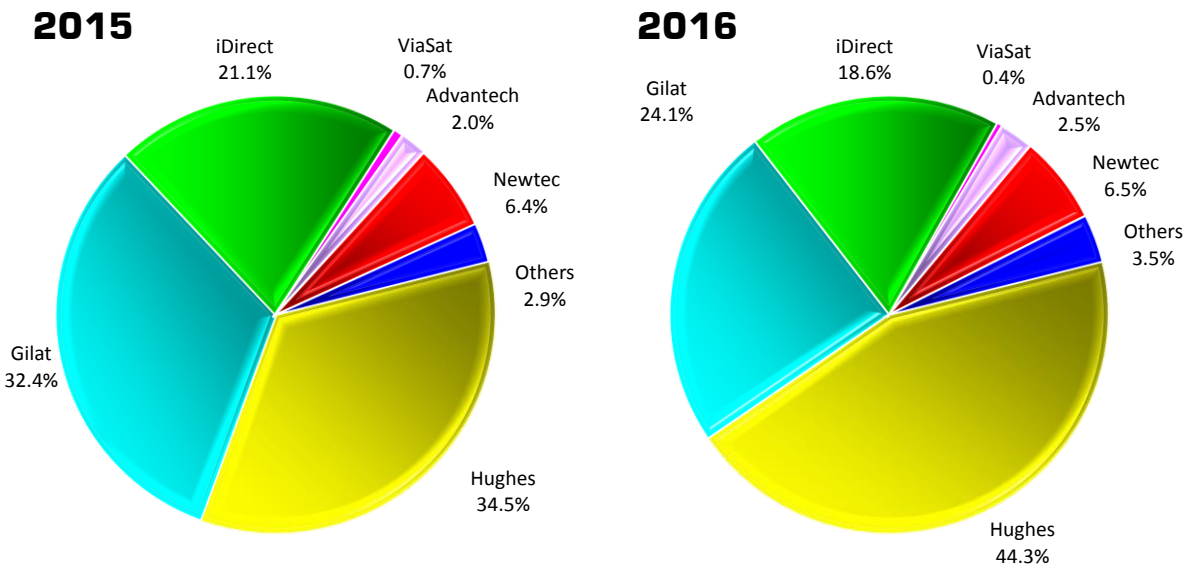


Figure 12 - Vendor Enterprise VSAT Shipments, World Market Share 2015 and 2016

A summary of how the market has looked, year on year, broken down by orders booked to date by manufacturer is given in Figure 11. Hughes' sales in 2006 were significantly buoyed up by the introduction of DVB-S2 functionality on the HN7000S – a year ahead of any other because it was the only manufacturer with the capability of designing its own chipset. 2016 saw another advance with its introduction of DVB-S2X with the release of its Jupiter 2 platform, this time at least six months ahead of any of its competitors. Some companies were already claiming they had the capability in their systems, but although theoretically they did, the technology was not embedded in their VSAT product range only hosted on an FPGA in some very expensive terminal options. The fact of the matter is that only Hughes designs and manufactures its own chipsets while all other enterprise system manufacturers are reliant on a third party product.

Hughes was some way ahead, but certainly not alone, in bringing new generations of product to the market. As demand for data rates have increased so too has the pressure to raise processing and throughput on all system. The days of thinking about kbps have pretty much gone for all but the transactional type applications like ATMs and SCADA and now all talk is in Mbps. This has opened up a whole new set of issues related to packets per second (PPS) processing, the number of IP sessions that can be supported, how things like TCP acceleration and header compression are integrated along with packet size management, especially for the different requirements of 2G/3G/4G cellular backhaul variations. Customers need to be aware of these issues because sometimes one metric can affect another or port "throughput" claims are blurred by the fact that they are dependent on the ratio between receive and transmit rates. Interviews with operators who have tested many terminals suggest that maximum port rates can often be theoretical rather than operationally practical simply because the processing requirement has become huge.

4.2. Consumer

The consumer satellite Internet access business was launched in 2001 by Gilat and Hughes, the former with StarBand and the latter with the service now branded as HughesNet. Despite a belief by many, including COMSYS, that these services would have trouble achieving viability, both are known to have done so. Having said this, the StarBand service suffered first from Gilat's issues at the time and then rapidly increasing competition from Hughes and then ViaSat. StarBand reached a peak at 40,000 subscribers, but declined year on year until SageNet made the decision to terminate the service in 2015. At the end of 2015 Hughes had surpassed over one million subscribers on its service and its core enterprise business has benefited from the massive increase in manufacturing volumes that the consumer market has brought. ViaSat entered the market later with its SurfBeam system, originally designed for WildBlue as part of the company's strategic decision to find and partner with the major consumer satellite projects. The product has since been completely redesigned and is now selling via ViaSat's own Exede service in the US and Eutelsat's Tooway services as SurfBeam 2 with a third generation due out soon.

In Europe, Astra launched a consumer internet access service called Astra2Connect (now SES Broadband or SBBS) based on a new platform developed by Newtec in 2006. Sat3Play was designed specifically for the consumer system market with a low cost remote terminal able to be self-installed - the complete subscriber equipment is sold to resellers for €275. Never one to let SES steal a march on it, Eutelsat announced its own Tooway service within a year. Finally, Avanti launched its HYLAS-1 Ka-band satellite in 2010. The spacecraft does not quite have either the attraction, capacity or power of Eutelsat's KA-SAT, but Avanti's intention has been to address the consumer market and the company selected Hughes in November 2009 to provide the gateways and terminals for the service. Under Eutelsat's KA-SAT, consumer service was also kick-started in Russia in 2012 and the operators there have begun extending service in the east of the country using conventional satellite capacity as well. A deal to use Gilat's SkyEdge II-c platform for consumer services on the Express AMU1/Eutelsat 36C satellite now shared between Eutelsat and RSCC was also announced in 2016. Eutelsat's KA-SAT footprint is quite extensive and Tooway consumer services are now also available in countries as far afield as Ukraine, Turkey, Egypt and Morocco.

Outside North America and Western Europe, Hughes, Gilat, ViaSat and Newtec have sold into accounts which use their systems in consumer markets – NBN in Australia, Yahsat across the Middle East and Africa, Eutelsat and RSCC in Russia and MNLA on Amazonas across Latin America are the major examples. There are now around 75,000 subscribers on satellite internet services in Australia, although the situation has become a little bit confusing as the transition from the IPStar and Optus interim service to the recently launched NBN Co. platform has been taking place. This number is down on two years ago despite the success of the interim NBN Ku-band service, primarily due to the rapidly increasing competition from LTE/4G services. IPStar designed its own VSAT system with the help of ECC (now part of ViaSat), Codespace and Nera and has produced around 250,000 terminals since beginning production, although a good proportion of these have gone to enterprise accounts. In the Middle East, before WildBlue came to market, ViaSat sold a system to Intelsat to support Orbit's consumer service targeted at Saudi Arabia. Again, expectations were high, but Orbit struggled with a number of issues (including regulatory access) and its deployments sank

before the company finally restructured the service and then it was terminated. The hope was revived with Yahsat's YahClick, but the company has also struggled to obtain access to Saudi and whilst it does have a few thousand sites across the region in Iraq, UAE, most of its sites are with SMEs and enterprises rather than consumers. Other challenges certainly remain, and will grow no doubt, now that Taqnia has struck a deal with Arabsat and KACST to launch its own HTS satellites.

In Latin America, Media Networks (MNLA), the wholesale television distribution arm of Telefónica, initiated its satellite internet consumer business based on Ka-band capacity on Hispasat's Amazonas-3 spacecraft using Hughes' latest Jupiter Technology-based HT system for the ground segment in 2013. MNLA has two gateways in Texas and Chile which are ultimately controlled from its network operations centre in Peru and is believed to have had some consumer success in Chile, but elsewhere its main source of business is the same as Yahsat in the enterprise/SME segments. In 2014 both Yahsat and Hughes do Brasil announced their own plans for a consumer service. In Yahsat's case it is bringing 20 Gbps of capacity to Brazil on its AY3 satellite, which is due up later in 2017 and for which it has selected Newtec's Dialog platform. Hughes however, is a step ahead with its own consumer service which was launched in mid-2016 off the back off capacity it has leased from Eutelsat. As we describe in the Hughes do Brasil operator section of this report, the indications are that this has done well and established a healthy subscriber base. Hughes kept its cards to its chest for a while – probably unwilling to give its competitors any knowledge boost! – but in early 2017 revealed that it had already reached 40,000 subscribers and was commissioning around 500 sites a day.

Other than those already mentioned, consumer initiatives elsewhere in the world from the likes of Star One in Brazil and Dream in the Philippines have not gone well. In Brazil, Star One's service is now wholly focused on the small business market and in the Philippines we are not aware that Dream has established any subscribers at all. IPStar has gained access to both the Philippines and Indonesia a few years ago and had hoped to develop a consumer business in both countries, but most of its business so far has centred on enterprise and government programs.

Despite various initiatives of varying commitment, the largest consumer businesses by far are found in North America with Europe and Australia struggling on behind. Even in North America it is primarily the United States where Hughes with HughesNet and ViaSat with Exede are the leaders, innovators and big investors. In Canada, Telesat Canada stepped back into a bandwidth provision role and it has been Xplornet that has pushed out its alternative wireless consumer services using capacity and systems ultimately provided by Hughes and ViaSat which is now believed to have more than 160,000 subscribers in service. Galaxy Broadband also operates a government subsidised service using Hughes equipment on Anik-F2, but this is not expected to exceed a few thousand sites. During this slow progression towards different services in various regions, Hughes, ViaSat and Xplornet have been successfully plugging away with their services. By the end of 2012 Hughes had shipped over 3.5 million consumer VSATs, mostly in support of its own service, and ViaSat had manufactured over 2.5 million, mostly for its own service and Xplornet. Thus, the battle lines are drawn between ViaSat and Hughes as system suppliers, but Gilat and Newtec are both certainly now in the mix. We commented in our last report that we believed that all of the system vendors had a long way to go before they could match the scale of

manufacturing currently enjoyed by the two leaders, but actually this does not appear to be the case. Both Gilat and Newtec have been very competitive and there does not seem to be a large price differential between them and Hughes or ViaSat.

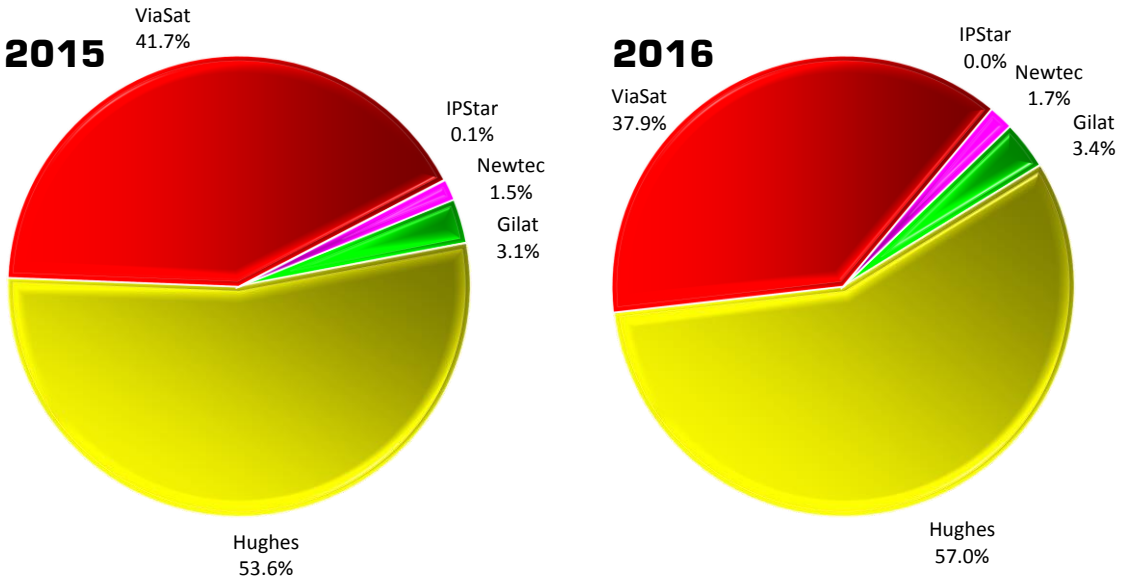


Figure 13 - Vendor Consumer VSAT Shipments, World Market Share 2015 and 2016

At the manufacturing end a comparison of financial results between Hughes and ViaSat would probably be very different. Neither company breaks out its results in this much detail, but Hughes manufactures both its indoor unit and RF system in its own factories in comparison with ViaSat which uses contract manufacturers for its IDU and only receives a licence royalty from its US Monolithics design on its RF system. In addition, the combination of Hughes' existing enterprise business, which also incorporates a SME broadband access service, with the manufacturing volumes the consumer service generates is clearly a powerful one for the company. There are also obvious synergies in terms of space segment purchasing power and sharing of NOC resources and management of which Hughes is able to take advantage. Hughes ultimately is the final word in vertical integration – it builds its entire ground segment (with the exception of the antennas); sells, operates and manages its own service; and owns its own satellite. Since its acquisition of WildBlue, ViaSat established a similar vertically integrated advantage with the one notable exception that it uses third-party manufacturers, but all on its own design.

Both companies are committed to maintaining the design and manufacture of their own product platforms, despite the fact that they make little or no money on the sale of hardware. In truth, their hardware business is now seen mainly as being able to give them an advantage in terms of their ability to limit costs as most terminal costs are subsidised and incorporated into the monthly service charge. Designing their own VSAT platforms also allows them to optimise use of their spacecraft and so it looks unlikely that either Hughes or ViaSat will walk away from their product platforms. As we have speculated elsewhere in the report, this might be taken as a lesson on the part of the satellite operators and become an element in their strategy to move into a vertically integrated managed service business

model. It is probably more likely that the satellite operators would begin to look at acquiring an established manufacturer rather than attempting to put together their own system.

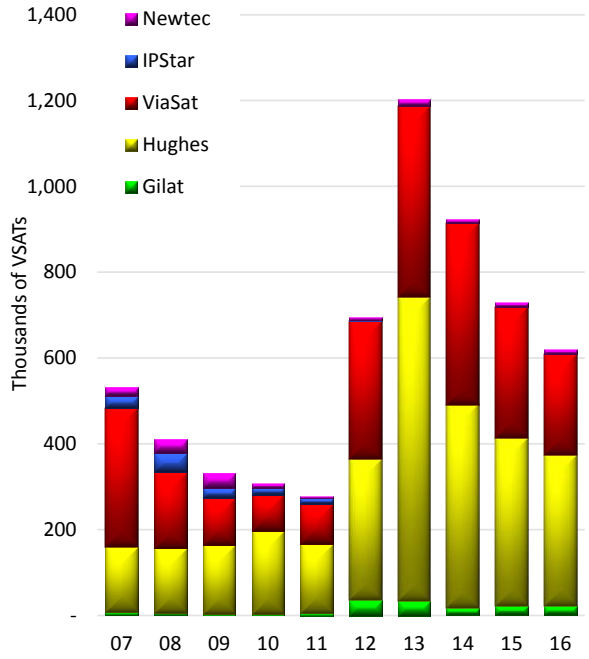


Figure 14 - Vendor Consumer VSAT World Unit Shipments by Year (2007-2016)

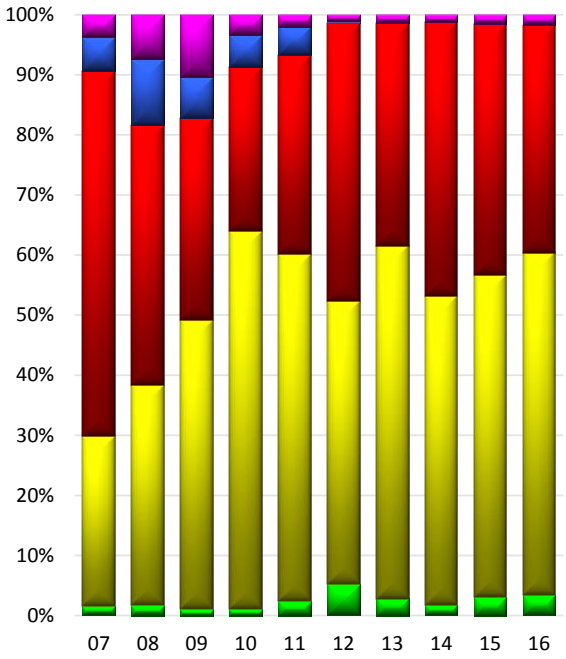


Figure 15 - Vendor Consumer VSAT World Market Share by Year – Shipments (2007-2016)

5. Services

5.1. North America

The North American VSAT market has largely completed a process of change that we have reported on for some time. Traditionally the US has led the industry, setting the tone some years ahead of other regions. Whilst the lag time has diminished and some international operators have introduced an idea or innovation in advance of the US, the basic tenet of this holds true. What we now see in the US and Canada is a polarisation of VSAT services. On the one hand there are now few large outright VSAT network contracts as enterprises standardise on generic service solutions and VSAT has simply become one of the multitude of technologies available to service a customer. At the other end of the scale, there are customers, locations and applications that can only use VSAT and although these networks tend to be much smaller, the bandwidth per site requirements are much larger and growing fast.

In the hybrid enterprise network market Hughes continues to dominate the scene in the United States, followed by Spacenet in the enterprise market which trails a distant second. They are, in turn, some way ahead of any other operator, although entrepreneurial companies like X2nSat have managed to maintain a presence of note as has Verizon which has re-emerged with a surprisingly strong VSAT play over the past few years. At the same time, both Hughes and Spacenet also compete against the big specialist corporate network operators, like Harris CapRock, RigNet, Panasonic and MTN as well as a raft of smaller providers like DTS, GDS, Knight Sky and IsoTropic. The consumer rollercoaster powered by the bounteous availability or dearth of capacity as their satellites fill up has seen ViaSat and Hughes stall and then leap ahead with a new launch. We commented in our last report that both companies were growing fast, but had an eye on a potential gap that might have opened up if their growth consumed all of their capacity before the launch of their new satellites. This indeed became the case and growth slowed in 2015 and then came to a grinding halt in 2016. Jupiter 2 was launched successfully at the end of 2016 and is expected to be brought into commercial service before the end of Q1 2017 whilst the launch delays suffered for ViaSat-2 will delay its operational launch until the last quarter of 2017.

***Hybrid networking**:* At the large networking end of the business, the three leading satellite-based companies – Hughes, Spacenet and Verizon – all have managed DSL products as part of a hybrid service offering. Hybrid services are not necessarily the way some would have chosen to go, but the strategy has proved to be an effective way of retaining and regaining ownership of the customer and placing VSAT technology back in the front line of enterprise networking solutions. Our previous reports questioned just how sustainable hybrid service businesses would be for all but the largest operators and it is now obvious that scale is an absolute requirement. As the largest VSAT operators in the US, Hughes and Spacenet pulled away from the pack with their offerings and then were joined by Verizon which had been a long time operator since its MCI days. It would appear that the focus on hybrid networking at Spacenet finally convinced Gilat that the business had moved away from its core and that it made more sense to sell it. The general consensus in the market and amongst the potential buyers was that the most likely outcome would be for an aggregator or CLEC to acquire the company and this was indeed the result with SageNet, a managed terrestrial

service provider, acquiring Spacenet for $16 million in a deal which closed in December 2013.

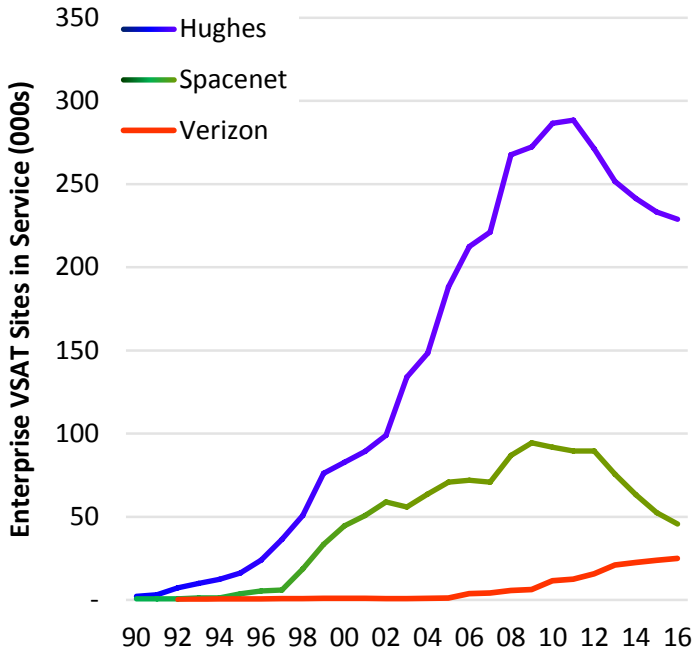


Figure 16 - Hughes/Spacenet/Verizon US VSAT Service Comparison, 1990-2016

A big difference between these three companies was that Hughes and Spacenet were once totally VSAT-focused whilst Verizon has always been primarily terrestrial. Hughes, the market leader in the US VSAT market since its birth in the mid-1980s, has retained its dominance, but alongside Spacenet it has transferred many sites to its terrestrial service and converted a large proportion from primary to backup. The same is true of Spacenet – one of its largest networks, Dollar General which has more than 12,000 sites in service, is now completely backup with primary connection maintained via SageNet's terrestrial solution. By contrast, Verizon has grown its business over time based on backup, extension and enhancement solutions rather than primary.

COMSYS has always believed that the VSAT operators were better placed than any other enterprise service provider to take on greater network management responsibility simply because VSAT has always required more hands-on understanding of the customer's needs and how applications run over the network in comparison with most carriers who simply connect sites together and make sure the bits get from A to B, leaving the customer to worry about whether the application actually works. The adoption of DSL into a VSAT services portfolio proved, however, to be a steep learning curve and also a salutary lesson that all is not wonderful for DSL service providers with long lead times for delivery, uncertain link performance, patchy coverage and great difficulty in getting the actual infrastructure providers to react to service call-outs.

As the number of terrestrial sites being supported has risen, both Hughes and Spacenet have released devices that interface with a range of alternative connections that essentially support the same operational and management functionality that the operator obtains from its VSAT terminal. Spacenet first released its Prysm and then its Prysm Pro, a network edge device able to host various application specific functions, even an embedded VSAT. In 2010, it announced its deployment of Prysm Pro across 7,000 Regis hair salons with not a VSAT in sight. Over 70 per cent of SageNet's 160,000 sites were terrestrially-based as of the end of 2016 with many of its long term large enterprise customers having converted their primary VSAT links to back-up. Hughes has also substantially developed this part of its business, initially along similar lines to Spacenet. However, from the initial network edge SR device that the company derived from its VSAT IDU, the past five years have seen it develop a far more comprehensive solution set that incorporates a sophisticated set of applications. With

a wide variety of different connection types and often erratic performance, terrestrial connections require additional levels of control and enhancement and so Hughes has embedded capabilities to support operation and management of security, quality of service, bonding, compression, traffic routing, intelligent path creation and SDWAN as part of its HughesON business services. The company's HR4700 is a security device manufactured by Fortinet, one of the leading vendors in the provision of enterprise protection including such items as firewalls, IPS, application and endpoint control, intrusion detection and data leak protection.

Business Continuity: Hybrid networking essentially breaks down into two main branches – extension of what is fundamentally a terrestrial network and business continuity where a VSAT network is overlaid as a completely diverse route solution. Some enterprises that have been tempted by the lower hardware cost and easier deployment of cellular data services have been stung with outrageously high bills following a failure or risked having their back up fail along with the wired connection as a major fibre link goes down. The need for business continuity has always been there, but it has only been in the last five years or so that we have seen the willingness to purchase manifest itself in predictable sales. USSC, the operator that primarily services its parent SuperValu group of retail stores, has been running its Hughes VSAT network as a business continuity solution incorporating application load balancing for many years now. The company informs us that the driver behind continuity of service has moved on from being a simple need to keep the business running to a critical avoidance of having to try and catch up on the traffic and processes that were lost during the downtime. Enterprises now pass such significant volumes of data in support of their business processes that full recovery can become almost impossible if the service is down for too long, but this looks as if it is about to change.

The move towards hybrid solutions also plays into this with products, such as the High Availability Network (HAN) from Hughes, which offers two connections at every location with automatic switchover in the event of a failure. VSAT is often an essential part of the offer, but not necessarily always. The irony is that it is DSL which lets this type of arrangement down because it simply is not available at between 20 and 60 per cent of many major enterprise sites. Nevertheless, Home Depot for example placed a contract with Verizon in 2006 to provide a VSAT at every one of its 2,400 locations just for business continuity and Wal-Mart followed suit in 2010. Hughes has a number of customers on its HAN service today and informs us that the absolute criticality of maintaining connectivity has now started to drive demand for tertiary services – three diverse connections, one of which would, by definition, have to be VSAT. So, on the plus side, the positioning that the primary operators have taken has brought in business they would not otherwise have had and even provided the foot in the door that has allowed them to convince an enterprise that VSAT provides a better solution for their needs, sometimes turning a DSL procurement into an all-VSAT deployment.

Enhancement & Augmentation: After years of VSAT finding itself pushed away from primary connectivity into less valued extension and backup roles, possibly one of the biggest areas of potential growth of the technology's application in enterprise networking is now emerging. More businesses are now beginning to require universal high bandwidth connectivity of rates of 20 or 30 Mbps or more. Whilst terrestrial broadband services cover most of the populated areas, it simply cannot support these data rates whilst fibre coverage is significantly more limited in availability as illustrated by Figure 17. The simple fact is that satellite will be the primary means of serving this need and, with their next generation of multi-Mbps satellites, both Hughes and ViaSat now have plans to expand the application of their systems to include enterprise services. In one way ViaSat has already begun this with its use of ViaSat-1 to provide connectivity for the commercial airline segment, but in the future we expect to see the company expand back into the fixed enterprise business with VSAT solutions providing high data rates with integrated local wireless access systems.

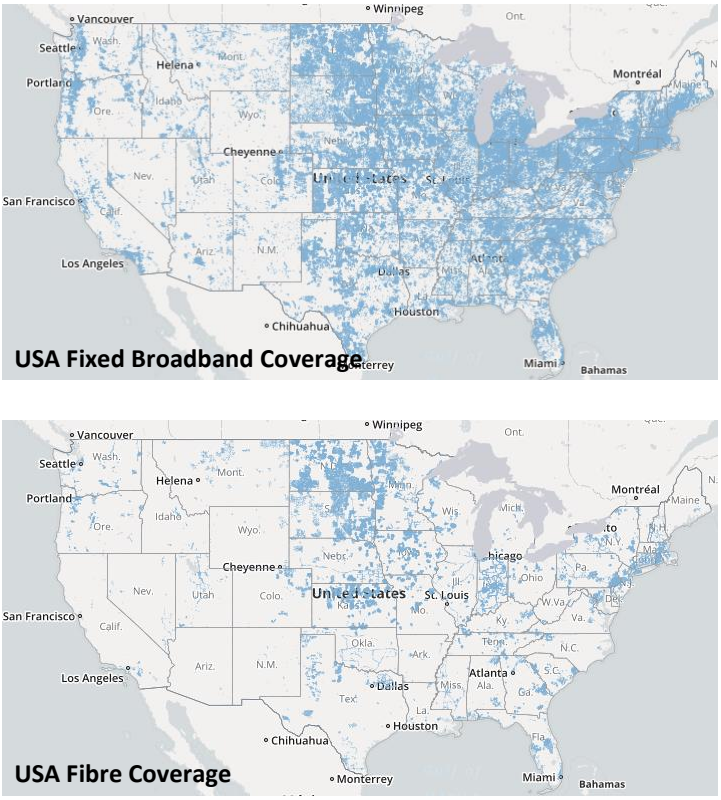


Figure 17 - Terrestrial Fixed Broadband Coverage Maps[2]

As one of the major players in the hybrid networking business, Hughes has extensive plans to make use of its Jupiter 2 satellite to substantially enhance its enterprise offerings. The company has an impressive track record with the value added Active technologies which are part of its HughesON service and it already has in place its ActiveClassifier which examines the flows into the router and places data into different queues depending on the requirements and ActivePath which creates intelligent multiple paths and application level policies, enabling it to automatically and dynamically select the best connection for any particular application – the perfect solution to integrate a higher bandwidth, but high latency service with a more bandwidth restricted, but low latency terrestrial connection. With the prospect of the world's population being connected via fibre a complete pipe dream (until Star Wars becomes a reality perhaps!), the use of HTS satellites and higher powered, lower cost VSAT terminals as an enhancement to terrestrial connectivity may well become one of the largest areas of opportunity for VSAT in the global enterprise market.

Disaster and Emergency: As smaller operators turned their attention back to the North American market following the decline in the Middle Eastern military business and a slowdown in Africa, many of the emerging opportunities were found with federal and state

[2] Source: FCC National Broadband Map (https://www.broadbandmap.gov/technology)

government agencies. 9/11 and Hurricane Katrina left their messages loud and clear, but it takes time for strategies to change, budgets to be allocated and resources put in place. More than two years after some of these events prompted large mobilisations (at least by VSAT standards), US Government agencies at all levels finally appeared ready to begin putting some permanent measures in place to deal with emergencies of all types. Whilst in some cases this was driven by a logical and reasoned argument, in others it seems to have been borne out of desire not to be seen on national television having to explain why nothing had been done to prepare for a potential disaster. Not an insubstantial number of terminals, both auto-deploy and fixed, have been sold to Federal and State agencies, but the fact that they will only see the light of day when disaster strikes means that it is not necessarily good business for an operator.

Rapid deploy VSAT terminals are also being deployed in the commercial world where we have seen an on-going demand for high bandwidth specialised applications often based around some form of disaster recovery, business continuity or emergency response requirement. In some instances the application is a specialised set of equipment for that "rainy day" whilst in others it is a more contiguous solution which may involve VSAT networks as a permanent back-up or even prime connection. Mobility has become a key area of opportunity as the number of auto-deploy antenna products has multiplied, prices have come down and acceptance has grown. Applications ranging from emergency response to broadband for motorhomes and from digital SNG to mobile libraries as well as land-based drilling have proliferated across the US over the past few years and many operators moved quickly to exploit these opportunities including IP Access, Skycasters and TrustComm, although those companies specialising in the O&G segment have not had an easy life recently.

Up in the air: Aeronautical services targeted at military aircraft, commercial airlines and business jets were first really established in any scale in North America, but are ultimately a global networking requirement. Almost all of the major initiatives have originated out of the United States. This is considered to be an area of high opportunity for a number of operators, but it has reached a stage where the level of investment required is phenomenal. The largest players are US-based and the North American market has unquestionably seen the world's largest airline deployments. The big players hitting it out right now are ViaSat with its Ka-band Exede In-The-Air (ITA) service based on its own satellites; Global Eagle which uses a Ku-band managed service from Hughes, but which will introduce Ka-band on Jupiter 2 during 2017; GoGo which has shifted its emphasis from its ground-to-air technology to satellite for which it uses the iDirect system (now moving to Gilat) to access multiple spacecraft from different operators; and, Panasonic which currently operates on the iDirect platform, but has recently decided to migrate to Newtec's Dialog system and which has increasingly been moving towards a more owner-orientated satellite capacity strategy than simply leasing from operators.

O&G and E&P: Mobility has also become a key driver behind the growth of many of the sub-sectors of the Oil & Gas business. Exploration and production boomed as energy prices skyrocketed from 2003 onwards. This is an industry that takes a while to get moving, but by 2006/7 deep water, shallow water and land-based drilling activities were growing rapidly. With more demand to pull data back from a rig, VSAT operators serving the segment saw both sites in service and the data rates required rise rapidly. The established players took

full advantage of the opportunities, but this still left plenty of potential for new operations and this became particularly evident in the land based drilling segment in both the US and Canada. At its height, the industry had around 2,000 land rigs in constant use in the lower 48 states with multiple VSAT operators supplying different oil & gas service companies with several different VSAT connections at each site. The same was true in Canada, but mining and other natural resources were also part of the mix. Prices rose and fleets of auto-deploy and trailer-mounted VSATs were built.

The O&G industry however, has suffered from two major crashes over the past 10 years. In 2008 the number of land rigs in service dropped by 60 per cent within months of the end of the year. Shallow water activities also began to fall off and by mid-2009 deep water exploration was also in decline. The larger specialised operators with extensive international businesses followed their customers, as they had been doing for a few years, into West Africa, the Middle East, Asia and Brazil, but the smaller, domestic operators took a beating. However, land based drilling activities are, as they say, the first down and the first up again and by the end of the 2009 a recovery was underway that saw a complete re-birth of this part of the VSAT business in North America and a dramatic rebound for the main providers. Many of the smaller US-based providers – DTS, GDS and Datacom for example – grew strongly on the back of the exploitation of the shale oil fracking boom as did the big boys – Harris CapRock, RigNet, Spacenet and Hughes. However, competition from 4G/LTE services also began to increase as deployments began to proliferate and custom wireless networks were rolled out specifically to meet the needs of land-based drilling in rural areas. DTS in particular was very active in extending its hybrid wireless, microwave and satellite service to this segment of the market.

Then came the crash of 2015 which has been even more dramatic with the number of rigs in service halving in 2015 and halving again in 2016. It should be pointed out that it is not a case of one VSAT per rig, but more like four or five because it is not only the drillers who need communications, it's also all the companies that service them like Schlumberger, National Oilwell Varco and Halliburton amongst many others. From a high of around 10,000 VSATs in service we now believe there to be less than 3,500 and so many of the operators which specialise in this area now have 60 per cent or more of their trailers and quick-deploy VSATs sitting around awaiting a recovery which just began to show signs of emerging in early 2017.

Maritime focus: OSVs – Offshore Service Vessels – have been a source of demand for some years now and drove a good proportion of the overall maritime VSAT market growth up through 2014. North America in general, and the Gulf of Mexico in particular, saw quite large deployments as a result of services using smaller antennas based on spread spectrum solutions. KVH and its association with ViaSat's ArcLight CRMA system found a niche alongside others using solutions from iDirect and Hughes. Again, DTS, GDS and Datacom along with companies like Elite, ITC Global and BlueTide found opportunity in the provision of permanent and skid-mounted short term rental services. However, the past two years have seen a considerable downturn as a consequence of the global oil crisis and all of the companies mentioned above have had to cope with a dramatic fall off in demand. Some companies, BlueTide being an example, were smart enough to see the fall coming and began to diversify into other areas including yachting and inland. Those who were concentrated on the O&G market almost exclusively however, took a big hit and continue to struggle.

However, although once easily the largest part of the maritime market in the US, the offshore O&G segment has not been the only area of maritime business and government, inland waterways and leisure vessels have all grown into VSAT services based on small antennas.

VSAT continues to be the solution of choice for the maritime and the offshore oil & gas industry. The competition from VSAT service providers and all these alternative initiatives coupled with the headlong rush into maritime services by almost any operator that barely knows what a stabilised antenna looks like, but likes the prospect of the revenues associated with the segment, have had an unsettling effect on the market. Customers might not consider it a problem, but the result has been to commoditise a specialised service and drive down prices to levels that some believe are simply not sustainable. O&G operators with mission critical applications remain at the high-end and are unlikely to risk service levels and reliability for a few dollars off the monthly price, but small workboats and other sub-segments of the market have fewer constraints.

Operator	System Vendor	Sites in Service	Market Share
Hughes	**Hughes**	**226,821**	**66.87%**
Spacenet	Gilat	48,478	14.29%
Verizon Business	iDirect, ViaSat	24,560	7.24%
Infosat	iDirect	3,057	0.90%
X2NSat	ViaSat, iDirect, UHP	2,987	0.88%
USSC	Hughes	1,394	0.41%
Others		31,900	9.40%
Total		339,197	**100.0%**

Table 5 - North American Enterprise Operator Market Shares

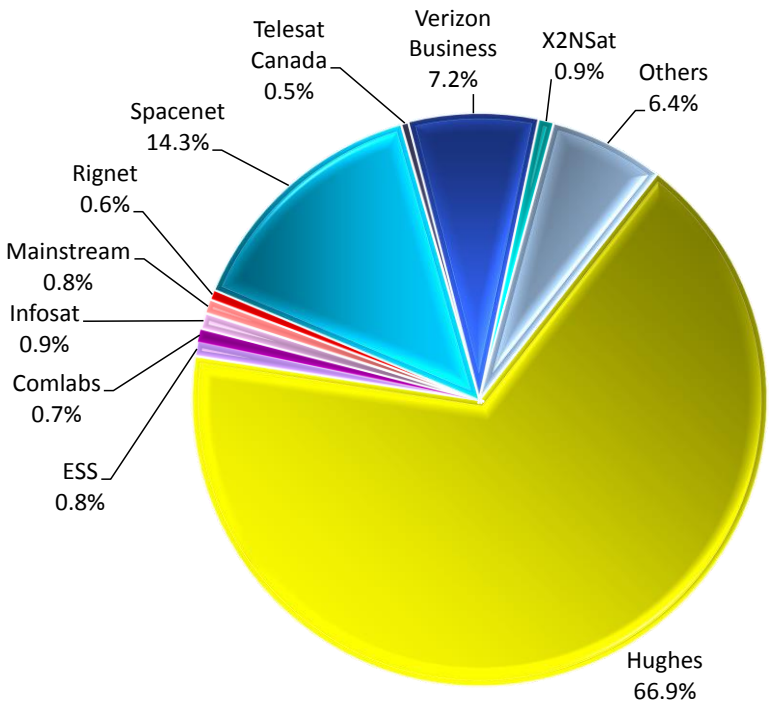


Figure 18 - North American Operator Enterprise Market Share

The hidden cost behind maritime and O&G services is not satellite capacity, but the ability of the provider to service an offshore installation. In many instances this will require a considerable investment in technical resources on the part of the operator, particularly if the customer suddenly needs to move a vessel from the Gulf of Mexico to offshore Brazil or Angola. We no longer hear complaints about capacity shortages over North America and although many operators continue to believe that prices are too high versus those seen in other regions, availability is no longer the concern that it was a few years ago. This is partly due to the fact that Hughes and ViaSat now sit atop the three highest capacity satellites ever built for their consumer service platforms,

HughesNet and Exede, and partly a result of unfulfilled potential on the part of IPTV applications. Whilst Hughes and others have managed to sell some behind the scenes applications in support of product information, staff training and entertainment in staff rest areas, the front of store display market does not appear to have found much traction.

Outside of the specialised verticals, the US VSAT enterprise market might have grown tougher and the willingness of a customer to consider the technology as a primary solution might have declined to almost nothing, but this has not stopped Hughes. Despite the company's increased focus on its consumer service platform, it continues to dominate with well over half of the enterprise VSAT sites in North America – not just the US. In fact, over the past three years Hughes' share of the enterprise VSAT business has grown. The breadth and depth of the company's long term customer base has placed it in a very strong position when competing for network renewals from the largest enterprise customers in the US and once it commits itself to a strategy its determination and application brings a predictable level of success. This has been demonstrated by the fact that its North American enterprise business finally began to show real growth again about five years ago as the company refined its hybrid value proposition.

Leaving aside the number of VSAT sites in operation, the underlying revenue trends have undergone several different shifts over the years. When VSAT was sold as a primary solution prices fell consistently year to year, but then took a major plummet if a network was moved from primary to backup – a backup network anywhere in the world will yield between 10 and 20 per cent of the monthly revenues of a primary network. However, as the role of enhancement has begun to emerge we expect to see average revenues per VSAT site grow. In Hughes' case this began a few years ago due to the fact that connectivity and diversity has been sold as a value rather than simply trying to compete on price at every site. The penalty has been lower VSAT sales volumes in the enterprise market, but this has been more than made up for by the growth in the consumer business. In any case, hardware is not seen as an enabler at Hughes, where service revenue growth has been the primary strategic object for many years now. As part of this, the company has also been pushing harder into many of the vertical markets mentioned previously – land-based drilling, maritime (with BlueTide), government, military and aeronautical where it still has the second largest number of commercial airline VSAT installations in service with Global Eagle.

Spacenet has had its ups and downs. The company has a strong and loyal customer base with some key household names, but it does not have the same scale as Hughes. As the second largest enterprise VSAT provider in North America, Spacenet has always struggled to make money and the question of just how much commitment its parent, SageNet, will have for VSAT services remains. In some ways it appears that SageNet acquired Spacenet with the intention of converting its VSAT customers to its terrestrial offering and, given the underlying trends in the market, this was probably a smart strategy. The past few years have seen the number of VSAT sites Spacenet services fall, mainly due to the conversion of many of its lottery customers to cellular solution. Nevertheless, the company has done well to maintain connection with several major customers by making use of established VSAT networks as backup to a new terrestrial solution and it has also performed well in some of the niche markets, particularly for land-based drilling and SCADA applications where it has successfully sold both directly and through a network of value added resellers.

By contrast, Verizon's continued commitment to its VSAT service has been quite impressive for a carrier of its size. Since the days of MCI the company has always had an element of satellite service in its portfolio. Initially this was primarily to serve its international customers, but it also developed several domestic service platforms in a somewhat haphazard way with different parts of the company competing for dominance. However, a more coherent strategy emerged when it won the backup network for Home Depot using iDirect's system and then went on to win the hotly contested Walmart back-up service. The company's service has continued to develop on the iDirect platform and, as far as we are aware, some of its more diverse activities, have been gradually scaled back.

Like Spacenet, we believe that Telesat has also found the enterprise market in Canada to be hard going. As we have mentioned in previous reports, after some years of decent growth the company's progress had slowed by 2008 as the larger telcos began to change their own strategies to counter the loss of large enterprise accounts. One by one the company has slowly lost some of its largest accounts and it has mainly been the government segment that has sustained the business. As pointed out earlier, retail VSAT services have an uneasy relationship with the wholesale nature of the larger satellite capacity business and the increasing proportion of terrestrial connections raises further questions. Strangely, the widely expected process of consolidation between the company's in-house enterprise VSAT activities and those of its subsidiary Infosat has still not happened. Infosat, suffered from the drop-off in land based drilling activity in 2009 came back strongly in 2010 only to fall off the edge of the cliff alongside all of its Canadian and US competitors as the next crash began in 2015. All of the companies involved in the land based drilling segment have taken a big hit – Infosat, Galaxy, DataDrill, Virgin and others – and it is not beyond the realms of possibility that some may just decide to exit the business if the industry doesn't recover soon. There is now far more competition in the O&G and mining segments of the market, particularly from Galaxy Broadband which has managed to craft a compelling value proposition with a combined Ka/C-band service able to deliver both high reliability and affordable bandwidth. Along with its government subsidised residential internet access service in western Canada, Galaxy now has exclusive rights to the Ka-band spot beams covering the northern regions of the country and has continued to perform strongly in the E&P resource segment.

Two new names on the list include Comlabs and ESS. Comlabs is a company we previously considered a manager of dedicated government networks, but which acquired the assets of SDN Global and we have now classified as a full managed service provider. ESS (Energy Satellite Services) was formed in 2013 by people who had previously worked for Centrepoint, a specialist utility company and customer of Spacenet. ESS now supports almost 3,000 VSAT sites, mostly for SCADA, utility and land-based drilling customers. Of the other companies that make it onto our enterprise market share list for North America, there are no major surprises. We have to bear in mind that, between Hughes, Spacenet and Verizon, almost 90 per cent of the enterprise VSAT sites in the region are accounted for. There remain some longer established companies, such as SpeedCast (which acquired the CapRock business from Harris in late 2016), RigNet (which jumped in US enterprise market share after acquiring Inmarsat's old Stratos Broadband business once known as Novanet), Mainstream Data and X2nSat that still have several thousand enterprise sites under contract – Harris CapRock in the oil & gas segment, RigNet in the O&G and SCADA segments, Mainstream in the delivery of healthcare support, EMC/GEE in the cruise and yacht market

and ESS in the SCADA segment. There are also the "smaller" niche operators, of which the offshore and maritime specialists have already been mentioned.

RigNet's once SCADA networking-dominant Nova-Net business has met with greater competition from the likes of Spacenet, ESS, NSS and X2nSat over the past few years. TrustComm, USSC, LBiSat, Mobil Satellite, Elite, SSI Micro, Isotropic, IP Access, Novanet (Canada) and JuchTech are other examples of relatively small operators that have managed to survive in the intensely competitive market which has grown up largely as a result of the heightened competition between the smaller VSAT operators whilst the big players battle it out in the wider telecoms market against terrestrial solutions. However, survive is probably the best description for many of the smaller players – SDN finally went down in 2014, Tachyon was sold to AASKI and Pathcom finished whilst others like Mainstream Data and EchoSat have largely diversified out of the VSAT business.

In 2013 we suggested impending disruption in the oil & gas market at several levels with smaller operators becoming increasingly aggressive when competing for the shale-driven land based drilling business and a constant jockeying for position between DTS, GDS, Datacom, LBiSat, RTC, Infosat, DataDrill, Network Innovations, Beyond Communications, Virgin Technologies and Novanet. Few of these operators ever had many more than a few hundred sites although most were profitable – until the crash of 2015 happened and active sites went through the floor. CapRock (now SpeedCast) continues to hold the largest share of the offshore oil & gas segment, but with the company seemingly preoccupied with deploying the substantial cruise contracts it won over MTN in 2013, the company lost some of its focus on energy services. RigNet had begun to push harder in North America, helped by its acquisition of Inmarsat's oil & gas activities that included the offshore microwave and WiMAX networking businesses in the Gulf of Mexico. At the same time, ITC Global started making a strong play and very successfully positioning itself as a strategic alternative provider to CapRock and RigNet. The company, acquired by Panasonic in 2015, has taken some major networks from both competitors and, whilst CapRock and RigNet's revenues have seen a major decline, we understand that ITC Global has maintained its revenues through these new wins despite experiencing the same drop off in demand from established customers. EMC also attempted to jump into the segment, but failed. Now that it has been acquired by Global Eagle it seems its focus will become more maritime related.

Once a big chunk of the market, broadband services to small and medium sized businesses has undoubtedly become a smaller area of business. This is especially true in the US due to the increasing bandwidth available on the consumer side, although both Hughes and ViaSat do team with partners who target SMEs rather than consumers. Those companies with a large number of SMEs in their installation total in North America are very few these days and it is no surprise that Hughes is by far in way the largest provider. Pre-packaged standard priced solutions once formed a reasonably large part of the value proposition in the enterprise market. Spacenet, for example, used the Connexstar brand as its main offer allowing for a range of predefined options to be added, with customised solutions generally being reserved for the larger and more specialised networks, but this service seems to have fallen away. Hughes continues to offer a range of packaged services and it also offers customisation of these, seeming to view them as something of a starting point as opposed to a strictly defined package.

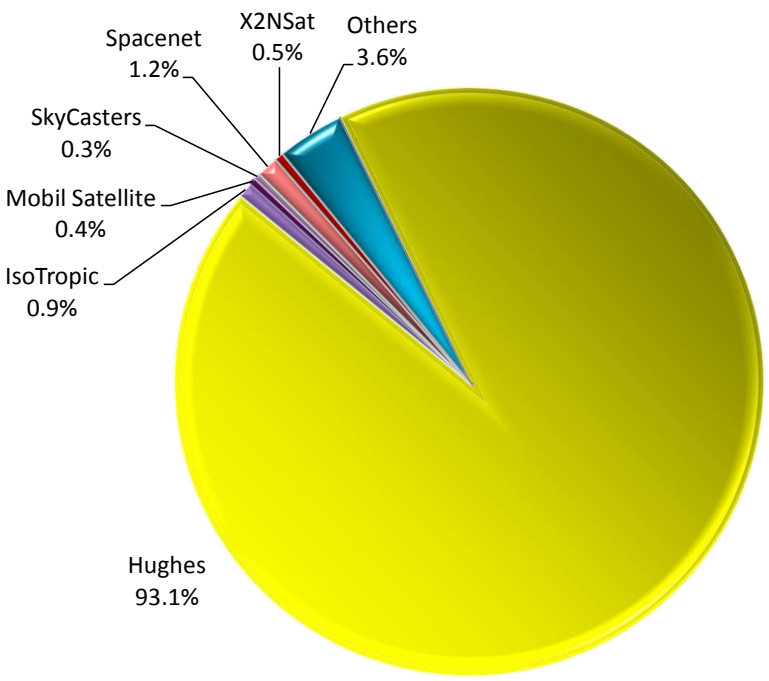


Figure 19 - North American Operator SME Broadband Market Share

Operator	System Vendor	Sites in Service	Market Share
Hughes	**Hughes**	**56,395**	**93.11%**
IsoTropic	iDirect	518	0.86%
Mobil Satellite	iDirect	220	0.36%
Skycasters	iDirect	209	0.35%
Spacenet	Gilat	731	1.21%
X2NSat	ViaSat	292	0.48%
Others		2,201	3.63%
Total		**60,566**	**100.0%**

Table 6 - North American SME Broadband Operator Market Shares

The provision of broadband services to businesses in the US has changed from a focus on vanilla internet connections for SMEs more towards targeted sales through VARs which specialise in a particular segment – local public services, emergency response, O&G service companies or SCADA networking for example. Our research shows that the basic SME broadband business, whilst still significant, has declined slightly over the past five years. The services that are still promoted are led primarily by Hughes, but also Spacenet and, we believe, Xplornet with their specialised VAR broadband service products which verge on the customised business and the businesses picked up through the highest end consumer platforms providing the greatest volume. Below this come a handful of other smaller operators with a few hundred sites each. SME broadband services were never a great area of interest for WildBlue and, in the past ViaSat always found it hard to maintain focus on its managed services business at both enterprise and broadband levels. It was of no great surprise when it chose to dispose of its Immeon service to X2nSat in 2010 and, in any case, most of the company's SME BB subscribers were whittled off the platform before the disposal because they were simply not profitable. However, ViaSat has introduced a professional version of its Exede terminal which appears specifically designed to address the market for digital SNG, emergency response and government/military applications and which is being sold through a network of specifically qualified and selected resellers, such as AIS Engineering which focuses on the defence market. We understand that a more generic broadband service offer is also supported on Exede with the possibility that some partners are able to pre-specify some of the networking parameters (QoS, rates, caps, etc.) that they require to address their particular target markets.

Higher & Higher, Consumer and Ka-band: In June 2005 WildBlue and Telesat began offering commercial Ka-band consumer services in the United States and Canada and, at the end of 2006, WildBlue augmented its services with the launch of WildBlue-1. In August 2007

Spaceway-3 was successfully placed into orbit with Hughes beginning its own Ka-band consumer service on the satellite early in 2008. These events marked the beginning of the rise of Ka-band, not just in North America, but elsewhere in the world also. Once again, it has been North America that has contributed most to the progress of a global trend. From the introduction of Ku-band consumer services by Spacenet and Hughes in 2000 to the dogged determination of Telesat, WildBlue and Hughes to launch the first generation of consumer multi-spotbeam high capacity Ka-band spacecraft and now the third generation of 200 Gbps satellites from ViaSat and Hughes, it has been the United States that has brought innovation and demonstrable success.

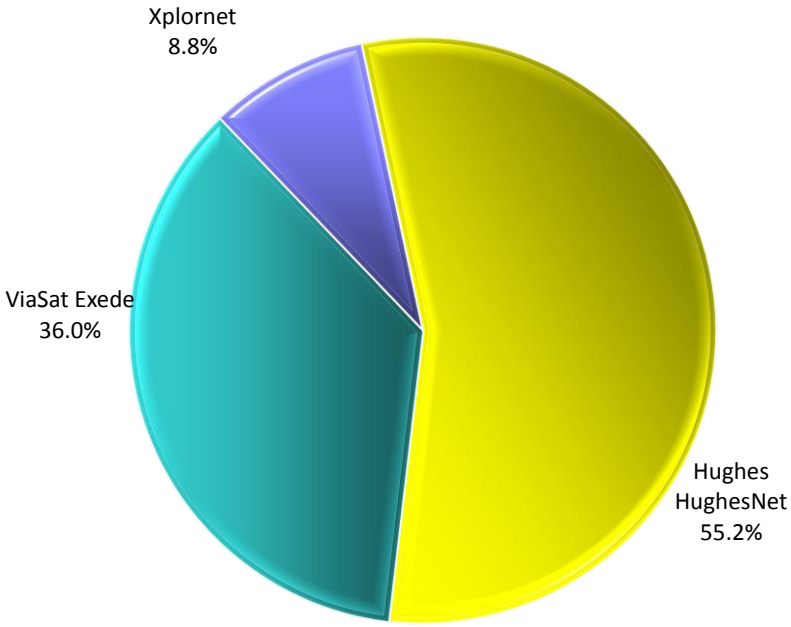


Figure 20 - North America Consumer Subscriber Share (mid-2016)

As of mid-2016, Hughes had 55 per cent of the North American market share – up 2 per cent over 2013 – with ViaSat's Exede service accounting for 36 per cent and Xplornet in Canada almost 9 per cent. Telesat's original service on Anik-F2 using SurfBeam had been selling proportionately the same as WildBlue in the smaller Canadian market, but began to decline when Xplornet, its main sales partner, began to move its concentration to the Spaceway capacity it had purchased from Hughes. Xplornet went on to commit to all of the Canadian capacity on Jupiter-1 from Hughes and the same from ViaSat on ViaSat-1. Even though these contracts were ultimately transferred to Telesat, Xplornet remains the primary sales channel in Canada and of its 300,000 subscribers, around 160,000 are satellite-based split between Hughes and ViaSat terminals and capacity. The company informs us that by 2016 it faced exactly the same restrictions as Hughes and ViaSat in terms of capacity constraints and it was eagerly awaiting the launch of Jupiter 2 and ViaSat-2, on which it has contracted all the Canadian coverage for both.

The one other provider of consumer services in Canada is Galaxy Broadband which operates a Hughes HN9000 system on Anik-F2 to meet its requirements under a subsidy scheme it won to offer service to almost 10,000 homes and businesses in British Colombia in western Canada of which only 1,400 have been connected to date. However, Galaxy has cleverly leveraged its new capabilities to also address the enterprise market and provide broadband service to the resource industry. In September 2015 Spacenet terminated its StarBand service which had significantly declined in the consumer market as the lower paying subscriptions were encouraged to leave from 2010 onwards. The service was temporarily bolstered by the Federally supported OpenSkies broadband service program in Alaska for a while, but consumer service has not been a focus for Spacenet for some years now.

***Strategic Bandwidth**:* These days the quantity, cost and power of bandwidth is discussed and reported as one of the biggest influencers in the market almost every day. What few people seem to stop and acknowledge is that the beginnings of this started in the United States. Arguably it was Hughes' Spaceway initiative which kicked things off – it certainly prompted a great many large companies to suddenly propose their own projects. But of these, only Spaceway made it to space and even that was delayed and jumbled up by the sale of Hughes and DirecTV's decision to take the first of the two satellites and just use them to supplement its television broadcast business. Telesat then came in with its 10 Gbps Anik-F2 satellite and partnered with WildBlue.

Then, in 2007, ViaSat began its planning for a second generation Ka-band spot-beam satellite of its own design based on its belief that a step-change increase in capacity coupled with a corresponding drop in price was essential for the future of the VSAT industry. Initially it hoped that WildBlue would adopt its design, but when this did not happen it was prepared to go it alone and, at the beginning of 2008, subsequently announced that it had committed itself to building a 100 Gbps, Ka-band spot-beam satellite for North America. When Hughes announced in early 2009 that it too would be launching a 100 Gbps spacecraft as a follow on to Spaceway, ViaSat's bandwidth arms race prediction was proven to be accurate. ViaSat-1 was initially planned for launch in the first half of 2011, but a series of unexpected mishaps and delays pushed this back to October. Hughes' Jupiter-1 was launched around six months later and both companies immediately reported strong sales based on considerably strengthened service packages which took advantage of the focused, high density, low cost capacity that their satellites brought.

The push into consumer services first began with Hughes' one-way DirecPC service twinned with a terrestrial return solution in 1996 and then Gilat came in with its two-way StarBand service in 2000. Ironically Gilat originally partnered with EchoStar, now the owner of Hughes, and is now gone from the consumer market in the US. When WildBlue entered the market with a more attractive cost base due to the frequency re-use of its Ka-band spot-beam satellite in 2006, it was expected to severely curtail the growth of Hughes' service. This was especially true because Hughes was reliant on "more expensive" Ku-band capacity and had enjoyed an effectively competitive-free market for almost four years. However, the actual experience was completely different as WildBlue's presence lifted the overall perception of satellite broadband as an option and the HughesNet service along with it. In 2004 Hughes was signing around 8,000 subscribers a month, but by 2009 the company reported record gross adds of 50,000 in its second quarter with all new subscribers on Spaceway. WildBlue's service was growing equally fast and both companies informed us that managing growth within the bandwidth constraints that they faced was a greater issue than encouraging sales. This continues to be the case today with Hughes and ViaSat having to plan further into the future as their satellites have filled up faster than they perhaps anticipated.

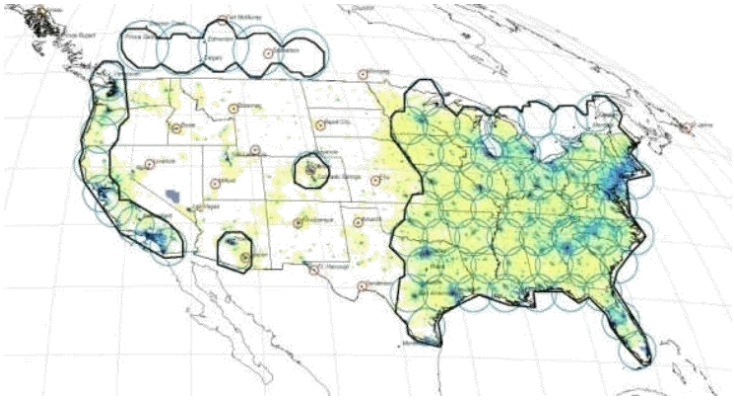


Figure 21 - ViaSat, ViaSat-1 North American Coverage

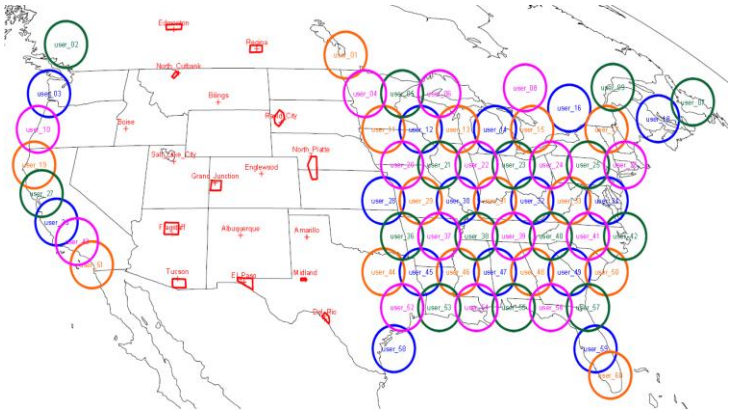


Figure 22 - Hughes, Jupiter-1 North American Coverage

The issue of bandwidth management was further exacerbated by the patchy nature of demand as the US operators found most business flowing from the suburbs where lower density housing has higher income households able to afford a service that remote DSLAMs often can't provide. This left many fixed spotbeams over the rural regions of North America lightly loaded and unlikely to ever be profitable whilst the suburban beams were quickly overloaded. After WildBlue gained an initial advantage with WildBlue-1, Spaceway-3 levelled the field for Hughes and then went on to confer an advantage as a result of the flexibility provided by its on-board processing – fortunately for Hughes, General Motors had long since paid the development bill for this capability. Either way, both ViaSat and Hughes have made use of their first generation CONUS coverage satellites because the footprint of the second generation systems are limited to the high demand, but this does present a problem in bringing equitable service plans to these remote areas given the advances brought by ViaSat-1 and Jupiter-1.

The coverage design requirements and decisions have continued to change. Hughes is believed to have essentially maintained the same approach with Jupiter 2, although coverage has been expanded to cover Mexico, with the aim of focusing capacity in defined and proven markets. ViaSat however, has broken the mould and continued its ambitious expansion based on its belief that it can bring game changing capacity and bandwidth pricing to the market and skip ahead of the established satellite operators. ViaSat-2 extends coverage across the North Atlantic to cover the airline routes and link its North American service up with coverage from Eutelsat's KASAT and Yahsat, but its ViaSat-3 proposals are even more ambitious promising three 1 Tbps spacecraft with global coverage. The company also believes that it now has the technology to shift capacity between beams in order to avoid the frustrations seen with WildBlue-1, KASAT and others where capacity lay dormant and was never used.

Seemingly frustrated by the lack of innovation seen at many of the mainstream satellite manufacturers, ViaSat has taken things into its own hands and now has an agreement with Boeing to use its satellite platform whilst designing and building its own payload. ViaSat-2 will be the next step for ViaSat back into the enterprise VSAT market moving up from aero into segments like cruise lines in the Caribbean and O&G in the Gulf of Mexico, but ViaSat-3's global coverage will catapult the company into a whole new market strategy.

There will undoubtedly be challenges in finding partners, obtaining local licensing and meeting various domestic regulatory requirements, but ViaSat is confident that these demands will be solved in some regions and danced around in others by shifting capacity coverage if countries essentially block the service. By contrast, Hughes has long had a very targeted and defined strategy which focuses interest and investment on key identified market demand – the company's operations and initiatives in India, Brazil and now Mexico are good examples of this. Now it remains to be seen which of these giants have chosen the right strategy.

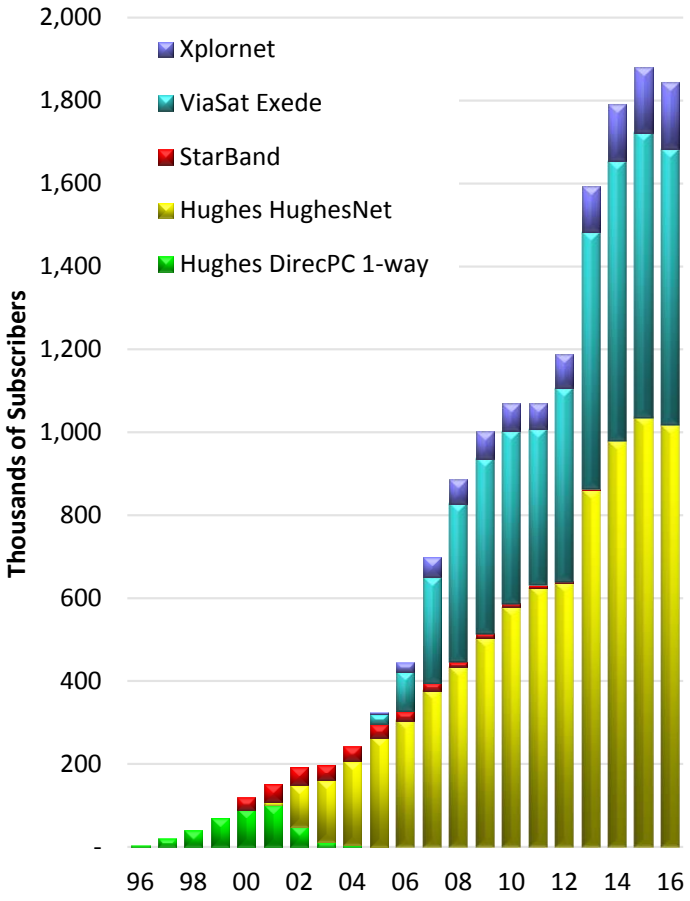


Figure 23 - North America Consumer Subscriber Growth

The US market has continued to provide both Hughes' HughesNet and ViaSat's Exede consumer services plenty of growth. It has been the availability of bandwidth that has largely defined progress of these services as first ViaSat (when it was WildBlue) and then Hughes ran into capacity constraints. As ViaSat waited for ViaSat-1 and had to eke out an existence on WildBlue-1 and Anik-F2, both of which faced saturation in the high-demand regions, its subscriber base first levelled off and then started to decline slightly as Hughes was able to leverage Spaceway and its greater flexibility. When ViaSat launched its new 120 Gbps satellite and rebranded its service as Exede in early 2012 in order to highlight the step change in performance, its sales suddenly accelerated and, with Hughes then facing its own capacity constraints, subscriber growth for HughesNet also slumped. However, by the end of that year with Jupiter-1 in place, both Hughes and ViaSat were selling at record rates – Hughes reported 225,000 net new subscribers and ViaSat 154,000 in 2013. Both reached their peak in 2015 and subsequently faced slight declines as bandwidth became more constrained, but Hughes surpassed the one million mark in 2015 and ViaSat almost managed 700,000. Together with Xplornet, North American consumer subscribers now amount to over 1.8 million with the expectation of another surge in growth with Jupiter 2 and ViaSat-2.

Distribution has always been a crucial issue in this market, generally defined by Hughes' decision to take a retail approach and WildBlue's favouring of wholesale arrangements with partners including EchoStar, DirecTV, AT&T and NRTC. This has been reflected by the higher ARPUs that Hughes has historically driven from its business, but the wholesale strategy undoubtedly helped WildBlue grow as fast as it did in the early stages of its business. As a

result of ViaSat's acquisition of WildBlue and then EchoStar's acquisition of Hughes it looked likely that there would a significant rearrangement of sales channels and distribution strategies. In fact, other than EchoStar's decision to commit HughesNet to add a more defined wholesale strategy to its sales, the status quo has largely been maintained. It had been anticipated that as the parent of EchoStar and ultimate owner of Hughes, DISH would terminate its relationship with ViaSat, but this did not happen and, almost as surprisingly, Hughes also signed up DirecTV as a sales partner. Despite all the old rivalries and competing relationships, it would appear that the DTH television operators see availability of satellite broadband as part of a bundled service that is simply an important part of their value proposition regardless of its origin.

There is a secondary impact to the enterprise side of the VSAT market of all this activity. The services behind these satellites are based on dramatically lower price points for capacity and hardware – prices for a complete VSAT are now below $300 – and this is having a knock-on effect for the wider enterprise segment, but as of yet, not as much in the United States as in international markets. This is because the US consumer market is proven and far more defined than elsewhere, even Canada. Having grown out of the enterprise market, Hughes has always maintained an element of value added enterprise service in its consumer portfolio, but WildBlue never really did much with any conviction. This is now changing as ViaSat expands back into the enterprise market it essentially abandoned when it sold its Immeon service and Hughes looks to exploit the full capabilities of Spaceway as consumer subscribers are migrated to the Jupiter platform.

ViaSat believes, and we agree, there is simply too much bandwidth on the latest generation of Ka-band satellites to rely only on the consumer market for sales. Not only will new markets have to be found, but much more sophisticated applications will have to be supported as a result and this will definitely have an effect on the enterprise VSAT system vendors. Hughes of course has already demonstrated that a highly functional, feature rich, extremely reliable terminal can be manufactured in quantity and sold at very competitive price points. It is sometimes too easy to forget that Hughes is the only company to have developed a platform that competes and wins at the highest and most specialised levels of the market as well as in the mass consumer business – this is achieved on a single, unbelievably flexible operating platform.

Alongside its direct success in the consumer market, Ku-band services have also contributed scale for Hughes, which shipped over 40,000 units of all types a month on average between 2014 and 2015 – more than ViaSat, iDirect and Gilat combined. Without question, this has given Hughes a lower cost to manufacture than any of its competitors and an advantage which it has made pay. What Hughes, ViaSat, Xplornet and all the others have proved is that a substantial market for satellite consumer broadband access does exist and can sustain a viable business. 1.8 million subscribers is not huge by DSL standards, but it still represents a significant indication of interest, especially when the fact remains that the price point is considerably higher than for terrestrial broadband services.

With the exception of iDirect and Newtec, all of the major system vendors have pursued the service business in the United States in one form or another. Hughes has, almost since its inception, had a foot in the service camp but it took a few years before it became the primary strategic growth area over development and sale of hardware. The determination

to turn an engineering-led hardware company into a customer-orientated service business has been impressive and unrelenting with the company's success and leadership in the consumer market the most impressive feat of all. In addition, not only has Hughes managed to establish and maintain the largest VSAT service operation in the world under its North American division, it has also successfully leveraged the expertise it gained in the US to create some of the biggest operations internationally. Hughes is unquestionably service-led today and nowhere more so than in North America.

5.2. Latin America

After a few years of looking very much healthier the Latin American VSAT market entered a more turbulent time for the operators from 2012 onwards and the same remains the case today. For many operators there has still been some growth in terms of sites, but for a few there have been some particularly difficult changes to have to cope with. The saying goes "the bigger they are, the harder they fall" and so has been the case as Mexico, Colombia and Brazil have all seen considerable changes as government networks and initiatives are re-assessed, restructured, re-bid or simply come to an end. Just as in other parts of the world, the VSAT market in Latin America has polarised between large accounts attributable to carrier extension and government projects at one end and smaller, more specialised networks commanding higher value business at the other. The growing emergence of Ka-band HTS capacity is another thing that offers both opportunity and threat. In addition, so much business in Latin America is influenced by politics, corruption and economic turbulence.

Governments in the region have long been the world's strongest proponents of broadband in general and satellite in particular as a means of raising the competitiveness of their economies and connecting rural and isolated communities, but 2011 saw both Mexico and Colombia begin to re-assess their support of satellite-based networks and this resulted in a number of large network projects being disbanded from 2012 onwards. To what degree the reasons behind these actions were political rather than economic and just how much reality there was behind decisions which seemed to favour alternatives to satellite services, is a difficult thing to judge. Nevertheless, after some years of ongoing opportunities that had almost become predictable, this change of attitude and approach undoubtedly caused some shock waves through a number of large operators. On the brighter side, governments in Brazil, Colombia, Peru, Venezuela and Bolivia have maintained commitment and extended a number of broadband initiatives, in some cases with new and innovative universal service schemes, and general encouragement at state and federal levels have helped prop up the market. This is partly a consequence of the fact that there is only patchy coverage by terrestrial services and although governments need to evaluate terrestrial alternatives they finally find themselves forced back to a satellite solution.

Capacity Paradox: Ten years ago operators suffered as satellite capacity, especially Ku-band, became increasingly harder to find and prices rose as a result. The satellite capacity environment in the region is something of a paradox because there has been almost constant talk of shortages of capacity, especially Ku-band, over the past ten years and general grumblings from the VSAT operators about bandwidth prices and restrictions on access have been common. As capacity prices began to plummet in many other parts of the

world, Latin America remained relatively high – typically between $2,500 and $3,000/MHz. There was always some major event related to a new satellite that was about to change the landscape for better or worse, but capacity pricing in Latin America has been amongst the most stable in the world and certainly a very far cry from the huge swings in price and availability that have been witnessed in Africa and the Middle East over the same period. However, this is now changing with the influx of several high capacity HTS spacecraft from the likes of Hispasat, Eutelsat and Intelsat with upcoming launches from Yahsat, SES and others. The great change that feels like it's been teetering on the brink for so many years is now happening and this is likely to result in a major shake-up of the market and has already initiated a new round of consumer internet initiatives. Whether Ka-band can sustain a reliable enough service for enterprise services in some of the most rain intensive areas of the world has yet to be truly assessed, but there is no doubt that the new consumer services will change many aspects of the SME business.

Ka-band and Consumer: The business of provision of generic broadband consumer internet service has now moved into its third stage. First, Star One made a push with its EasyBand service back in 2000 when growth, the internet and optimism ran high. Then, in 2013 Media Networks, the wholesale television distribution arm of Telefónica, launched a consumer business based on Ka-band capacity on Hispasat's Amazonas-3 spacecraft. The company's plan was to follow a similar model for consumer broadband as it had successfully pursued for DTH and it committed to nine beams comprising 15 Gbps of capacity on Amazonas with coverage of Mexico, Brazil, Argentina, Chile, Colombia, Ecuador and Peru. With such patchy coverage it does not look like the company has been able to darn everything together. Some areas, like Chile, are said to be doing (relatively) well in the consumer space whilst others, like Peru, are making use of the system for lower availability enterprise services. However, other areas, like Brazil, are nothing less than a disaster.

Enter Hughes. In 2014 Hughes do Brasil (HdB) announced a 15 year contract with Eutelsat for all of the Ka-band capacity on the company's 65 West A satellite. This supports 24 spot beams of which 16 are said to cover a significant portion of the Brazilian population and generate over 24 Gbps of throughput. HdB subsequently installed the latest Jupiter2 VSAT platform and began planning the launch of a consumer service based on its local expertise in conjunction with the long established consumer internet experience of its parent. The service was launched in June 2016 and Hughes has engineered a very successful entry into the market. With 40,000 subscribers and rapid take up, the company now has a considerable head start over its incoming competitors. HdB has targeted the top-tier of the consumer segment which it believes is the type of customer that both needs and can afford such as service. With the lack of an ability to wrap the hardware cost into a monthly service charge, very high import duties and monthly licence fees, meeting the economic constraints of the wider, poorer population is undoubtedly a major challenge, even for Hughes.

It is likely that it will be an even bigger challenge for Yahsat which has its Al Yah-3 satellite due for launch during 2017. With coverage of both Brazil and Africa through 58 beams, half of which provide coverage of 95 per cent of Brazil's population, AY3 carries 40 Gbps of capacity in total of which around 20 Gbps is available in Brazil. The company has established a team in-country and has been actively looking at the best strategy to penetrate the market which is likely to be a multi-faceted approach. There is a good deal of scepticism about the likely success of consumer Ka-band service across Latin America. In part this is based on the

more obvious concerns regarding service availability in the higher frequency across some of the higher rainfall areas and in part it is simply a question of whether enough of the market can afford it. The scale of demand and the addressable market is not the issue that COMSYS hears commentators raising, it is whether service can be delivered economically at a price that subscribers are willing or able to bear. Hughes' premium service in Brazil is the company's first step, but it has ongoing intentions to ultimately bring lower cost service plans to market and to provide an integrated wireless extension solution using the WiFi feature already incorporated into its VSAT terminal. Mexico is another area of interest with both Hughes and ViaSat extending coverage with their latest generation of satellites. Hughes already has a partner committed to providing a service in Mexico and ViaSat is known to be working on rural internet for communities with an extended PAYG integrated WiFi service. Most agree that some form of wireless enabled PAYG service is the most credible business model to bring a cost effective and affordable service to rural populations in almost all areas of the developing world.

Corporate confusion is being caused by the unstable economic situation in the region. The O&G and mining segments were a good source of business a few years ago and in some respects still are, but the downturn in oil and commodity prices have undoubtedly had a dampening effect. The big global O&G VSAT operators like CapRock, RigNet and ITC Global do play in the Latam market, but not as extensively as in other regions and mostly in the offshore segment. Several of the local operators like Satelital, Anditel, Axesat and Level-3 do decent business with land-based resource operations and whilst there has been a slight dip in demand over the past two years, it does not appear to have been as bad as in other regions for some reason. Mining tends to be a business with longer term commitments and this segment has seen flat rates, but no declines.

Latin America appeared to grow up 15 years ago as the bigger international enterprise businesses took a different approach and a shift of gravity occurred from headquarters located outside the region, usually in the US, to in-region centres. In particular Brazil and Mexico have become prime locations and operators like Level 3, BT Latam and others inform us that much of the business they do is in region, rather than between continents. The key players in this segment remain Level 3, BT Latam and Telefónica. The strategy of supporting local operations from regional facilities has slowly given way to direct in-country investment by all of these operators as the business was brought in to support it.

Carrier network extension has continued to grow and is now a far bigger source of demand than direct enterprise networks. Carriers across many of the countries require a satellite solution to augment their terrestrial coverage and the most popular way of doing this has been to team with a specialised local provider. In Colombia, Axesat has built a thriving business on this model, working with all of the major carriers in the country as well as with some operating in neighbouring territories. In Argentina the situation has changed though and, whilst Telefónica always had its own extensive VSAT business, it made use of Servicio Satelital for a small part of its SME broadband offer. Arsat also used companies like Servicio, but both have pulled their operations back inside over the past two to three years. Having said this, Servicio still serves Copol for extension and continues to do well in many other parts of the business and has grown its presence in the land-based O&G, gas station and utility segments. As we look across the changes that have occurred in the region, carrier network extension is one of the largest areas of demand that emerged in 2008 and has gone

on to become the second largest source of business after government broadband networks with probably more predictability.

Government Hesitation: Latin American governments have led the world in their active acceptance of VSAT to meet the need for rural connectivity services. Politically, the need to modernise infrastructure and, in particular, invest in the education of the next generation remains a major requirement. This has continued to drive some of the largest deployments in the world in Colombia, Mexico, Argentina and especially Brazil. The problem is that this can be a real rollercoaster for operators. In 2011 BT Latam won the 7,000 site Correios post office network away from Embratel, adding this to its earlier renewal and extension of Caixa Economica, a federal social banking network that now reaches 18,000 bank and lottery sites. The company managed to roll out over 18,000 sites between 2011 and 2012 – a real achievement given the remote and isolated locations. Then, in 2016 BT lost the Correios re-bid to Embratel and the same year the government cancelled a large proportion of the sites that Embratel is running for the GESAC program. Despite extensions to e-Mexico and Compartel, both the Colombian and Mexican governments began to re-evaluate their use of satellite networks by 2011. In Colombia most of the Compartel subsidies came to an end and the government decided to let many sites find their viability (or not) under commercial terms. This resulted in mass terminations and a regulated disposal program as local users largely declined to maintain the service primarily because these are services that they believe central government should fund. In Mexico, the scale of the Enciclomedia project in Mexico was huge even by Latin American standards. The project reached about 45,000 sites in 2007 and a second phase was ordered to take the deployment up to 70,000. However, a change of government brought an immediate review and the expansion was put on hold and then a decision made to discontinue the service entirely. Peru's FITEL program has continued and now numbers around 6,000 sites. There have also been other, much smaller government programs and network awards in Argentina, Bolivia, Panama and Chile, but a gradual decline of sites between 2009 and 2011 turned into somewhat of a bloodbath in 2012 before picking up in 2013. Since 2012 the number of sites under government programs had grown by almost 40 per cent in 2016 from 100,000 to 137,000. This seems to be indicative of several governments considering alternative technologies or even abandoning their subsidies completely, before being forced

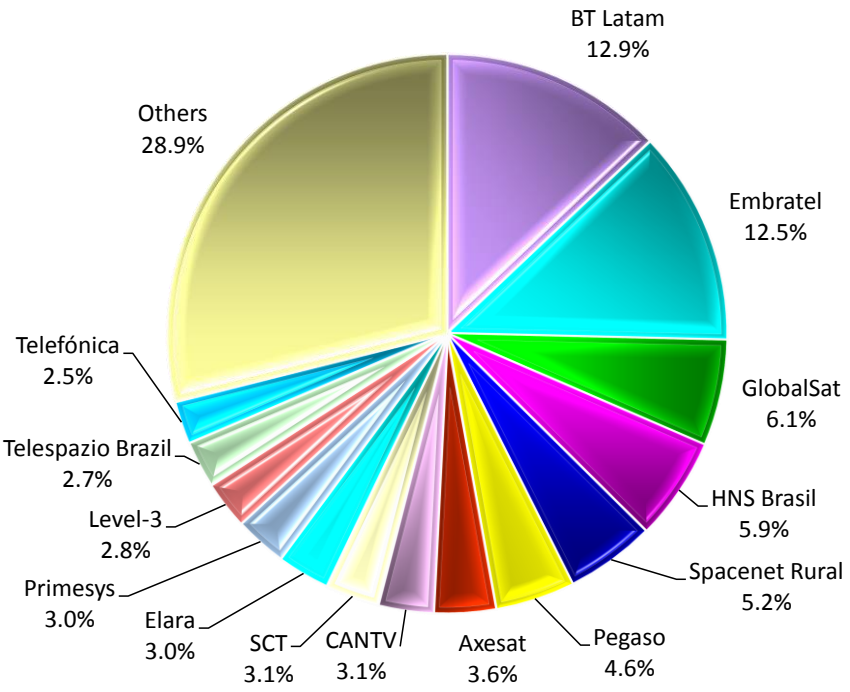


Figure 24 - Latin American Operator Enterprise/Broadband Market Share

back to maintain their support with the only networking technology that is ultimately viable in some of these difficult to reach places.

Fall-back to base: Until a few years ago there was a growing sophistication that was pervading the market and which was seen in focused IP video and point of sale solutions servicing the retail and banking segments. Although these solutions remain in place, operators do not seem to be seeing the same buoyant demand of five years ago and an increasing number of sites are falling to backup rather than primary connections. One operator with more than 10,000 sites commented that three or four years ago only around 2-3 per cent of their sites were for backup and today the number is more than 30 per cent and contributes little more than a few per cent of the company's revenues – generally a common situation for most operators. Nevertheless, in many countries, where the massive roll-out of fibre seemed to herald the death of VSAT as a mainstream solution, market growth has been healthy. Brazil was always going to be a hard bit of geography for terrestrial operators to dominate completely and, after the initial low hanging fruit in the southern part of the country had been taken away from satellite, the VSAT operators have begun to build out from demand in the less well served north and west. Colombia, Chile, Argentina and Mexico all experienced huge investment in fibre, but this only seems to have stimulated a latent demand in regions where there is little or no terrestrial coverage. Even Chile, where the joke that a single fibre route from top to bottom of the country covers 90 per cent of demand has an element of truth to it, has seen increased activity associated with rural connectivity, telecom extension and cellular backhaul. In Central America VSAT activity has continued to be modest and, at best, the number of sites in service has been stable.

5.3. Asia/Pacific

The Asia/Pacific region is a market of extremely mixed parts. There are some extremely bright spots, but a lot more markets to be extremely depressed about. This not a new phenomenon, we have been disappointed with the overall performance of the Asia/Pacific region for many years now. The perpetual disappointments are China and the Philippines; the solid performers are the countries of Central Asia, Indonesia, India and Malaysia; and, the surprises (for a variety of different reasons) have been Myanmar, Australia, Korea, Japan and Pakistan.

Good news, bad news*:* The Filipino market has always seem to shun VSAT services for some reason, but not for want of trying and whilst several operators ceased their operations - Globe and Millennia for example - a host of others have started up, although none with any real success. There has been little in the way of progress over the last two years and the hope we reported a few years ago in the form of a promised Government digital divide broadband programme for schools in the country which could, potentially, yield 10,000 sites or more has remained just that. The country continues to intuitively offer great potential – especially when compared with its larger neighbour, Indonesia – but sales do not bear this out despite some hopeful initiatives by IPStar through WIT, KT Sat with TOPH and FUBC.

The single largest disappointment has always been China. Generally information on the market is always difficult to obtain and verify. Once again, we believe we have the best coverage in our report, but we are never very happy with the level of information we have in

comparison with other countries. The system vendors continue to find it hard to sell significant networks, although some of the specialised platform manufacturers continue to do small, high margin deals. Most local Chinese service providers, sometimes backed by a provincial telecoms company or even one of the major carriers, continue to struggle. In fact of 30 or more operators less than a handful can be considered to be viable concerns and at least two of these rely almost completely on parental anchor networks of large size. The situation is however beginning to show real signs of change, not least with plans for new HTS satellites from Chinese operators. Additionally, a number of initiatives and ventures have been kicked off over the past two years including several maritime service platforms usually formed around one of the low-cost Chinese stabilised antenna manufacturers. There has been talk of government initiatives to implement VSAT connectivity on tens, if not hundreds of thousands of vessels and local companies like GW Sat, Marinesat and Comdi all seem to be positioning themselves for this. Beyond the supposedly rooted demand for interactive distance education and various government schemes to provide infrastructure connectivity or public broadband (which often end up being dedicated networks), the two areas of demand in China for VSAT have been emergency services and GSM backhaul.

The government continues to roll-out networks for various rural connectivity projects and national departments, although these are quite modest considering the size of the country. Disaster relief and emergency communications VSATs have been bought by various local administrations, especially as some awful events have unfolded over the past few years. This has been good business for some manufacturers, but others report being asked by authorities to donate equipment for free – a hard thing to justify in a market where you do little if any business. This remains a market where a VSAT vendor or operator can make a small fortune – provided they start with a large one. We used to say that hope springs eternal, but for a VSAT business in China to reach viability it might just take eternity – just ask IPStar. Whether this is about to change with the HTS initiatives and licensing deals which have been done recently is another question, but we would have to conclude that opportunities really could open up in China once more.

In direct contrast to China, Indonesia has amongst the best managed operators in the region with Metra, Lintasarta, Primacom, PSN, Satkomindo and many others. Most of these companies have continued to invest in their systems, expand their services and show growth even as many new broadband services have entered the market. At one time there was a push from operators with hubs outside the region, but this has long since given way to enough new domestic providers that seem to spring up eternally. Prices continue to fall dramatically - sometimes by around 20 per cent a year for all types of services - as competition has grown and it is becoming increasingly difficult for some of the more solid businesses to make money and there have been some real catastrophes. The country's economy is now much stronger and growth has been seen across many levels of the VSAT business, but somewhat like India, this has come in the form of volume often at the expense of margins. The vast majority of TDMA sites serve the thin-route transactional applications, especially ATMs whose parent banks demand C-band VSAT reliability for GPRS prices having tried and rejected Ku-band services in many instances. These customers form the core TDMA VSAT business of Satkomindo, Lintasarta, Primacom and several other smaller operators which effectively have only one customer in the form of a major bank, although the price levels have caused some operators to simply walk away even from multi-thousand site deals. However, it was the SCPC GSM backhaul business that grew to sustain many of

these companies, but this has begun to change. At the same time, the corporate SCPC market is not quite as tough as we judged it to be two years ago. The best business is still isolated to the specialised segments, like oil & gas and mining, but there is also demand from other primary producers, like plantations, and even banks.

GSM backhaul: The provision of SCPC links to support GSM backhaul remains an important business, but it is has begun to shrink in two ways in recent years. At its height more than 1,100 E1 SCPC circuits were in service spread throughout the vast VSAT operator community. The business became tougher for these companies as greater efficiency pushed in and prices dropped proportionately, but then the largest user, Telkomsel, made the decision to bring almost all of its operations in-house to Telkom (Metra and Patrakom), suddenly pulling the foundation out from many operators. The falling off the cliff event that we predicted three years ago has now come to pass. As the major example, CSM, the first ever VSAT operator in Indonesia founded in 1988, had been struggling for a few years, but this effectively sounded its death knell despite being part-owned by Telkom. Indonesia's government's actions helped define the market in more than one way. In the first instance the approach to support the USO seems to be similar to a few other countries that also see the profitable cellular operators as the best candidates for taking the responsibility. The Asian region, and the Pacific particularly, is seen by O3b as one of its key markets especially for cellular backhaul and in our discussions with operators like Telecom Cook Islands, Solomon Telekom and SpeedCast, the satisfaction with the performance of the O3b connection has been very high – only mitigated by the frustration of the attenuation related outages due to its use of Ka-band and the poor reliability of the mechanically steered antenna systems which are used. Having said this, O3b is known to have been working hard on the latter problem and reports suggest that the latest generation of antennas are working more reliably.

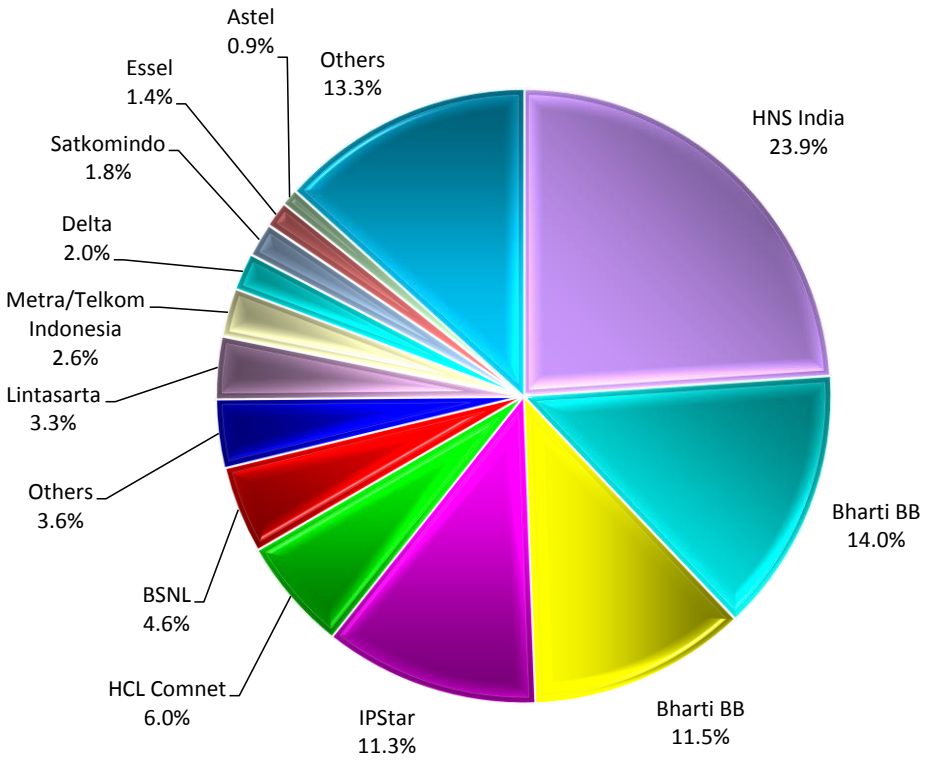


Figure 25 - Asia/Pacific Operator Enterprise/Broadband Market Share

Government broadband programmes: Indonesia's use of the GSM operator for its rural telephony USO programme moves us nicely on to government broadband and connectivity subsidy programmes in general. The past two years have seen a continuation of past

initiatives in this area from several countries including Indonesia as well as other large programmes in Australia and India. Additionally, the Thai schools broadband network remains with IPStar, but has not expanded and perhaps even shrunk slightly. There is promise of a new government digital program which will need VSAT, but we are not aware of any definitive decisions on this yet. 2,500 locations of Malaysia's 3,000 site SchoolNet project were replaced and upgraded by Maxis during 2013 and although this has shrunk slightly it remains in place. Smaller networks supporting community centres, libraries, schools, clinics, local government administrative offices and the like have also been seen in Malaysia, Indonesia and other countries, but these have been relatively minor. Overall, large government broadband programs outside of these countries have been pretty sparse and there has been little growth worth reporting on, although Bangladesh is working on a program with Thales Alenia Space and ESA which will comprise a new VHTS satellite and the latest Space Gate platform with a multi-band hub able to operate in the Ku, Ka, Q and V-bands.

South-East Asia has not generally been a happy place for VSAT. The best markets are clearly Indonesia and Malaysia, but an intensely competitive telecoms market in which volumes bring an expectation of huge price reductions has resulted in tough conditions for all of the operators. Whilst many have been able to maintain and even grow their revenues, profits have continued to stagnate and margins are under pressure. The markets of Vietnam, Cambodia and Laos that had seen some increased activity five years ago which seemed to indicate promise have since dropped back substantially and companies like IPStar that had been running several thousands of sites now have no presence at all in these countries. What little activity there is comes mainly from the government, but besides this there is little hope of any real growth prospects for VSAT without any concerted government initiatives.

The country of promise today is Myanmar following the political changes that have opened up and liberalised the market. The IPStar-based business YTP and MPT which had around 2,500 sites in service is being actively transitioned to new platforms now in place with KBZ Gateway, Seanet, KSGM and others. At present it looks as though KBZ and Seanet are making the most progress – both have Hughes Jupiter hubs in operation – KBZ because it is a huge organisation encompassing the country's largest bank and with over 80,000 employees and Seanet because it was one of the largest resellers of the IPStar service and has an extensive sales, installation and maintenance network. This gives both companies an advantage because Myanmar has some very remote and isolated areas which can take days to reach if there is no local presence. Activity and intrigue has been a feature of the market in Papua New Guinea. Most of the major VSAT providers are Australian-based working with local partners and there have been major changes on both sides of this equation. SpeedCast expanded its presence through several of its acquisitions. Digicel also works with IPStar which, following the acquisition of Orion in 2014, probably has more sites in PNG than any other provider with the possible exception of Telikom PNG itself. All these realignments and acquisitions are only the tip of an iceberg of political manoeuvrings in a market with almost no infrastructure, extremely hostile terrain and huge natural resources which are attracting some of the major mining and oil & gas companies.

The regional breakdown of market share naturally shows just how important IPStar's presence in its home country is, but also the scale achieved by the Indian operators. The large deployments in India, Indonesia and elsewhere have come at a price however, and this

is often manifested in the operators' desire for lower hardware costs. Having said this, VSAT operators everywhere across the region have shown themselves to be amongst the most resilient of businesses. There has been a continual investment in new systems, both Ku and C-band, with the intention of expanding into new markets and opportunities, particularly relating to cellular backhaul.

Space segment variance: For many years Asia consistently enjoyed the lowest space segment pricing in the world with rates hovering around $2,000 to $2,500/MHz for both C and Ku-band capacity. Then, in late 2010 and 2011 the situation changed and reports flooded in of prices between $3,000 and $4,000/MHz depending on coverage and power. More recently, as competition has intensified, satellite operators have become more desperate and new HTS projects have begun to peak through the door, prices have dropped dramatically. This has been fortunate for the VSAT business because if Asia had gone through a similar inflation of prices as happened in Africa and the Middle East between 2006 and 2010, given the fragility of some of the businesses in the Asian region, bankruptcy could have become commonplace. The trend towards lower pricing has been led by the likes of IPStar, ABS and Kacific (at least its promises!). However, it has not affected some markets like China, where there is effectively a monopoly controlled by China Satcom, despite all the names in the market. Indonesia also has not seen major reductions, not least because demand from DTH is said to be pretty robust.

To some degree this also affects the markets in the Pacific and this is the area in which Kacific believes it can bring some changes. However, this is not the largest market in terms of population – less than 3.2 million people live across all the islands in Oceania excluding Australia, New Zealand and PNG. If we count all types of VSAT systems – TDMA, SCPC, DAMA – the total number of sites COMSYS currently tracks is just under 2,200. With its raft of acquisitions, SpeedCast has come to completely dominate this market. The region also emerged as O3b's bread and butter and we believe it is still the company's largest area of business at the moment.

Australia's Ka-band saga*:* Australia is, by far, the leading light in terms of Government subsidised broadband access policies in the region. At the end of 2010 the total number of consumers served by VSAT in the country under the subsidy schemes amounted to 115,000. The Australian government continually renewed programmes and subsidies over the years, but in 2008 its Australian Broadband Guarantee (ABG) spawned an RFP to provide a National Broadband Network (NBN). It stated that no more than 10 per cent of the total connections would be based on alternative wireless technologies, but it acknowledged that satellite would be required and contracted with Loral for two Ka-band spot beam satellites. Named Sky Muster, the two spacecraft were launched in 2015 and 2016 respectively and support 135 Gbps of capacity between them. It is unknown how many of the stated 10 per cent of households expected to be connected via wireless and satellite would require a VSAT. The estimated number varies from a high of 400,000 to a low of just 50,000 – not enough to justify one satellite, let alone two. Most believe that the number of satellite households will peak at around 100,000 and cite the fact that the expansion of 4G/LTE services has already brought significant erosion. Thus, there is a question mark on just how viable the satellite part of the business will be and this has a consequent knock-on effect on the commercial VSAT business.

Whilst NBN Co. has claimed it will not compete in the commercial market, this would not apply to government networks. Additionally, most VSAT operators believe that the mutual attraction between NBN Co. and the resource industry brought about through lots of spare bandwidth and the need to justify an investment coupled with growing bandwidth consumption, will ultimately see NBN capacity servicing the enterprise market one way or another and the company is known to be seeking a partner able to maintain and manage a separate enterprise-related VSAT platform on its satellites. A further complication is that IPStar will also find itself with growing capacity availability as the transition from the interim to the full NBN service takes hold. Either way, the Australian VSAT market is likely to face an unprecedented level of change over the next two to four years.

Today, IPStar is understood to have almost 40,000 of its own terminals in service in Thailand of almost 80,000 in total across all of its Asian markets. However, this total has declined from 160,000 in 2010 as IPStar feels the heat of competition from the terrestrial network as its VSATs are routinely replaced when DSL becomes available, even in its core market. The company also has sites in New Zealand, Myanmar, Japan, Malaysia, India, Indonesia and the Philippines, but not in the same scale as it has in Thailand or had in Australia. The two important markets the company really struggled with were China and India, both of which proved to be extremely difficult to crack at both political and market levels. In India where there is no open skies policy, the company works through what appears to be a strong partnership with BSNL which now has almost 20,000 sites active in the country. Then, in 2016, BSNL and IPStar reached an agreement to install Hughes' Jupiter2 system for India as well as partnering to market and sell the service.

In Pakistan, cellular backhaul has swung backwards and forwards as an opportunity. Initially seen as a major opportunity for the VSAT operators, the business was whittled away as the cellular operators, encouraged by government subsidies, took operations in-house. However, over the past few years SuperNet has signed a number of deals with at least three different mobile operators and has grown strongly on the back of this segment as well as some government networking. Banking accounts for the largest proportion of sites, but pretty much everything is backup.

The Afghanistan Ka invasion: Growth was also astronomical in Afghanistan up to 2010. Military surges and the need to build infrastructure as a prelude to the withdrawal of Coalition forces in Afghanistan meant that spending on satcoms increased substantially based on efforts to bring civilian governance and a greater integration with the rest of the world after years of isolation. However, as the timetables were set for an early withdrawal of US forces and other countries began to move out well in advance of this, so it became evident that operators would have to face up to some hard terminations. Added to this, the market changed dramatically with the launch of Avanti's HYLAS-2 and Yahsat's 1B Ka-band satellites. Suddenly capacity availability was not the problem it had been and pricing went into freefall. The major European satellite broadband providers – Bentley Walker, Nynex and Talia – reacted quickly by locating Hughes and iDirect hubs in Avanti's Cyprus gateway and proactively swapping out their Ku-band sites with an upgraded, more cost effective service. These companies were the winners, but there were plenty more losers. In 2013 one of the longest term VSAT providers in the country told us that its satellite capacity has dropped from 500 MHz to 100 MHz over the previous three years and that it fully expected

to be out of the satellite business in Afghanistan within three years – a very accurate forecast.

India VSAT sets the pace: The Indian market continues to set expectations, price points and strategies that, in some ways give great hope and in others, real concerns. The country has reached an advanced stage of maturity in many ways. We forecast that the Indian VSAT market was about to start growing in terms of revenues in our last report and indeed this has been the case – 13 per cent in revenues and almost 30 per cent growth in the number of terminals in service by our calculations between 2013 and 2015. VSAT services have been a large part of the effort to bring connectivity to all regions of India from the earliest days. NICNet was one of the first ever VSAT initiatives in the world which aimed to harmonise communications between different remote government offices – something it still uses VSATs for. For many years the government of India has been driving a number of eGovernment projects, particularly connectivity for schools, community centres and rural business and whilst many of these continue other initiatives have provided more fuel for growth and there's more to come. Some highly ambitious plans to extend fibre connectivity to 50,000 villages and support cellular services have been voiced by the government. Although we have some real doubts about the practicality of this, with 600,000 villages and around one million schools it seems clear that there is plenty of growth potential left in the Indian market.

Between them, Hughes, Bharti, HCL and Tata control over half the entire TDMA market in Asia as a whole and make up four of the top five largest VSAT operators in the region, eclipsed only by IPStar with its completely different vertically integrated satellite/VSAT model. This success however, comes with pain. India is by far the worst country in which to do business for the vendors. Prices are under continuous pressure and re-negotiation is an ongoing daily process. With volumes and ambition have come the lowest prices in the world for hardware and for service. However, this began to change from 2012 onwards and price points hardened and even increased in some cases. As a consequence, the new level of realism that seems to have taken hold is encouraging and, once again, shows a depth of maturity in the Indian market that perhaps was not immediately apparent before. In part this has come about as some of the terrestrial operators have had to face up to some stark realities. Two years ago telcos were being sanctioned for unfair price practices and some of the wireless operators made to scale back their plans or even give back their frequencies, all of which has been good for the VSAT operators by relieving some of the price pressure and expanding the addressable market.

That said, 4G/LTE coverage is growing and cellular services are seen as the major future competitive threat. However, they could also be a major opportunity. The government is now funding two or three new projects under its USO to push 2G cellular services out to even more rural areas and some of the major mobile operators are looking at extending LTE networks with VSAT. The major government-induced push to extend ATM services from 100,000 to 160,000 sites has now ended and the banks have been left to do their own thing. Nevertheless, the number of ATMs connected by VSAT jumped from around 30,000 to more than 80,000 in a couple of years and there continue to be RFPs from the banks, although most are only for a few hundred sites. The government business has been good across the spectrum from eGov and USO projects through to dedicated networks for civilian and military organisations.

Battles for leadership of the VSAT market in India have always had one common theme – Hughes. From the earliest of days Hughes India traded punch for punch with names that have long since disappeared into history. By 2006 the rivalry was Hughes versus HCL, by 2008 it was a three-way race with Bharti coming up fast but Hughes still leading by a few percentage points, in 2010 Hughes and Bharti were separated by less than a percentage point. However, Bharti's charge exposed it to some aggressive offers for ATM banking customers and by 2011 the company was forced to reassess its strategy and began to fall back. As probably the strongest positioned of all the totally integrated infrastructure based carriers, many believe that it was building its position in the VSAT market based on an aggregation strategy designed to drive customers to its terrestrial services in the longer term. This made life much harder for the VSAT-focused operators like Hughes and HCL Comnet, but also for other integrated carriers, such as Tata. However, facing losses, this could not be sustained and Bharti's aggressiveness has been supressed since 2011.

Hughes India continued to power ahead, taking the largest part of all the volume deals that have been bid over the past two years. The company faces criticism that it is also pursuing an unsustainable strategy with some of its price points, but the answer is said to be found in its innovative management of bandwidth. Its strategy has always been amongst the most innovative in the world and instead of running scared as prices dropped to ludicrous levels the company instead looked at how it might reduce costs through its networking and management capabilities. Hughes actively manages its services by scheduling different customers and applications by rate and time of day, creating a dynamic system which delivers defined SLAs, but which also maximises the use of its satellite capacity across all of its networks. This has been coupled with a more innovative sales strategy that enables a low entry offer at acceptable margins with a high rate of upselling of additional applications. The company believes that its strong technical heritage and the fact that its parent is also the world's largest manufacturer of VSAT systems brings it an edge that its competitors simply do not have. Having said this, it is also true that Hughes India simply has to be successful with its VSAT business because it has no other revenues to hide behind.

The company has adopted two approaches – to position itself as the preferred partner for carriers and large integrators and to aggressively pursue the large network bids directly. This has allowed it to focus on its core expertise and concentrate its investment on market leading satellite infrastructure. It is now the preferred partner for companies including Wipro, Infosys, HP, TCS, Reliance and (even) Bharti and has leveraged off its own experience of providing hybrid solutions and designed its offer to look and feel like an MPLS service, making it easy for carriers to understand and integrate into their own offerings. At the other end of the scale, Hughes has pursued the major network bids with a determination that its competitors have begun to find scary. Of the large RFPs for public sector banking, ATMs, school connectivity and community broadband services, Hughes India took the lion's share helped by its efficient use of capacity and vertical integration as the manufacturer of its VSAT platform. The company is also the leader in the provision of digital film delivery services - it currently delivers 12 to 14 Gbyte MPEG-4 movie files between 25 and 30 times a week to 3,500 UFO Moviez cinemas and 70 GB MPEG-2 files to 2,500 Real Image cinemas across India as well as support for applications including ticket and licence fee settlements.

All of this has continued to increase the problem of satellite capacity which is essentially sold, controlled and regulated by the Department of Space whether this be on domestic

spacecraft or capacity leased from foreign operators. Back in 2013, Hughes claimed that despite the country needing 150 transponders in 2014, less than half this amount was available and the forecast was that the shortfall would grow significantly in 2015. The company has a big axe to grind in this instance because it has been lobbying hard for several years for permission to build and launch a Ka-band HTS satellite for India. However, critics claim that the DoS has resisted these and applications from other companies by simply dragging its heels. Part of the explanation of all this is quite likely the fact that ISRO has had its own HTS satellite, GSAT-11, under construction which is due for launch in 2017 and which will bring 12 Gbps of capacity to the market. BSNL, the state-owned telecoms company, also has access to an HTS satellite through its partnership with Thaicom for IPStar. BSNL currently uses the old IPStar VSAT platform and so over the past year both ISRO and BSNL have issued RFPs for VSAT ground segment solutions to support their capacity. To Hughes' credit it won both bids with its Jupiter2 system, once again placing it at the forefront of the market with a definite head start over its competitors in the application of HTS capacity. This is particularly the case with BSNL because it is not only supplying the system, but has also partnered up to sell the service.

By contrast to the VSAT-focused Hughes India, the VSAT businesses of Bharti, Tatanet and BSNL are all just one solution within a wider, terrestrially based product portfolio. Even HCL derives most of its revenues from integration and management services rather than VSAT and, of all the other major VSAT competitors in India, its determination to maintain margins regardless of the size of the opportunity makes the most sense in the white heat of the battle that has ensued between the others. HCL's strategy has focused on the upper part of the TDMA service business for some years, staying with extended C-band networks wherever possible and maintaining its VSAT business as a way of adding value to its suite of software and integration value added services. The company has diversified considerably over the past ten years and is driven by many more issues than the price of a VSAT. This brought about a decline in the number of sites HCL manages on its services between 2013 and 2015, but it has recently picked up from this and its site count has risen back to the levels it last saw almost ten years ago. During all this, the company has maintained its profitability as a result of its high-end strategy and it's worth mentioning that one of its first ever customers – the National Stock Exchange – remains its largest captive network customer after more than 20 years.

Hughes also informs us that its bandwidth management strategy has allowed it to maintain its profitability, but just by virtue of the fact that by the end of 2015 it was operating almost 105,000 sites – 45,000 more than its nearest rival and almost 80,000 more than HCL – it can be seen that the two companies have polar opposite approaches. By contrast it is those in the middle – Bharti, Nelco and BSNL – that face some of the biggest challenges. Nelco is now the third largest operator in the country and it also has a credible integrated offer as one of the major carriers. It is beginning to look towards other, more specialised aspects of the market, particularly mobility applications, as a means of future growth. However, this will only happen if the government loosens its current regulations which restrict any mobile VSAT service. There is a strong belief that this will change, not least due to the growing demand for connectivity at sea and in the air. Bharti remains the second largest operator and has been growing consistently, but much slower than its rivals. Some have begun to question what the company's longer term expectations are for its VSAT business and it does appear to be the company has begun to look more towards international markets for

opportunity than domestically. A very good example of this is the company's commitment to OneWeb's LEO project – ironically alongside Hughes which also joined the gang. The smaller players like Infinium, Infotel and PlanetCast (previously Essel Shyam) have endured an even harder life. When last reported at the end of 2015, Infinium had no VSATs in operation, Infotel had 2,000 and PlanetCast had 100 and had informed COMSYS that it had decided to exit the business.

	Shared		Captive		All
Operator	Sites in Service	Market Share	Sites in Service	Market Share	Market Share
Hughes	**104,744**	**39.5%**	**15,019**	**74.0%**	**41.9%**
Bharti	59,309	22.4%	115	0.6%	20.8%
NICSI	2,580	1.0%	65	0.3%	0.9%
HCL Comnet	26,287	9.9%	3,000	14.8%	10.3%
TataNet	50,233	18.9%	-	-	17.6%
BSNL	19,979	7.5%	-	-	7.0%
Others	2,156	0.8%	2,100	10.3%	1.5%
Total	**265,288**	**100.0%**	**20,299**	**100.0%**	**100.0%**

Table 7 - Indian TDMA and DAMA Operator Market Shares (End- 2015)

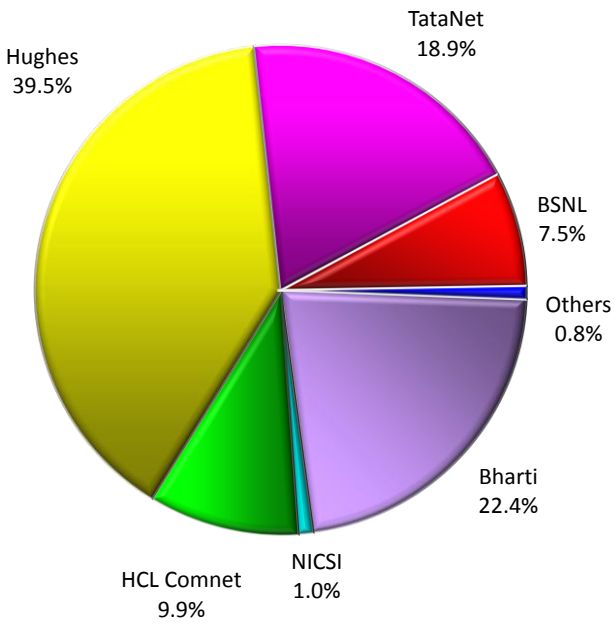


Figure 26 - Indian VSAT Operator Shared Hub Market Share

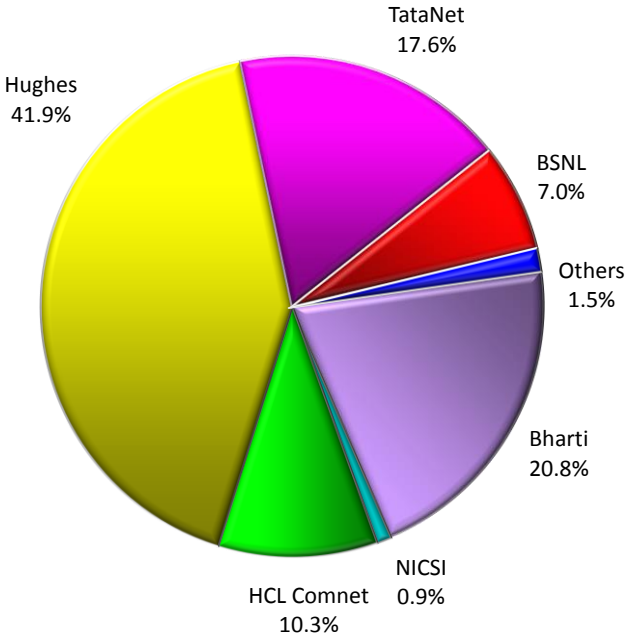


Figure 27 - Indian VSAT Operator Shared/Captive Market Share

Cellular backhaul has been one area that India lags the world, hampered by the bureaucracy that was learnt from the British and then perfected. It takes as much as six months to licence a single GSM backhaul site in India and security concerns have tightened regulations and dramatically increased potential liabilities. Hughes and Bharti are known to have a few links running for various customers and some links are operated by the cellular companies themselves, but nowhere near as many as would be expected for a country the size and development of India. As already mentioned, this may change if the government decides to move ahead with its plans to integrate VSAT backhaul with rural cellular installations and regulations and high licence fees are reduced.

Countering the disappointment seen in the cellular backhaul segment, there has been an increased demand for custom integration of specialised networks, particularly for the Indian military. Several companies including Nelco and Hughes directly have brought in some significant contracts often integrating highly specialised Indian MIL-SPEC network hardware – Hughes has even supplied stabilised VSAT antennas to six submarines as part of its major contract with the Indian Navy. The company also won a valuable systems integration contract to provide the Defence Communications Network in 2013. HCL Comnet has also done some work for the Indian military and has a number of captive accounts in the government and oil & gas segments. In fact, between them, HCL and Hughes account for most of the remaining captive network customers.

In the other developed markets of Asia - Japan, Korea and Taiwan in particular - the market has continued to move away from larger network deployments and more towards opportunities in niche segments, such as maritime, military and emergency response. This has been especially true for SCADA networks supporting several utility companies in Korea, although most have been dedicated facilities. The number of operators in Japan decreased considerably with the merger of Sky Perfect, JSAT and SCC to form Sky Perfect JSAT Corporation. This brought together a number of disparate systems and, during 2008 and early 2009, the company decided to consolidate its activities on a new system from Hughes. The big story in Japan is based on the saddest. The tsunami that hit the north-east coast of the country in March 2011 caused enormous devastation and, amongst other things, brought the communications infrastructure to its knees. SoftBank, one of the cellular operators, immediately deployed several auto-deploy VSAT backhaul units that were provided by IPStar. As the realisation of the scale of the disaster struck home many more units were delivered by the likes of C-Com and now IPStar has several thousand terminals in operation in the country with a correspondingly huge uptick in the bandwidth contracted. The company has gone on to use Gilat's SkyEdge II-c VSAT platform for the deployment of its 4G service in rural locations in Japan that started in 2016 and which, rumours have it, it's about to extend to its Sprint business in the US. Having said all this, sales generally in Japan, Korea and Taiwan have been very sparse.

Finally, Central Asia, particularly Kazakhstan, has operators aplenty; although business has toughened up and opportunities are not as plentiful as they have been in previous years. Several of the older operators have slowly but surely been falling away. Of the ten VSAT operators we track in the country, only three – Astel, Kazteleradio and Kazakhtelecom – look healthy whilst several others look close to finishing up. The site count is up year on year from 2010 onwards, but revenues have declined slightly as TDMA terminals have replaced SCPC and mesh systems and primary has given way to backup. Elsewhere in Central Asia, most of the remaining activity is seen from Delta Telecom in Azerbaijan, which has built a substantial fibre and VSAT business in competition with the national operator's terrestrial services. Gilat has managed to win some small amounts of business in Kyrgyzstan and Eastar/UHP, presumably as a result of its Russian heritage, has some small networks in Tajikistan, Kyrgyzstan and Armenia.

5.4. Europe

Europe is a strange market for a variety of reasons. The West is similar in size to the United States, but high quality, good coverage terrestrial services get worse and the land masses get much bigger as you move east with the infrastructure positively spartan in the parts of the FSR beyond the Urals. Whilst the European Union does its best to unify the continent, Europe remains culturally divided. The far east of Europe is not unlike parts of Asia/Pacific and Latin America - and terrestrial services are often expensive and unreliable although there have been marked changes in this in recent years. Many Central European countries have been expanding their digital, fibre-based, connections beyond the major metropolitan areas and cellular coverage has also grown alongside the same trend of falling prices for bandwidth that is seen everywhere.

In Central and Eastern Europe the terrestrial network has slowly but surely improved and even service in the rural areas does not exhibit much in the way of demand. The national markets in the region retain a high degree of independence in terms of VSAT services with operators essentially existing on domestic business alone. As terrestrial service has improved, so these markets have become tougher and tougher for the VSAT operators and we have witnessed businesses fail or enter terminal decline with a few managing to find success through consolidation or diversification. Generally, Central and Eastern Europe is not an easy place to do business for an enterprise VSAT operator and it is becoming progressively harder. This is not helped by the proliferation of low cost satellite internet services from the large satellite operators which are led into some of the larger enterprise deals by resellers and some of the operators themselves because the opportunity looks attractive given slow progress in the consumer market.

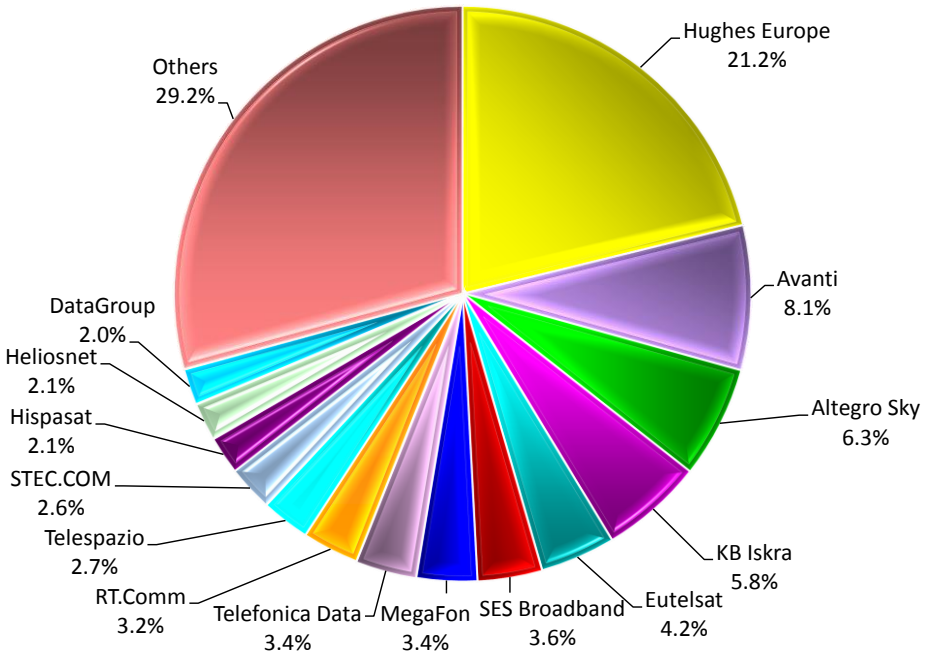


Figure 28 - European Enterprise Shared Hub Operator Market Share

The king of VSAT services in Europe continues to be Hughes Europe, which leads in terms of the most enterprise sites in Europe, helped significantly by one of the largest single deals ever seen in the world. In 2007 the company booked over 25,000 sites with the Camelot lottery in the UK and, amazingly, deployed the whole network during 2008. This network has been extremely successful

and Camelot has gone on to expand its reach, substituting GPRS sites for VSAT to achieve the highest rates of availability possible. Today the network stands at more than 31,000 VSAT sites out of a total of 37,000. Hughes Europe has sold a number of much smaller networks over the past couple of years, but on the downside for VSAT it has been just as successful, in some cases more so, by positioning itself as a managed network services provider rather than just a VSAT operator. Some long term customers have been turning towards DSL as an alternative over the past few years and others have suffered as the economic downturn has taken hold. Like its parent in the US, Hughes Europe supports a hybrid VSAT/DSL service, with customers like Avis, BP Europe, Body Shop and Shell, and now supports 50,000 managed sites, as well as hosting other operator's NOCs located at its teleport in Griesheim. Today, around 13,000 of the company's sites are managed terrestrial connections. In addition, in late 2009 Hughes signed a deal to supply the ground segment for Avanti's HYLAS-1 Ka-band spot-beam satellite. When HYLAS-1 came into service in 2011, Hughes helped Avanti with the replacement and move of over 4,000 existing Ku-band DVB-RCS sites to its HN platform. The company currently maintains the ongoing configuration and management of this service and has moved some of its VSAT sites onto the HYLAS capacity that it contracted for as part of its hardware deal.

In many ways Europe is the centre for the shipping industry. It is a major destination, has some of the world's largest ports and hosts many of the largest and most advanced shipping companies. Whilst Asia is seen as a growth market and a critical area of coverage, it is Europe where the major sales are made. As a consequence, it is not surprising to find that most of the largest maritime VSAT operators are located in the region and others that are not, such as EMC/GEE and SpeedCast, have important operations or sales offices in the region. Hughes' initial contract with Camelot to provide and manage more than 25,000 lottery sites – since grown to over 37,000 – was expected to catalyse more demand from lottery companies across Europe. There are several other large lottery networks served by VSATs in Europe – Spain, Portugal, Hungary and Ukraine use the technology and there were hopes of deals or extensions in the Czech Republic, Russia and Poland. However, in many instances the new franchises have deployed terrestrial wireline and wireless solutions, often at the direct request of the licensing authority. SCADA networking is another enterprise segment that appeared to have a good outlook for growth a couple of years ago, but again, the past two years have actually seen a slight decline. Nevertheless, we believe that the potential remains. In previous reports we highlighted the opportunity from wind farms and this has continued to provide demand, but the requirement to connect broadcast towers was driven primarily by the switchover to digital television services and this is now effectively complete. The demand from gas pipeline and electricity networks across Western and Eastern Europe as well as Russia that was evident two years ago has continued as many utilities have finally begin the migration of their systems from legacy to IP. All these types of applications require some or all support for monitoring, control, safety and back-up.

Once again, the high volume, low cost consumer platforms like SBBS and Tooway are eager for any kind of business and the fact that they have coverage, bandwidth and low cost terminals has definitely given them an edge in the segment. There are good reasons to believe that this segment of the market will find growth over the next few years, driven in part by applications like smart grid systems. However, like all utilities, businesses in the segment invest for the long term and have equally long planning and procurement cycles –

resulting in a frustrating and slow sales process plus there are many instances of dedicated networks which separates the opportunity from the operators.

2012 saw a pickup in broadband sites largely due to the growth in Avanti's service and it remains slightly cloudy as to whether these sites should be classified as SME broadband or consumer internet. It should therefore be noted that without Avanti's subscriber base, the SME satellite broadband site count in Europe would have been on the decline since 2009. Along with Avanti, Eutelsat and SES are the operators with the most commitment to this segment of the market, but have increasingly moved their focus to Africa and, most recently, searching for end-user enterprise customers to fill in the sluggish growth in SME broadband. For its part, Hispasat has pulled back from the provision of managed network services and positioned itself as an infrastructure provider for VSAT operators – something that might prove a very smart move as these types of companies become increasingly nervous about doing business with satellite operators that are looking more like competitors than partners. Europe remains a key market, but this status is increasingly dominated by the east rather than the west. Most European operators have been gradually slipping down the league table in terms of the number of sites in service as the major enterprise customer base has leaked away – the only Western European operator to hold a place in the top 10 is Hughes Europe at number seven and the only other European operator in the top twenty is the growing and highly acquisitive Russian operator, AltegroSky. Hughes' service focus really shows through on these rankings with its businesses in North America, India, Europe and Brazil taking first, second, seventh and 17th places in enterprise services, first, 16th and 18th places in the SME broadband segment and, of course, first in the consumer satellite internet market.

Ka Consumer proving grounds: During 2006 SES Astra announced the creation of Astra Broadband Services (ABBS) and the intention of providing a low cost internet access service called Astra2Connect, since renamed SES Broadband Services (SBBS). Between 2007 and 2010 we witnessed what might be described as a "phoney war", with the two companies battling it out for potential projects and distributors. Tooway gained an advantage with a contract to provide up to 10,000 sites to Swisscom to serve rural households as part of that operator's USO, but SBBS definitely gained the upper hand in the all-important race for distribution channels and pulled ahead while Eutelsat prepared for its service on KA-SAT which was launched in mid-2011. Similarly to Eutelsat, Avanti also launched an initial service, but based on leased satellite capacity and the DVB-RCS platform. This solution as a whole did not have the economics nor did the company have the resources to take the hit on a true consumer platform and, as a consequence, Avanti brought in most of its business

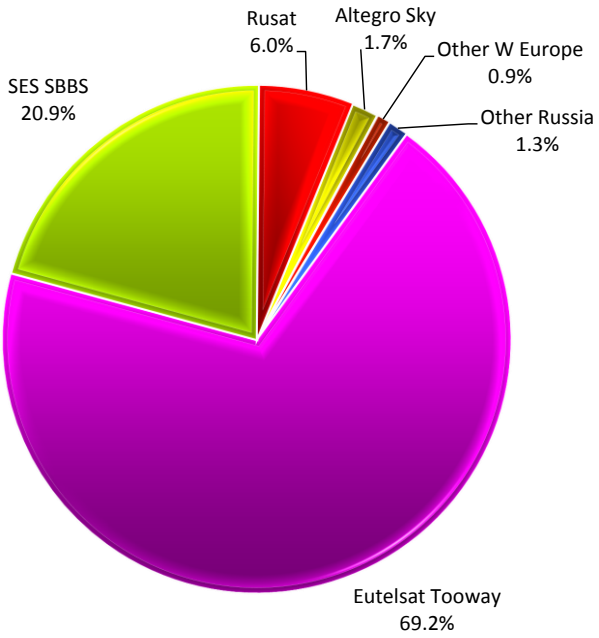


Figure 29 - European Consumer Subscriber Market Share, 2016

through local and national government broadband platforms as well as a network of distributors selling mostly to SMEs and SoHos. In 2016 Eutelsat had 175,000 subscribers on its Tooway service and SES, which had added some Ka-band coverage to its offering, had around 60,000. Avanti, widely known to have been for sale during 2016 decided that a refinancing package was preferable at the end of 2016, is believed to have over 10,000 sites on its service, but the proportion of consumer versus SME is unknown. Given its difficult circumstances the company has pretty much shut the door on any information regarding its business.

Inmarsat's Global Xpress system was the first to really attempt to bring Ka-band to the maritime market followed by the regional Ka-band coverage provided by TSBc on Thor-7. Both of these systems now have service implemented for the maritime broadband market and are pushing hard to make an impact. Very soon after Inmarsat announced its Global Xpress plans, the company began to position its VSAT service in the same way that it had successfully sold its L-band MSS services – essentially on a managed service reseller model. TSBc appears to be following the same path starting out with its acquisition of SatPoint in 2016. Global Xpress will also support an aeronautical service and Inmarsat has struck a deal with TSBc to use its Thor-7 capacity to augment this – with maritime specifically excluded from the agreement. During 2016, SES announced its own Ka-band managed maritime service and so the growing fear from many VSAT operators that they would face increasing competition from their capacity partners is now coming to reality.

***Eastern promise**:* Reliable prospects, especially in the enterprise segment, grow the further east you go. The market in Ukraine boomed up until 2008 thanks largely to the innovative thinking and aggressive approach of Datagroup. In Russia companies like AltegroSky, Stec.com, MegaFon, RTComm and KB Iskra have emerged as amongst the larger operators in the world. The frenetic activity associated with government funded USO, broadband connectivity and education programmes has settled down in Russia, but remains a substantial source of demand and growth. We believe that educational establishments of all kinds account for more than 14,000 VSATs in service today. However, many believe that the terrestrial network will not be able to connect the 45,000 schools beyond the current satellite network and that VSAT will continue to play a strong role in educational connectivity. Initially Global Teleport had the official remit to provide the majority of these sites, but now MegaFon, Stec.com, Crosna, RTComm and Telematica.Net also have some of the Ministry of Education's business although we would suspect going forward that the lion's share of government and USO business will involve RTComm in some way. A part of the Rostelecom Group since 2008, the company is responsible for all VSAT and satellite activity and has set its sights on becoming a commanding presence in the sector. Although not finalised at the time of writing, its purchase of AltegroSky will undoubtedly result in it occupying a much stronger position. AltegroSky continues to power ahead, operating services for the Pensions department and the Ministry of Taxes & Duties as well as various USOs whilst also entering into the consumer sector, working through RSCC. USI has also integrated networks for post offices and rural payphones at almost 2,000 sites. KB Iskra remains strong and is growing, having deployed close to 11,000 terminals via its 11 hubs in Moscow, Krasnoyarsk, Khabarovsk whilst 2016 saw its acquisition of Orion Express's VSAT business, further enabling ISKRA to raise its share in the VSAT market in the western parts of Russia and the Republic of Yakutia.

This region of the world has been amongst the hardest hit by the economic downturn in which has followed on from the dramatic drop in energy prices and the vast scale-back on the part of O&G companies. Russia, in particular, had its budgets based on high oil prices and the effect on government spending and the economy was immediate. Adding to the misery, falling exchange rates increased dollar-denominated expenses and credit became extremely hard to find. This description is almost word-for-word the same as we made in 2009 when the last big economic dip was experienced. Back then most operators saw a gloomy future with limited growth prospects and so it was a real surprise to see Russia rebound quite as strongly from 2010 onwards. Government funding returned to the sector, and the major carrier-based operators saw their VSAT business growing strongly again and investment in new platforms and services was re-energised. However, it turned out that companies were more vulnerable and when the latest economic collapse started, so did so many VSAT businesses in the region.

The mighty Datagroup in Ukraine has seen VSAT diminish as a source of business and now there seems little prospects for growth at Ku-band, although we understand the company had rolled out some 10,500 Ka-band terminals on its KA-SAT service by the end of 2016, with expectations it will roll out a further 2,500 in 2017. The company had effectively wiped the floor of all its competitors of any note in the years prior to 2010 and now that it has taken a path more focused on fibre, Ukraine does not look like a particularly promising satellite market at all. In Russia we continue to see companies growing, but the truth behind this is that the only ones which still exhibit strength and growth are taking business from their competitors – the market as a whole is barely moving.

Some of the operators that have suffered the worst have been those that relied heavily, in some cases almost totally, on government projects or took some big bets on consumer and rural broadband service initiatives. The smaller companies that remain strong in a few key verticals include Stec.com, Crosna, Telematika-Net and Satis. These operators tend to specialise in maritime, aeronautical, government/defence, cellular backhaul and other mobility related services which, for the moment, yield high margins and stable customers. Satellite capacity pricing and availability was a big problem back in 2013, but the expectation that the investment and plans on the part of RSCC and Gazprom Space Systems would fix this by the end of 2014 turned out to be well funded and none of the companies we interviewed for this report brought capacity up as a problem, unlike last time. This is also down to the fact that the last few years have seen Ka-band brought to the country and the beginnings of high volume consumer services.

In Central Europe, the market was once vibrant in terms of the number of operators focusing on different segments and business models, but the domestic nature of most of these businesses has seen a gradual attrition that now leave just a handful of operators, many of which now struggle to eke out an existence. In 2009 Hungaro DigiTel acquired the GTS VSAT business. This makes HDT easily the largest VSAT service provider in Hungary, indeed the largest in the Central European region as a whole, with almost 3,500 sites in service. However, the number is down from the 4,000 sites it had in place three years ago and volume is no longer the company's focus as many of its largest networks have moved to backup. This is a common problem across the region and HDT's response to sell the flexibility and reliability of VSAT is the only really credible long term response. In Poland, TTcomm continues to aggressively pursue new business directions, but the going has

become tougher. The company acquired almost every one of its competitors it could – Exatel and Datatrans – and finally decided that the domestic market was unlikely to ever yield enough potential. The other major VSAT operator in the country, Pagi, has, against all the odds, survived and maintained its VSAT service although we understand that most of its recent business has come from its wireless services rather than satellite and its VSAT business is becoming less and less an important element. Other markets in Central Europe - the Czech Republic, Slovakia, Bulgaria and Romania - offer few, if any, prospects and mostly seem to be stagnant or in decline, although most sustain some small service operations.

Europe has long been established as the world's telecoms hub – at least in VSAT terms. Many operators have chosen to locate hubs in the UK, Netherlands, Belgium, France and Germany because they are able to obtain coverage of Africa, the Middle East, Central Asia and some other parts of Asia. Frankly, it is never very easy to differentiate between which services should be classified as European and which would be more accurately described as African.

5.5. Africa

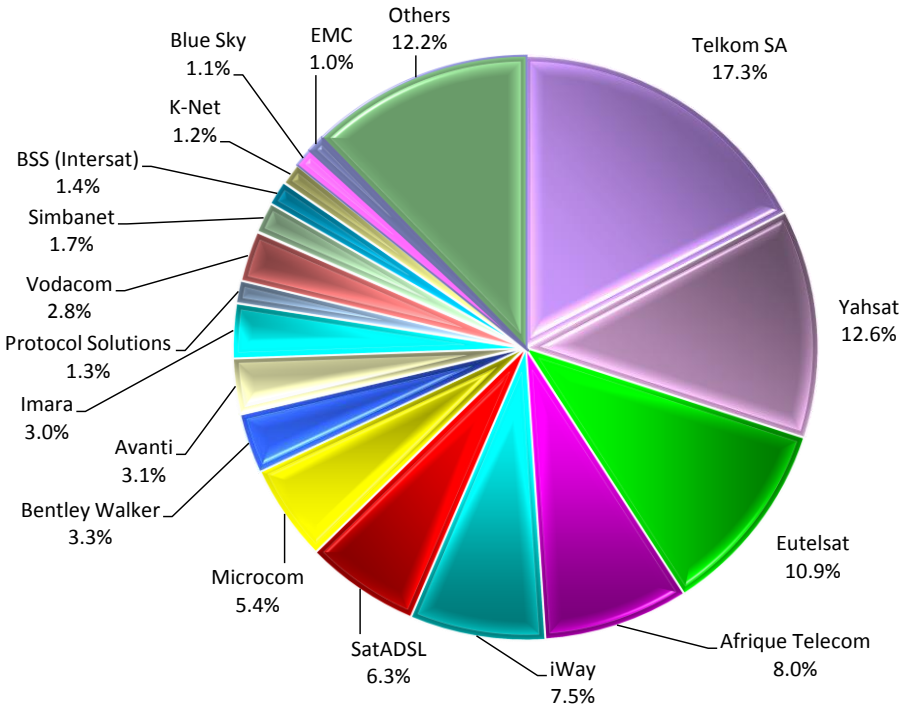


Figure 30 - African Broadband Access Operator Market Share

(Enterprise Networks Excluded)

The African VSAT market has undergone some big transformations over the past 10 years. By 2003, African managed broadband services could be found all across the region and companies began to focus solely on the African market. From outside, small enterprises like GlobalTT based in Belgium moved to provide broadband via satellite. From within the continent, local IT and integration companies like Wilkens Afsat (now iWay) which had been positioning its business for several years, initiated a service and today indigenous African service providers are commonplace in almost every large market alongside international suppliers like GlobalTT, Nynex, Constellation, Gilat Satcom, SkyVision and others. Africa and the Middle East were the last bastions of monopoly practices (aside of the Caribbean) and whilst they still represent a problem in some countries, the difficulties are nowhere near as bad as they once were. South Africa is one of the three economic pillars of Africa and has an economy

which looks more like the developed world than the developing nations of Africa and so this makes it an attractive VSAT market. It is the country which holds the key, in large part, to successful African enterprise VSAT services because most corporations choose to locate their regional headquarters there.

Markets and customers have not gone away, they have merely changed. Just as seen in Asia and Latin America in the past, the idea that satellite services were likely to survive long term as a pure bandwidth play in major urban environments is a false one. VSAT is able to sell competitively against terrestrial services if a true solution-based value proposition is the battleground, but bit-for-bit, the technology will always lose against a terrestrial infrastructure. There are many countries and regions in Africa where VSAT does, and will continue, to find business but for the past ten years most revenues have come from the top three cities in each of the continent's largest countries. These were, of course, the top targets for fibre services and many already had significant fibre deployments. Having said this, fibre continues to suffer from reliability issues caused by a variety of factors that include poor build quality, theft, extortion and even, it has been alleged, competitive sabotage. Some countries that have been largely immune to competition include many inland nations – Sudan, Burkina Faso and Chad for example – but also countries where distances are great, economic activity is diverse and environments are particularly harsh for one reason or another. These include the Democratic Republic of Congo and Angola. Those VSAT operators with a high dependency on the first countries connected to fibre on the east and west coasts – Kenya and Nigeria being the prime examples – suffered disproportionately versus those with a more distributed business in many, what were considered, marginal markets.

2012 saw a recovery of both the large enterprise and SME VSAT business in Africa which extended into 2014, but then saw another drop-off in 2015. The recovery was probably largely due to falling capacity prices and increased competition amongst the greater number of smaller operators. Demand has been pushed out of the major cities and away from some of the countries that used to dominate. For example, despite large enterprise networks having grown across Africa, Nigeria – which was easily the largest market outside of South Africa –saw the number of sites fall by more than 40 per cent between 2009 and 2012. This has fundamentally altered the structure of the market and once big names like DCC, Direct on PC, Netcom and Telnet are now just a reflection of what they once were and barely surviving. Some have re-oriented their business to focus on other wireless and terrestrial solutions, but others have simply withered on the vine and there are several that have gone out of business. iWay led the satellite broadband market for many years and, as by far the largest pan-African provider, it was inevitable that it would feel the pain as much if not more than others.

In terms of bandwidth pricing, the market cracked in 2012 and from a holding plateau of between $3,000 to $3,500/MHz in 2011, we began to see pricing below $2,500/MHz and, in some extreme cases, below $2,000/MHz. This was brought on by the realisation on the part of the satellite operators that some of their operator customers were simply going to default or go out of business if greater concessions were not made. By 2013, especially in markets like Nigeria, VSAT operators were pushing for prices closer to $1,000/MHz. By 2016, $1,000/MHz was beginning to look like a high price as deals were done as low as $550/MHz in some instances and talk had begun about the possibility of $200/MHz now being on the

horizon. *"Ahh ….. but that's for inclined orbit or very low powered badly connected beams or a huge long term commitment to Ka-band HTS capacity"* – was the response from so many involved in this, but the truth was, and is, that is not the case. For a satellite operator, obtaining $500/MHz is 500 times better than getting nothing.

The advent of Ka-band service from Yahsat in some countries has also served as part of the catalyst of change. By early 2013 YahClick had added over 2,500 subscribers to a service which only got off the ground towards the end of 2012. It then grew, based on a combination of consumer and SME subscribers, to serve reportedly more than 30,000 sites at its height. Subsequent changes to policies and pricing plans caused a sharp drop across all of its markets and today the general belief is that it has less than 20,000 subscribers in service – Yahsat doesn't talk about numbers anymore which leads most to believe the news can't be good. The company now has its Al Yah-3 satellite due for launch during 2017 which will extend its coverage, bring an additional 20 Gbps of capacity and, presumably, reduce bandwidth pricing. Just as happened when Yahsat and Avanti entered Afghanistan, the advent of Ka-band in Africa has been one of the major drivers behind falling Ku-band pricing and as more capacity from Avanti and others is brought into use, so it is likely that downward price pressure will increase. Inmarsat's Global Xpress brings mobility with perhaps bandwidth to spare, STM's original founders have finally placed a contract with Boeing for the 160 Gbps Ka-band Global IP satellite that has been on the cards for years, Arabsat's BADR-7 satellite is now in operation, Intelsat has its Ku-band HTS Epic IS-33e spacecraft due to come into service in early 2017 and many others including Eutelsat and SES also have their plans in place.

Given all this – and we haven't even mentioned ViaSat's plans for its 1 Tbps ViaSat-3 spacecraft – there is no question that bandwidth pricing will continue to erode during the foreseeable future. Is this a good thing or a bad thing for VSAT services in Africa? Almost certainly a good thing for the poor rural communities that will ultimately have access to affordable connectivity, but for the smaller VSAT operators it is likely to ring an alarm bell if their margins are primarily derived from the mark-up they make on capacity.

Extending the connection: Bandwidth cost is no longer seen as the major hurdle to connect the unconnected. VSAT terminal pricing has always been under pressure and, whilst prices have come down substantially over the years, the market doesn't generate the same kind of volumes seen for cellphones, tablets or computers and even at just a few hundred US$ for a very powerful complete VSAT terminal these days, it is way too much for the average African household especially when additional charges like shipping, logistics, import duties, licence fees and installation are piled on top. The growing belief is that WiFi connectivity will be the way in which a VSAT connection can be shared at very low cost on a PAYG basis, not least because the number of Africans who own a smartphone is growing fast and the cost of some of these devices has fallen, in some cases, to less than $50.

Several companies are now pursuing this model in different regions of the world and in Africa it is Afrique Telecom that has been leading the charge with its TamTam offering. Impressively configured, simply and flexibly priced with a well thought out business model, TamTam now serves over 400 sites across Africa and not only helps connect rural villages, but also offers another source of revenue to local businesses. The service uses Newtec's Sat3Play platform with a WiFi router built into the IDU which Newtec designed based on

Afrique's request. Others, including Hughes and ViaSat are traveling very similar routes and also have WiFi incorporated into their latest systems.

Spice in the mix: The higher value segments of the market oil & gas, mining, banking, government projects and NGO and charity activities have seen a mixed set of results. Underlying demand for service from the resource industry continues to be strong, but the general slowdown in mining has seen fewer prospects revealed for future business as some of the major industry players have begun to back off. ITC Global leads the segment, but there is still plenty of focused competition from Marlink, NSSLGlobal, OBS and SkyVision/Signalhorn as well as local companies that specialise in this area, like Microcom in the DRC. Offshore and land oil & gas activities will always need high quality connectivity even in the current difficult times for the segment. Now that fibre has brought the internet to the coast of Africa, hubs in North America and Europe do not have as much advantage as they once did. This spawned a rash of investment in local hubs in many countries by the likes of SkyVision, Gilat Satcom, SimbaNet, Microcom, Liquid Telecom, iSAT Africa and others. This is based on the thinking that not only will internet traffic routed locally help a business case, more domestic connectivity will be required to meet the needs of expanding enterprises and government agencies.

A number of the operators in West African countries have integrated terrestrial fibre and wireless offerings and application-based products into their offerings and, although in the long term they might be forced towards a tighter integration with a carrier business, they tried to adapt their strategy to find ways to defend their business and open up new opportunities given the changed environment – DCC, Netcom, STL and DOPC are good examples. An overview of today's situation shows that DCC's business has now been merged into its parent CWG, Netcom continues to offer VSAT, but it's now a very small element of its business which focuses more on wireless internet connectivity and application support, DOPC's business was separated between its wireless and satellite operations and both were sold off. The bottom line is that VSAT, which once accounted for almost all of these companies revenues, now comprises a shrinking side business. The concern for those companies focusing on fibre

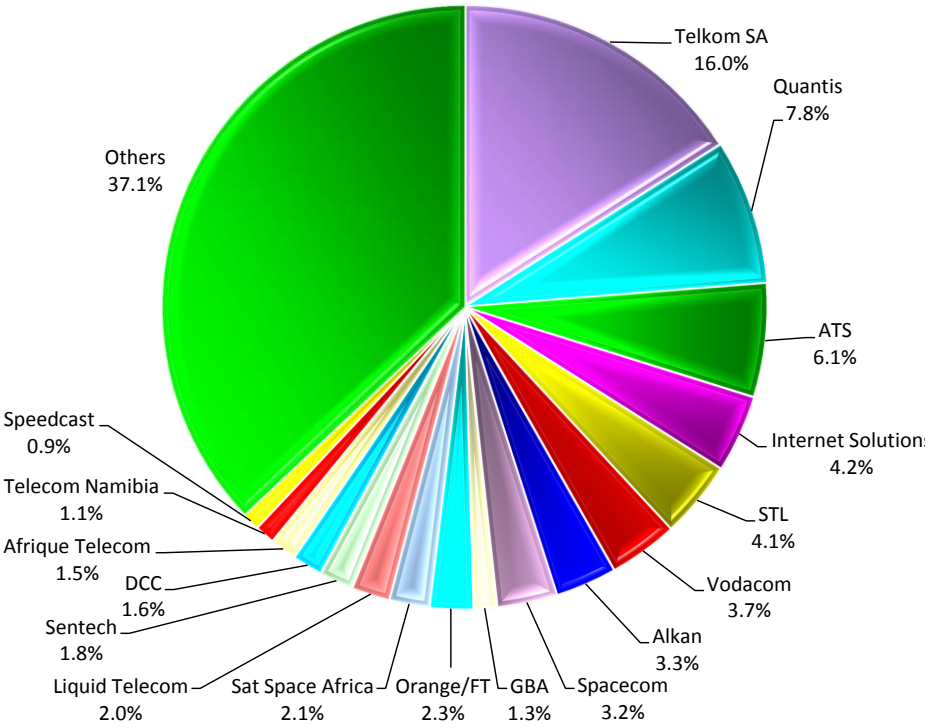


Figure 31 - African Enterprise Shared Hub Operator Market Share

(Broadband Access Excluded)

connections is that they remain small in relation to the major carriers and a focus on fibre threatens to make their business more vulnerable. A more sustainable strategy is probably the adoption of wireless solutions which many operators already had in their portfolio, but this first cannibalises much of their installed VSAT base and then comes to dominate the business with VSAT almost becoming a distraction in the longer term. Nevertheless, VSAT remains an important and vital means of ensuring wide ranging connectivity.

***Enterprising hot-spots**:* The past two years have seen the generic broadband service segment decline and now the vast majority of new sales are for enterprise net-works. Across the continent many of the domestic markets that have historically provid-ed the core growth for the region – Nigeria, Kenya, Tanzania and Angola for example – have either seen some levelling off or a decline in the number of sites in service. In Madagascar, the market leader is Blueline and it has seen a slow, but sure move from the VSAT services that initially formed the foundation of its business towards terrestrial services which now comprise 80 per cent of its revenues. The hot spots have largely been in countries which were often not a major focus such as Sierra Leone, Sudan, Senegal and Guinea. The big exception to this has been South Africa, always the centre of most economic investment with vibrant and well-developed manufacturing, retail, banking and agricultural sectors, all of which use VSAT in one form or another. After several years of strong growth the South African enterprise market levelled off after 2013 and the SME/consumer numbers have decreased slightly. Both Yahsat and Avanti see the country as a big area of opportunity and have been working hard to partner up with the major operators there. Yahsat has its largest population of YahClick subs in South Africa and Avanti has made some good deals with Telkom and others. The feedback we get generally is that Avanti is considered the better supplier in terms of service delivery, but this may be due to Yahsat's change of business model.

The Angolan market remains something of a hotspot despite the economic problems it faces with the oil downturn, but the real problem is often related to logistics for installation and maintenance of large national networks. Several operators have brought this up as an issue, especially as vandalism and theft of things like solar panels and cables is not uncommon. Cellular backhaul is the largest and most profitable segment for VSAT in the country. In Ghana, STL continues to maintain its major position in the government and banking segments and remains some way out in front of other local companies which include COMSYS (no relation), K-Net and a raft of international and regional competitors, some of whom have local offices. STL has found itself compelled to integrate terrestrial services into its solution as a result of simple customer demand. This has helped it maintain its customer base and the fact that it already has fully amortised VSAT installations on these locations makes it easy to include a VSAT backup service in a new offer, although the revenues from this are marginal.

Northern lights: North Africa is a completely separate market from the rest of the continent. There are plenty of operators, both international and regional that have substantial business in the south, west and east, but absolutely nothing in the North. In Libya, 2011 saw almost everything shut down and those operators that had any business of substance suffered badly. However, as the political situation stabilised and the conflict ended so demand skyrocketed helped in part by Avanti's low cost Ka-band coverage which several of the large European operators were quick to leverage. In particular Bentley Walker and Talia deployed a great many sites to connect local businesses and VOIP services across the country during

late 2012 and early 2013 only to see this business drop to virtually nothing as the political and economic situation suddenly flipped. A great many sites remain in place and ready for operation, but until they recover the means to pay, the users are not in a position to re-activate these terminals. However, if the economic situation should change, several service providers could see a big jump in business almost overnight.

The enterprise business was stagnant across North Africa between 2014 and 2016. The main area of expansion was for government schools projects, particularly the GENIE project in Morocco which Quantis (previously known as Nortis) won the bid and rolled out around 4,000 sites in 2015 expanding another 1,000 in 2016. ATS continues to find business in Algeria and ETC's government-related business in Ethiopia appears to be well standing. Tunisia seems to have made little progress, the renewed political upheaval in Egypt cannot of helped any of the operators there. North Africa definitely represents a different environment for VSAT services today in comparison with the rest of the continent.

There has been growing competition from many operators, especially those operating out of Europe, such as Orange, Marlink, EMC/GEE, Signalhorn, Sonema, CeTel, NSSLGlobal and ITC Global. Having looked as though they would also join this merry band, the big South African operators have, as already described, largely fallen back in terms of presence although they continue to specifically target multinational companies, government and quasi-government agencies as well as other high value vertical segments especially cellular backhaul. Through our research, we believe that, by 2016, the number of cellular backhaul links in operation in Africa was approximately 4,600, up 10 per cent since 2014, but with a decline in the share of Dedicated SCPC links as TDMA systems have become an increasing part of the solution for lower traffic cellular sites. In 2010 TDMA VSATs accounted for less than 20 per cent of all the links deployed, but this had risen to almost 60 per cent by 2016. Corporate SCPC services have also declined since 2010, but at much lower rates. Having said this, all operators report that the average data rates for dedicated links has risen appreciably – in some cases doubling or even tripling over the past three to five years. Unfortunately, this has not brought with it similar levels of growth in revenues which have decreased since 2011, but only by about 15 per cent.

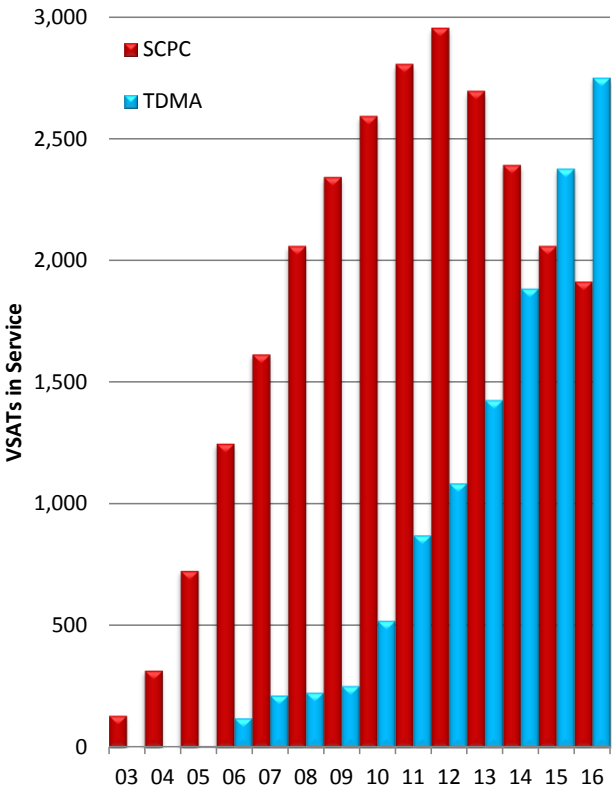


Figure 32 - Africa Cellular Backhaul Sites in Service by Access Type, 2003-2016

5.6. Middle East

A combination of deregulation and chaos can go a long way in favour of satellite links and it is this which spurned the growth of the VSAT market in the Middle East between 2002 and 2008. Until the conflict situation in Iraq began, demand was patchy and supply was monopolised by dominant country operators.

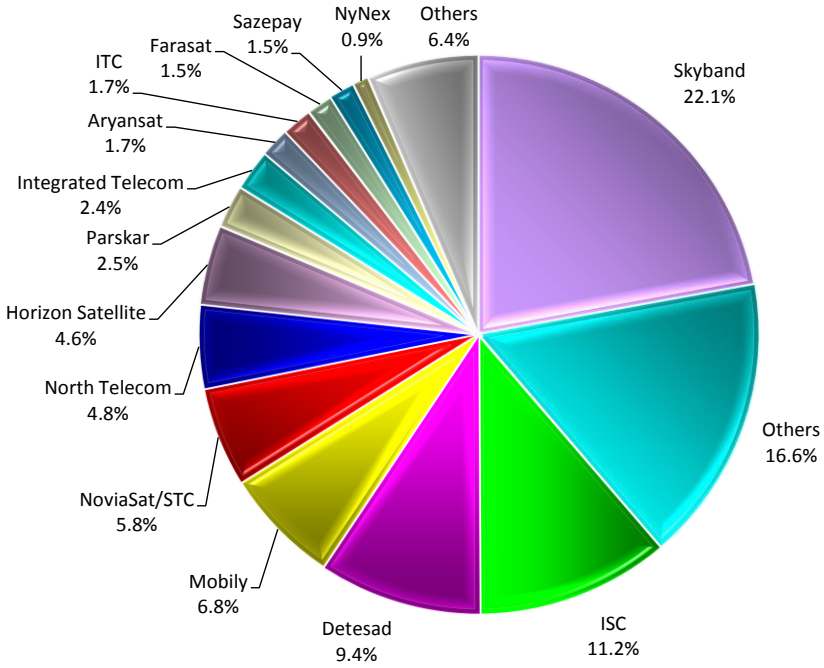


Figure 33 - Middle East Enterprise Shared Hub Operator Market Share

(Broadband Access Excluded)

Despite the fact that there are a number of hubs from iDirect, ViaSat, Advantech and Newtec in Iran, it is the legacy Hughes PES system, sold before the embargo in the 1990s that remains in operation and has the majority of the sites in service. The primary operator of the platform, Informatics Services Company (ISC), was the only long-time private operator in Iran having been born out of a private network originally set up by the Bank of Iran. The company currently has 4,500 sites in service, all deployed with banks supporting branch applications and ATMs making it the largest enterprise service provider in the region eclipsed only by Skyband in Saudi Arabia. Other operators in Iran include AryanSat, Saman, Parskar, Farasat, Sazepay and Ertebatat Faragostar. Most rely on banks for the majority of their business with AryanSat believed also to be amongst the most respected and diversified of the group.

Two countries dominate the Middle Eastern market – Saudi Arabia and Iran. Of the 40,000 or so enterprise VSAT sites in service with operators in the region, these two countries account for almost 65 per cent and together with Iraq the share rises to more than 80 per cent. Although this share has been stable over the past two years, the distribution has changed as Saudi Arabia has grown and the markets in Iran and Iraq have contracted. In Saudi Arabia most of the original licensed operators have done well, although a few are now struggling. In particular, Skyband and Detesad have grown strongly in the banking sector with Skyband also performing well with government customers. The influence of Saudi Arabia was supercharged by the government's program to bring broadband to the nations' schools by awarding a contract for 5,000 VSATs equally split between Mobily and STC, but although there was talk about this growing to as many as 15,000 sites the network has since reduced as the government faced funding limitations.

Military withdrawal: Outside Saudi Arabia and Iran, Iraq was obviously a big market for the military until the major withdrawal started to take place from 2009 onwards. With so many of the US DoD's networks operating with COTP and COTM antennas the numbers dropped off very fast as the military withdrew and took their terminals with them. There has been some pick up in the use of VSAT by commercial companies and civilian government agencies, but this has not replaced the sites lost and has come nowhere close to compensating for the loss of revenues. The commercial picture also leaves a little to be desired with operators informing us that demand is moving towards trunk satellite links supporting terrestrial access and cellular networks. Given what we witnessed in Africa for trunking services from 2011 onwards, this does not bode well for the longer term. Having said this, new sites are still being deployed for oil & gas, SCADA and civilian government agencies.

The amount of enterprise business that gets done in the Middle East outside these three countries is not huge, but has actually been seeing growth. The main areas of enterprise activity are cellular backhaul, banking and government – for civilian and military agencies and broadband extension projects. Azyan and Omantel are holding up and growing in Oman where Ooredoo is reportedly also running almost 500 sites for its own cellular network. Qatar is mostly driven by the oil & gas business – an area that RigNet had locked up in an exclusive deal before new licences were issued in 2010 and RigNet has since lost out with the biggest winner being SkyStream. Both SpeedCast/CapRock and RigNet have had good business in the region for many years, mostly partnering with local operators. Gulfsat in Kuwait is one of the companies which has provided support services for these global O&G specialists, but it also operates networks for banks and some Kuwait government agencies including the Ministry of Foreign Affairs. There is some minor activity in Jordan and Yemen and, Dubai's Internet City remains a centre for the hosting of many regional hubs from the likes of SkyStream, Etisalat, Du, Horizon and others.

Value subtract: A combination of greater stability and post conflict reconstruction has brought investment in terrestrial services and this, coupled with the withdrawal of troops that had often put in their own personal satellite broadband connections, resulted in a steady decline in the number of SME broadband sites in service across the region. Most erosion has been experienced by the European-based operators – Eutelsat/Skylogic and Hughes Europe had the most to lose – but all SME broadband service providers have suffered as the number of subscribers has fallen from almost 14,000 at the height in 2008 to barely 6,500 by 2013. Several once large names in this area of the business – DigitalSkys and NSTT to name two – are now no longer as a result of their inability to adapt. The situation was not helped by the ambitions of many value added resellers who fractured the market in their rush to move up the food chain. Then, in 2014 Yahsat's YahClick service came in and there was a sudden burst of activity which apparently saw a lot of churn over the past two years. There are several likely reasons for this – the economic downturn and exchange rate issues caused by the O&G price collapse, the rise of ISIS which was countered by regulatory restrictions to try and remove connectivity from the terrorists, the rapid expansion of fibre and cellular service across Iraq and Yahsat's decision to restructure its service model. Nevertheless, YahClick is now the largest SME/consumer broadband service in the Middle East despite the fact that the company has yet to access either Saudi Arabia or Iran. The service is also being used by some resellers to provide backup services for some enterprises like banks and Yahsat itself has made the decision to extend its platform to further increase its capability in the

corporate and enterprise segments. This takes the form of both adding iDirect Evolution hubs for VNO solutions and also upgrade its primary platform from the HN to the latest Jupiter2 system from Hughes.

There were also a number of other issues and trends from earlier years that hung over the market. Resellers had been quick to swap between wholesalers and prices had started declining as different wholesalers would offer an "introductory" deal to a new reseller. As a result of this and falling demand, so some of the broadband service hub operators in the UAE and elsewhere began looking more towards higher-value service opportunities with direct corporate and government customers. This necessitates a change in operational approach because, where once a company was able to simply buy a hub and sit at home managing it, leaving the dirty on-ground business to the local resellers, suddenly they need a real presence in the market they want to serve. SkyStream is a good example of a company that moved quickly to address an issue that it foresaw would eventually kill its broadband business. Its first step was to cede greater control to some of its resellers with VNO products from its own hub, but it then began to establish local operations in countries where it saw growth – Afghanistan being the best example – and transitioning its strategy more towards direct sales than third party resellers. It also began looking for niche opportunities and identified the maritime segment in the Gulf, particularly some of the large yachts, as an area it could exploit as well as military mobility integration solutions, all of which it managed with a high degree of success. Then, with prices in Iraq continuing to decline, it made the decision to simply abandon its SME broadband service offer and terminated all of its contracts in 2015.

Europe morphs: During the war years SME broadband services were provided by operators using hubs located in region and from Europe. Several local companies also made use of European teleports for their service. This has changed as demand has declined and Yahsat's YahClick service has been introduced – although Yahsat's four gateways are all located in Europe. Of all the European based operators – of which there were many at one time – are now pretty much reduced to Bentley Walker and Talia. Bentley Walker has proved itself remarkably adaptable moving from being a pure reseller to a VNO to a hub owner and operator and then back to being a VNO on some

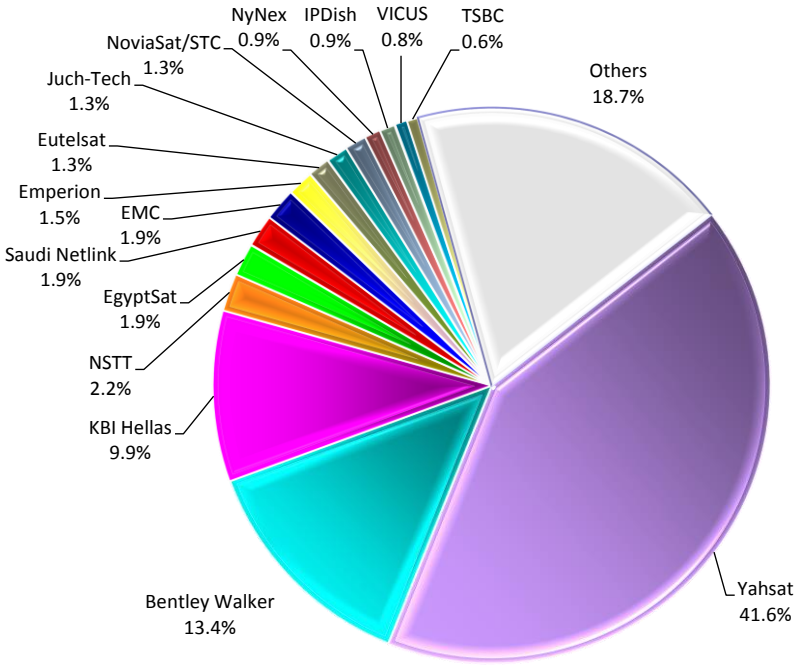


Figure 34 - Middle Eastern Broadband Access Operator Market Share

(Enterprise Networks Excluded)

services and a reseller of others. Whilst Talia has managed to sustain its service base in Iraq, it has become more focused on higher revenue trunking services, managed hybrid solutions and development and support of value added applications which has substantially diversified its business.

OKaY?: In terms of Ka-band satellite capacity, the Middle East has moved from nothing to a super abundance in a very short period of time with Yahsat and Arabsat particularly bringing satellites online. Politics and regulatory barriers can be a show-stopper as IPStar discovered in Asia and Yahsat's biggest problem is not the economics or the capabilities of its service, but the fact that it has not yet been able to penetrate the two largest markets in the region, Saudi Arabia and Iran, and both for different reasons. Saudi Arabia takes security and control of access to the internet extremely seriously and has established licensed gateways through which all internet traffic has to be routed and filtered. Yahsat operates from four gateways all located in Europe to ensure frequency separation from the user beams, but this means that any user traffic will first land outside the country of origin and the consequent lack of ultimate control has proven to be unacceptable for the Saudi government. The inability to address the Iranian market is obviously completely different and was, until recently, restricted by the embargo placed upon the country. This appears to be less of a problem now, but Yahsat seems to be reluctant to push its service into Iran, possibly due to the political ramifications.

Arabsat's position is more favourable, at least in Saudi Arabia, but the immediate decision by several large government departments to implement alternative independent solutions following the decision to place all control of the company's Ka-band coverage under KACST (King Abdulaziz City for Science and Technology) illustrated that power and control are as much a political game in the country as anywhere else in the world. With the move into spacecraft, ground segment and the VSAT service business, Taqnia (a government funded technical innovation company) is extending this situation. Over the past two years, Taqnia has partnered with Arabsat and KACST to bring two new HTS Ka-band spacecraft into operation, formed a joint-venture with Skyware, KACST and Crescent to develop its own ground segment platform for this type of satellite and signed a deal to use Eutelsat's 3B satellite for aeronautical services over the EMEA region.

Cellular replication: As we have noted many times in the past, SCPC is a great technology for high traffic sites, but TDMA makes more sense for lower density, less predictable traffic and, as mentioned in the Africa section previously, as a consequence we have seen TDMA systems take a far bigger role in the market. The Middle East has definitely been part of this trend and whilst 10 years ago all cellular backhaul sites were SCPC or DAMA-based, today TDMA accounts for 85 per cent of all deployments. Whilst it is true that the numbers are relatively small, the value is of course high. The largest operators in this area are those deploying VSATs to support their own cellular services – Ooredoo in Oman, Etisalat in the UAE and Mobily in Saudi Arabia.

Project projection: One major change in the Middle East that has been highlighted to us by those with a strong knowledge of the local market has been the emergence of large, often government-sponsored, projects as the source of most new demand. Operators may well end up fronting bids, hosting a service or providing system integration support, but the impetus for the business comes from programs within the government. Initiatives like

KACST's government sponsored Ka-band service, the Saudi Ministry of Education's schools program, the Oman government's schools program and various other civilian government and military networks are becoming more common across the region and providing relatively more business opportunities than investment and expansion by private operators which has, historically, provided most of the business growth. Some of the deployments for cellular backhaul and all of the Ka-band initiatives should also be viewed as part of this trend towards large, ambitious network initiatives.

5.7. International and Regional Services

At one time we were able to make a clear distinction between operators of domestic systems only and those that focused on international service. However, it has become impractical to discriminate between the companies which provide a global corporate networking service based on their own infrastructure versus those that make use of third-party teleports, local support and satellite coverage. As the satellite operators have increasingly built out their own support infrastructure, the options on the part of the VSAT operator have increased and even quite small companies can provide a global service quite easily when required. This situation is possibly best illustrated from a top down view of the CapRock business which, when it was owned by Harris and before it was sold to SpeedCast, the decision was made to cut a deal with Intelsat and shift all of its operational facilities into Intelsat's teleports and use the hubs that Intelsat had established for its Flex service. As a consequence, Harris CapRock no longer needed most of its teleports nor the hubs it had in place. Whilst it is true to point out that the company continued to maintain its network of global offices, warehouses, repair and maintenance facilities as well as its staff, in many ways its satellite VSAT communications network became no different from a small company for which the same approach has been adopted to minimise the scale of investment required.

Provided that the operator retains full configuration and managerial control of the network, there is very little downside to this approach other than the fact that a global deal of this type with a major satellite operator effectively ties the VSAT operator into a very sticky capacity arrangement. As the major satellite operators increasingly consider attempting to shore up declining capacity rates by moving further down the value chain, this method of deploying a global networking service might one day be seen as the first major step towards positioning themselves as full managed service providers and essentially competing with their current customers. One of the ways in which satellite service distinguishes itself from other media is its independence of geography and inter-continental services are possibly the most significant example of this effect. There are many factors that have made a service of this type relatively difficult to offer including the fact that multiple satellites and hubs can sometimes be required to obtain the optimal coverage of different regions, the enormous amount of work that has to go into arranging access agreements and licences as well as the logistics required to install and maintain terminals in many remote countries. Nevertheless, it is important to note that there is a huge difference between coverage - which anyone can achieve with a small number of well-placed hubs and the right space segment - and presence. The fact is that global presence - hubs, NOCs and staff in all regions of the world remains relatively rare.

In the resource segment some of the oil & gas majors began to look towards harmonising their service delivery some years ago and started to encourage their largest suppliers to extend their networks beyond just a few key markets. Maritime VSAT services have also been a driver behind the network and coverage expansion of many operators and some of the smaller, very specialised operators have developed quite extensive service platforms through a network of teleport and support partners. OmniAccess for example, is a small yet highly competent provider of VSAT services to the mega-yacht market and has customers roaming in most parts of the world on its network. The other maritime sub-segment that pushed small operators into the need for multi-regional if not global networking was the offshore service vessel companies. Companies like DTS and BlueTide started small in the Gulf of Mexico, but after establishing a very credible position with some OSV companies, they soon found themselves being asked to extend service into the North Sea, West Africa, Brazil and other areas.

SpeedCast is another company that grew its international coverage through its push into the global maritime business, first through partnerships and then through acquisitions. Today the company truly is a global provider having acquired 15 different businesses, several of which really helped it establish a firm footing in new regions for land-based services. The major space segment operators have helped the development of the maritime market through their network of teleports which provide managed hosting services for large and small operators alike, although none of the satellite companies have real on-ground installation and maintenance resources.

No one company is everywhere although we would have to categorise companies like Orange Business Services and Marlink as true global providers whilst Hughes has the largest worldwide footprint of service businesses and, although these have mostly been built around domestic markets, the company does provide global networks using its own facilities as well as local partners - of which it has many. There are also a few other companies which do not necessarily have the presence and which are actually quite small that have demonstrated their abilities to deploy and maintain large global networks. Examples include UltiSat and Signalhorn and some of the military-focused US operators, like AIS Engineering. Funnily enough, many of the small companies that had regionally or internationally based businesses have been snapped up over the past few years by the likes of ITC Global, SpeedCast and EMC. In addition, there are companies with exceptionally strong regional presence – PCCW Global in Asia and Africa, BT Latin America, Level 3 and Telefónica all in Latin America and Internet Solutions, Vodacom (Gateway), Liquid Telecom, Q-Kon and others in Africa are the main examples.

The prime customer segments for international networking services are:

***Foreign ministry embassy networks**:* at least 35 of these have been deployed to our knowledge with all different types of systems. The segment represents a good slice of business for several operators like Signalhorn, Gulfsat, Algeria Telecom and QSat, but Orange Business Services has been the most successful with multiple MoFA clients along with Marlink.

***Peace, Aid, Government (PAG)**:* representing NGO networks for various UN departments, charities, aid organisations and emergency relief as well as other government agencies.

Again, this is a large area of concentration for many companies, plenty of which provide generic broadband services with Marlink, EMC/GEE and UltiSat the leaders in this area.

***Oil & Gas**:* became an increasing international opportunity as exploration and production companies moved out of the mature fields in the North Sea and the Gulf of Mexico to West Africa, Asia, Latin America and Russia/FSR. Many companies continue to chase this segment, but the demanding nature of the industry and the high levels of extremely specialised expertise required really play to the long-term focused operators. Exploration and production activities have been inexorably moving out of the Gulf of Mexico and the North Sea into West Africa, Asia and Brazil over the past few years and the leaders in this segment are SpeedCast, RigNet and ITC Global/Panasonic, all of which have acquired many of the smaller specialised operators like Hermes, Tecnor and Newsat, with SpeedCast finishing things off recently with its acquisition of CapRock from Harris.

Mining and Resource: seems to be an obvious segment of opportunity, but several companies have tried to target it and failed to either generate enough traction or to find enough business. Compared with the O&G industry, the mining business is simply not as large in terms of sheer numbers or as extensive. However, one company, ITC Global, has really managed to establish a worldwide footprint and can be said to dominate the segment with networks in Asia, Africa, Russia, Latin America and North America for customers like Rio Tinto and BHP.

***Military**:* was a massively high growth area a few years ago due to obvious reasons and whilst deployments plummeted after the withdrawals from Iraq and then Afghanistan, there remains a core requirement. In some ways, it could be argued that the military actions that took place really woke the defence industry up to the scale of requirement that they have for ubiquitous connectivity. By far and away the US DoD is the largest customer, but many European nations and some from other regions also make use of international VSAT services. Almost every company with any international ambition at one time targeted the segment, but penetration can be very hard due to the qualifications and certifications (not to mention the need for a GSA schedule in the case of the US DoD) required by most military organisations.

***Maritime**:* has been a good segment for several operators which have grown large and very profitable businesses in the area. The segment has become one of intense activity and great interest to a lot of operators over the last ten years or so. Market leaders based on revenues and/or number of vessels in service include Marlink, Inmarsat, KVH, SpeedCast, EMC/GEE, NSSLGlobal and OmniAccess.

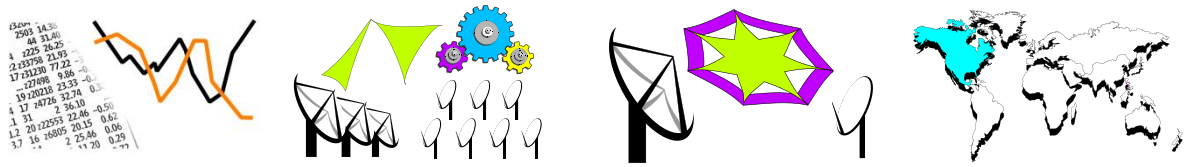
***Aeronautical**:* is considered to be one of the major growth opportunities for VSAT services today. The segment is dominated by a few key players – Panasonic, Global Eagle, GoGo and ViaSat – but there are plenty more with a few aircraft either in service or signed up from commercial airlines, military aircraft or private jets.

***MPLS carrier extension**:* At one time we believed that this was a strategically important service for all of the major operators, with MCI, AT&T, Global One and Concert all offering service. However, there came a time when they all largely walked away from satellite. This does not mean to say that we believe that these services do not make money, but we would

suggest that the revenue earning potential of a few hundred VSAT sites is inconsequential to most of these operators, and hardly their primary motivation. In fact, major carriers including BT, Orange, PCCW Global and Vodafone (which now incorporates C&W) inform us that their small groups are profitable and, despite their strategic nature, would not last long if they were not. Aside from the specialised requirements mentioned above, regional banking networks figure high on the list as well as other multi-national companies. There have been several suggestions that other global networks for corporate customers would also be demanded, but although some tentative beginnings were made by the likes of Ford, Shell and Mobil/Exxon, they have not become as prevalent as it was once believed they might.

6. Hughes System Platforms

6.1. Enterprise & Consumer Systems



Hughes continues to support previous generations of its broadband satellite network platforms that deliver its HughesNet branded solutions and services, namely the HN, HX and Spaceway systems. However, the upgraded Jupiter system now incorporates all of the relevant features from these past platforms. The system offers two gateways, the high density HG240 designed for HTS as well as the HG220 gateway for conventional widebeam satellites with both supporting five remote HT terminal types as detailed below.

6.1.1. Jupiter

Technical:

Topology:	Star
Antenna Size:	0.74-1.8 metres
Frequency:	**HT2000/2200 series:** Ku-& Ka-band **HT2300/2500 series**: C-, ext-C, Ku & Ka-band
Bit Error Rate:	Outbound 10^{-10} or better Inbound 10^{-7}

Out/Forward

Access:	DVB-S2X ACM
Gross Rate:	**HG240**: 4-up to 235 Msps **HG220**: 4-up to 70 Msps
User Rate:	Up to 200 Mbps UDP
Modulation:	QPSK, 8PSK, 16APSK, 32APSK
FEC:	LDPC with BCH outer code, rates ½, 3/5, 2/3, ¾, 4/5, 5/6, 7/8, 8/9, 9/10
Load Balancing:	Yes

NMS

Platform:	Blade Servers
Remote Optr:	Yes
Max Net Size:	Consumer market levels, no practical limit
SNMP:	Yes

In/Return

Access:	MF-TDMA with adaptation

IDU

IDU Ports:	**HT2000**: 1 GigE & 1 USB **All**: 4 GigE
Max Ports:	As above
Port Rates:	Up to 200 Mbps[3]

[3] Up to 200 Mbps of UDP traffic, or up to 100 Mbps of TCP traffic.

Gross Rate:	**HT2000/2200:** 256 ksps-8 Msps **HT2300/2500:** 256 ksps-12 Msps
User Rate:	Up to 200 Mbps UDP
Modulation:	**HT2000/2200:** OQPSK **HT2300/2500**: OQPSK, 8PSK (16APSK future for HT2500)
FEC:	Adaptive LDPC with rates of ½, ⅔, ⅘ and ⁹⁄₁₀
Schemes:	Diversity Slotted Aloha Dynamic Stream Constant Bit Rate On Demand Streaming
Bandwidth Management:	Frequency Hopping Dynamic Channel Partitioning Hub Signal Cancellation
Load Balancing:	Yes

Addl Slots:	None
IF Interface:	**HT2000/2200:** Single L-band cable (Hughes interface) **HT2300/2500**: Dual L-band cable
Other:	Terminal is RoHS compliant

Applications:

IP Protocols:	TCP/IP FTP, UDP Multicast (IGMPv1, 2 & 3), ICMPv4, Telnet, PPP, Unicast RIP v1 & v2 IDRP, VRRP, CIDR BGP VLAN Tagging Dual stack IPv4/v6
Acceleration:	Integral PEP
QoS:	Integral on Outbound & Inbound with DSCP & Dynamic CIR
Basic Services:	Addressable Data Data Broadcast/Multicast Video Voice

IP Services:	NAT/PAT Static/dynamic addressing DHCP V6 relay DNS Caching HTTP Acceleration TurboPage (HTTP object prefetch), TOS, DSCP, POP, SMTP, ACL Firewall support, Header Compression
VOIP:	SIP Call Proxy
Encryption:	2-way encryption, Integrated CA & DES on outbound, optional VPN Accelerator Bi-directional IPSEC and optional AES-256

Indicative Pricing:

Hub	
Start-Up:	HG220 $250,000 typically supporting 500 VSATs

VSAT	HT2000
Ka-band:	<$1,000 (0.74m/2w)
Ku-band:	<$1,000 (0.74m/2w)
C-band:	<$3,000 (1.8m/2w)

Supply:

Production:	>50,000 VSATs/month
Availability:	Current
Hub Delivery:	30-60 days ARO
VSAT Delivery:	30-60 days ARO

JUPITER Product Discussion:

The latest JUPITER System platform has a rich history with its origins back to Hughes' pioneering role first in enterprise services in the mid-1980s with the PES and then in consumer internet services in the mid-1990s. The company's first consumer two-way terminal, the DW4000, was an interactive version of Hughes' DW3000 Internet broadcast/multicast system which the company launched in 1996 using a terrestrial return path. The DW4000 represented the initial step in a series of designs for HNS and, although targeted at the consumer business, it was quickly adopted for internet access services in the SME and SoHo markets. It seemed that, unlike Gilat, HNS quickly learnt that the technology was not yet quite ready for the mass market in terms of price points and bandwidth efficiencies and its focus over the years was to address these issues. We also believe that HNS saw many of the users of its US consumer service coming from small businesses rather than true consumers. Coupled with the fact that networking a broadband connection suddenly became commonplace in both the SoHo and residential markets a new version of the DW4000 quickly emerged.

There followed a series of fast steps which took the product through the DW4020, DW6000, the HN, the HX and then the first of the HT series of platforms. Each of these releases significantly expanded the system's capabilities, adding full routing functionality, embedded VOIP service functions, data acceleration and optimisation as well as a constant reduction in the cost of the remote terminal. At the same time, the company was adding or improving the ability to efficiently carry IP traffic, sustain quality of service levels and manage mass market subscriber bases at both the network performance and business process levels. In previous versions some of the additional functionality was added in the form of stand-alone appliances attached to the IDU, but in the JUPITER system most of these capabilities are integral to the platform.

A consistent design criteria for each new system release has been to minimise cost, driven by the fact that the original product was targeted at the North American consumer market. Whilst today the HughesNet consumer service is a major pillar of HNS' revenues and growth, the company's latest JUPITER platform has been designed to address both the consumer and

enterprise segments in developed and developing markets. With each new platform, functionality and capability have increasingly been integrated into the terminal and bandwidth efficiency has become a key element in new systems. HNS has committed major R&D efforts in this area, working towards substantially improving the operational cost of owning its system as well as further enhancing its efficiencies. The company incorporates its own web acceleration and optimisation software in its systems. Known as TurboPage, this feature uses a variety of techniques to reduce the amount of bandwidth required during a web session and, in 2012, Hughes introduced its latest version incorporating a capability it terms 'ActiveCompression' which uses a two-stage process involving long range byte-level caching followed by V.44 compression and which can improve the efficiency of HTTP traffic by as much as 50 per cent.

Hughes began developing its Jupiter VSAT platform in 2012 for its North American Jupiter Ka-band high throughput satellites. The Jupiter spacecraft are optimized for capacity and, following the launch of Jupiter-1 (EchoStar XVII) at the end of 2012, Hughes began to deploy a new terminal design, the first generation HT Series, based on a gateway ground infrastructure that had been prepared for the new system and which underpinned the introduction of its Gen4 consumer service. Gen4 raised service plans to support transmit/receive rates up to 2 Mbps and 15 Mbps respectively and monthly volume caps to between 10 and 40 GB depending on the package, finally introducing a satellite broadband service that compares favourably with ADSL. With the launch of Jupiter-2 Hughes began developing the latest Jupiter platform in 2015 and this was released commercially in mid-2016. Based on an upgraded system-on-a-chip (SoC) and the incorporation of the DVB-S2X waveform for the outbound channel, Hughes was the first company to bring DVB-S2X to market for a shared TDMA VSAT platform. Once again, Hughes led the pack in its development efforts – a few years ago it had a commercial DVB-S2 platform a year in front of its competitors and now has a similar lead for DVB-S2X.

The second generation Jupiter VSAT platform incorporates two new gateway products – the HG240 for high throughput (HTS) systems and the HG220 for more traditional widebeam satellites. The HG220 carries many of the same features and functions of its larger sibling, offering a scaled down version for smaller systems, but is quite capable of also supporting smaller HTS deployments that are becoming more common in other parts of the world. A single HG220 is able to support multiple networks on the forward channel and multiple return channels over five different outroutes. The design is based on a single blade chassis and servers integrated with the demodulators and modulators in a configuration Hughes terms a Satellite Modem Cluster (SMC). The SMCs in the HG220 are limited to a maximum of 70 Msps throughput. The chassis incorporates an L-band matrix switch which brings virtualisation to the second generation of Jupiter allowing any SMC to back up any other in a 1:N redundancy. The HG240 is able to support a much larger amount of capacity for HTS systems – the Jupiter-2/EchoStar XIX satellite provides in excess of 200 Gbps of bandwidth – through multiple gateways and with extensive management and traffic shaping capabilities. Based on its own consumer internet service experience, Hughes has continually aimed to reduce the number of racks thereby minimising both the footprint and power consumption required for the equipment. These gateway stations are designed to be operated autonomously in a "lights out" fashion and deployed in multiple locations, each supporting several uplinks of several Gbps.

The latest VSAT terminal range for the Jupiter system consists of five different modems. The HT2000 series are all based on an upgraded Hughes-designed SoC ASIC named Sahara - bringing much more memory and processing capability and allowing even greater performance to meet the demands of today's consumers, which are increasingly driven by high speed video streaming applications. The SoC uses a new wideband waveform, capable of supporting channels of 200 Msps or more with modulation rates up to 64APSK and IP throughput rates up to 200 Mbps at the remote terminal. The new SoC has essentially doubled the terminal's throughput and we expect to see this increase further over time as the full resources of this very powerful chip are unlocked by future software releases. The HT uses Hughes' latest generation of integrated ODU which is not only smaller, lighter and more streamlined than previous generations, it only requires a single IFL cable helping to make the VSAT easier to install – self-install being another feature which Hughes supports in the Jupiter platform.

	HT2000	HT2000W	HT2200	HT2300	HT2500
Gig Ethernet Ports	One	Four	Four	Four	Four
USB	One	One	One	One	One
Integrated WiFi	-	Yes	-	-	-
Max Transmit Rate	15 Mbps	15 Mbps	15 Mbps	25 Mbps	25 Mbps
Max Throughput	200 Mbps	200 Mbps	200 Mbps	200 Mbps	200 Mbps
Optional Encryption	AES-256	AES-256	AES-256	AES-256	AES-256
Frequency	Ku & Ka	Ku & Ka	Ku & Ka	C, xC, Ku & Ka	C, xC, Ku & Ka
IFL Cable/BUC Type	1/Hughes	1/Hughes	1/Hughes	2/Standard	2/Standard

Table 8 - Hughes HNS Terminal (HT) Basic Function Variations

Jupiter also incorporates features such as ACM on the forward (outbound) channel and AIS with LDPC for adaptive burst coding on the return. In effect, AIS is a form of ACM for the inbound channel and features similar to it have also been introduced by other vendors under different names. Hughes' design is relatively unique because it incorporates adaptive inbound FEC coding without the need to change channel as well as automatic alternate symbol rate changes by frequency hopping the remote to a different inbound channel, and dynamic uplink power control. The last of these features also allowed the company to decrease the minimum required spacing between the return channels. Early on the HN9460 upped the bar with the introduction of adaptive LDPC coding on the inbound channel incorporating variable burst LDPC code block lengths that are dynamically sized to the amount of IP data to be transmitted – a feature that can bring bandwidth efficiency gains in excess of 20 per cent. The company informs us that with this closed loop control between the hub and remote, the system continually and automatically seeks out the most efficient transmission based on the link between each individual remote and the hub.

The high density Jupiter platform is a natural choice for any operator looking to build a business around a similar model to HughesNet in the United States. The system has been built on many years of experience serving the consumer market and whilst things like terminal pricing, network operations, bandwidth efficiency and management, IP functionality and optimisation are all critical factors, very few alternative platforms can demonstrate networks of more than 10,000 remotes and no other vendor has a system running more than a million subscribers. Whilst there are one or two alternative platforms running several hundred thousand users, the capability to install, manage, troubleshoot, bill

and upgrade this number of users is something that Hughes dominates at this time and is inherently part of the Jupiter platform.

Naturally, the next question is just how a consumer-optimised platform of this type would be of any interest for the enterprise market, but this is where the HG220 gateway comes into play. When the first generation of the Jupiter system was launched back in 2013, a lower capacity and more cost-effective option was provided in the form of Jupiter SRS which has been the foundation of most of Hughes' international enterprise sales over the last few years. With the advent of the second generation system and the HG220, Hughes has accelerated the process of porting all of the additional features and functionality from the HX to Jupiter. The HX was originally designed to provide a lower cost entry point for those operators looking to serve a small number of sites, but with far greater demands in terms of data rates, greater QoS granularity, application support and SLAs. Ultimately we believe that Hughes' vision is to consolidate all levels of capability – high-end corporate, large scale enterprise and consumer internet – on to a single platform allowing it to expand the addressable market for any operator and not restrict potential addressable opportunities.

Companies like Avanti, IPStar and Yahsat have already opened their systems up to different ground systems and COMSYS believes that this is likely to increasingly emerge as a trend amongst other HTS operators as they search for applications and customers which require the bandwidth these systems are able to deliver. It is clear that some ambitious satellite consumer internet programs in the international market have not delivered as expected and some operators have found themselves restricted in their ability to diversify into other areas within the enterprise segment. The HX system was also designed to support mobility applications, but again, as the market has developed it has become clear that data requirements are growing so fast in segments such as airlines, cruise and yachting that high throughput multi-spot beam satellite systems will become an essential part of delivering higher data throughputs and so mobility is another feature which has been integrated into Jupiter. Initially this comes in the form of a specific aeronautical implementation, but full land and maritime mobility is firmly on the product roadmap and is expected to be released within a year or so.

The incorporation of enterprise services into HTS systems is not only the preserve of mobility applications. Hughes has retained a large and extensive enterprise service in the United States supporting well in excess of 250,000 sites of which around 50,000 are terrestrially based. After seeing VSAT services slowly, but surely, being either replaced by terrestrial alternatives or moved into a back-up role, an increasing demand for levels of bandwidth that simply cannot be supported by terrestrial offerings other than fibre is indicating that augmentation of a connection via VSAT is the only realistic way of meeting the needs of suburban or rural sites which have no direct access to fibre. Even wideband satellite systems are challenged at this level and Hughes now sees that its latest Jupiter-2 satellite will be one of the few ways that its own and other carrier services can meet this need – hence the push towards integrating well proven and extensive features and functionality for enterprise applications into the new Jupiter VSAT platform. Additionally, the fact that the requirement to augment, as opposed to replace, and integrate a hybrid solution is bringing further enhancements to the system, including the ability to make use of Hughes' own "Active" software functions. A full description of the Active technologies are given in the Hughes operator section of this report, but it is worth mentioning ActivePath and ActiveClassifier

which will be incorporated into a new HR device and released in the latter part of 2016. ActiveClassifier examines the packet flow into the router and places data into different queues depending on the requirements and ActivePath creates intelligent multiple paths and application level policies, selecting the best connection for any particular application and thus enabling a hybrid solution with latency sensitive traffic routed via a terrestrial connection and applications like video streaming being supported by the satellite link.

Hughes is often perceived as a satellite engineering company whilst newcomers to the industry have positioned their products as "satellite routers" rather than VSATs. However, the truth is that the Hughes remote terminal is a fully featured IP router with almost too many standards-based IP protocols, services, performance and security features to list out – a glance at the IP Protocols and IP Services tabs in the technical description given above and a comparison with other systems covered in this report proves this out. One protocol that the company did not support until 2008 was BGP – an essential component required to integrate with MPLS. In a major bid the customer specified that BGP must be an option and a competing vendor believed that their product held a critical technical advantage over Hughes – it having taken them over a year to add BGP to their platform. However, within a few months Hughes was able to turn in and demonstrate fully featured support for BGP, illustrating the sheer strength in depth of Hughes' engineering resources and its strong IP expertise.

The latest Jupiter NMS is integrated into the HG gateway platform and provides advanced diagnostic functions with real time status and historical performance for both the gateway and remote sites. Depending on the network and satellite beam structure, several different configurations are supported ranging from management of a stand-alone gateway to control of multiple gateway systems with a 'manager of managers'. Automatic hands-free remote terminal commissioning is supported, but if required, individual or groups of terminals can be manually brought into service. The system also supports APIs through the implementation of RESTful which allows standards-based integration with other OSS/BSS products. The NMS also includes an integrated set of Host Network Operator (HNO) and Virtual Network Operator (VNO) capabilities which enable an HNO to establish and operate multiple independent VNOs, each of which can be provided with a logical partition of network resources including bandwidth. VNOs can be weighted relative to one another so as to enable high-value VNOs to be provided resources at a higher rate relative to lower value VNOs.

Extensive QoS features are provided via a standards-based classification of traffic types, primarily reliant on latency sensitivity, which allows an operator to assign bandwidth based on a variety of schemes including Committed Information Rate (CIR), on-demand Committed Bit Rate (CBR), Adaptive CBR (Outbound and Inbound) and backlog-based assignment. Hughes also has its own proprietary acceleration, optimisation and compression applications and algorithms which it claims significantly improves performance and removes some instances of latency through spoofing techniques and caching, appreciably raising user experience. With increasing security and encryption of many websites, acceleration - which requires access to packet headers - is effectively blocked, but Hughes has devised an alternative method of accelerating encrypted traffic through a different access scheme. Not only is this applicable to standard web surfing, we are led to believe that it also has application in the military segment.

In terms of traffic and connection management, the Jupiter system incorporates one or more contentious access channels which are used by the VSAT to signal to the hub that it has traffic to send - the terminal has no bandwidth assigned until the user data is available to send across the link. The initial request over the contentious access channel prompts the hub system to allocate the VSAT to a TDMA inbound traffic carrier and assigns it a "dynamic stream" within the carrier. The stream size is dynamically varied based on traffic load from the remote as well as overall network load. The VSAT then frequency hops to its allocated channel and from then onwards additional requests for bandwidth are piggy-backed on the traffic. Consequently the VSAT's channel is constantly re-sized on the fly, up or down as determined by the type of service it is running and the priorities and QoS for that user's service, as set by the operator. This ability to frequency hop – MF-TDMA – allows for traffic to be balanced across the system and some services to be prioritised or shifted to reserved capacity. In an enterprise environment, the platform can also support pure transactional services running traffic over a number of contentious access TDMA channels - essentially by allocating more carriers to this traffic scheme.

Each of the major manufacturers, including the DVB-RCS standard, has its own method of supporting Internet access services, but HNS believes that its approach is more efficient than its competitors. In the first instance, the fact that the terminal is inactive when not used for a long period of time means that the system overhead is low in comparison with many alternative systems which require the transmission of regular timing bursts. Also, whilst the immediate move to a reservation-based mode leads to a slight delay in the first traffic a user sends, Hughes believes that this is more than made up for by the overall bandwidth efficiency of the system. The company claims efficiencies in excess of 90 per cent - in contrast to the theoretical maximum loading of 36 per cent and practical limit of 20 per cent for a contentious access TDMA slotted Aloha scheme. It believes that systems which use a mix of contentious access and reservation modes cannot reach its level of bandwidth efficiency.

The back office systems behind the platform are sophisticated and have the ability automatically to provision a customer from the last click of an order on the web. With the receipt of a valid request, an account is set up, a VSAT is provisioned and shipped through the distribution partner to the installer and the work order to install is issued. The service is authorised and bandwidth and class of service is established at the hub. Essentially this is the system that Hughes itself uses in its HughesNet consumer service in the United States that was supporting over a million subscribers towards the end of 2016 and which had to provision as many as 60,000 subscribers a month following the launch of the EchoStar XVII (Jupiter-1) Gen4 service. Of course, this was when bandwidth was in plentiful supply in comparison to the current situation in which Hughes finds itself with a saturated satellite and little to sell in areas of continuing demand.

The question of standards is one that seemed likely to loom large over all the vendors of proprietary systems as DVB-RCS was ratified and systems began to enter the market. Frankly, we have always had our doubts whether an all-embracing standard in a market the size of the VSAT industry brings any real benefits given the fact that antennas, block up-converters (BUCs), LNBs, the use of DVB-S2 and DVB-S2X as outbound channels and receive modems and finally, cabling are all pretty much standard throughout the various platforms

today. Additionally, there are various aspects of a system which are not covered by any standard – TCP/IP and HTML acceleration, web and DNS caching and VPN support are all areas which render any real interoperability between systems pretty much useless. Nevertheless, HNS clearly felt the need to meet the threat and after attempting to work with the DVB-RCS initiative, took the view that its dominance of the market offered the opportunity to take a proactive initiative. In March 2004, the company announced that it was to publish its HughesNet air interface and establish it as a standard in both the US and Europe. The standard, termed IP over Satellite (IPoS) was subsequently ratified by both the TIA in the United States and ETSI in Europe. IPoS specifies a "Satellite Independent Service Access Point" (SI-SAP), which defines the interface between the satellite dependent functions and the application layers of a system, allowing application developers to easily interface their products with an IPoS-based system. In December 2006, Hughes obtained ETSI approval for version 2 of IPoS which now incorporates the DVB-S2 ACM standard. Currently a compliant IPoS system is only manufactured by Hughes as far as we are aware, but the company is adamant that it will offer royalty-free technical documentation as well as licensing of technology and technical support. The real success of IPoS is a hard one to judge. For one, it allows HNS to enter bids where a standard is mandated which has happened in a number of contracts in the past, primarily government RFPs. Whether any other manufacturer will decide to build an IPoS terminal was always debateable, but now it has been so long that it seems very unlikely.

HNS has developed and refined its HughesNet service platform from the one-way DirecPC system in the mid-1990s through to the present HT series. We believe that the company has been considerably helped by its own real-world experience of running satellite broadband services at all levels of the market – consumer, SME and enterprise. Initially, the hope for HNS and all of the system vendors was that the technology would break into the consumer market. This took longer than was originally forecast, but a lot has changed in the telecoms market over the past ten years. Today, satellite internet service to the consumer is a reality in North America with Hughes reporting over a million subscribers in service out of around two million in total in North America, including Xplornet which also makes use of the Hughes platform. As we indicate in the Business section below, we believe that Hughes has manufactured over 3.5 million units just for its own and its customers' consumer businesses.

Nevertheless, the enterprise market remains very important to Hughes and one of its real triumphs has been in its delivery of a system and terminal which leads both the consumer and enterprise segments of the market in functionality and price competitiveness. Its abilities in the enterprise network are demonstrated by the evolution of the platform from a basic access device with little in the way of integral IP service support beyond efficient connection, to what is now a high speed networking device in the form of the HT. The enterprise market has changed considerably over the past few years with the provision of basic broadband access for both large and small businesses now a significant requirement. Larger corporations continue to require higher levels of application support, yet are also beginning to demand broadband as a basic service to underpin many of the web-based applications they are either running or plan to introduce. Clearly, the Jupiter platform represents HNS' integrated product suite to meet this demand.

When we first reviewed the HN7000 in 2005 we suggested that it would be a hard product to beat. Since then Hughes has accounted for almost half of all the shipments in the global

enterprise market and shipped more than 500 hubs. It is all too easy to forget the scale of Hughes' achievement with the HN architecture. This is a product that scales from networks of a handful of high-value sites demanding individual QoS to millions of consumer subscribers – no other vendor is able to come close to such a claim. By rights, this should be a system of compromises, kludges and shortcomings, but instead it commands around half of annual global sales and leads each market in which it plays in terms of features, performance and price. With such a competitively positioned product and a reputation for delivering advanced features on time and providing a high level of support, Hughes is very hard to beat.

Beyond Hughes' own consumer service, the new Jupiter system has already been selected by Yahsat to upgrade the current Yahsat-1B platform, IPStar and BSNL for deployment on the IPStar capacity over India, PSN for its forthcoming Ka/Ku PSN-6 HTS satellite over Indonesia and, of course, Hughes do Brasil for its consumer service on Eutelsat 65 West A. The first generation Jupiter system is in use by many customers and COMSYS has visited and interviewed several of these companies. Without exception, every one of these Jupiter users has expressed their satisfaction with both the product and the support they have received from Hughes. A common comment often made has been that the system and the company delivers what it promises – no features that suddenly are "under development", no additional costs for things that were thought to be included and high levels of support. In the UK we have a slogan which was originally part of an advertisement and which is now widely used – "*it does exactly what it says on the tin*" and this seems a very appropriate description of Hughes' Jupiter system.

6.1.2. HX System

The HX System is positioned as a scalable system with high level quality of service (QoS) features, robust transmit data rates and support for specialised applications. Hughes supports four HX terminal models – the HX50, HX200, HX260 and HX280 . All operate off the same hub chassis with the HX50 serving as the base model. The major technical differences are highlighted in the tables that follow.

Technical:

Topology:	Star, Mesh, Multi-Star
Antenna Size:	0.74-1.8 metres
Frequency:	C-, ext-C, Ku- and Ka-band
Bit Error Rate:	Outbound 10^{-10} or better Inbound 10^{-7}

Out/Forward

Access:	DVB-S (see HN for specs) DVB-S2 CCM, VCM & ACM
Gross Rate:	1 to 5 Msps in 0.5 Msps steps, 5 to 45 Msps in 1 Msps steps
User Rate:	Up to 121 Mbps
Modulation:	QPSK, 8PSK, 16APSK
FEC:	LDPC with BCH outer code, rates ½, 3/5, 2/3, ¾, 4/5, 5/6, 7/8, 8/9, 9/10
Load Balancing:	Ys

NMS

Platform:	Various workstation sub-systems
Remote Optr:	Yes
Max Net Size:	Base rack: Up to 500 terminals, 18 inbound channels or total inbound aggregate bandwidth of 8 Mbps. System is expandable.
SNMP:	Yes

In/Return

Access:	MF-TDMA with adaptation
Gross Rate:	256, 512, 1024, 2048, 4096 & 6144 ksps **50**: 256 to 2048 ksps only
User Rate:	Up to 9.8 Mbps **50**: Up to 3.2 Mbps
Modulation:	OQPSK
FEC:	Turbocode rates ½, 2/3, 4/5, with adaptive coding Convolutional rate ½ Adaptive LDPC with rates of ½, 2/3, 4/5 and 9/10
Schemes:	Diversity Slotted Aloha Adaptive CBR Constant Bit Rate

IDU

IDU Ports:	Two 10/100 BaseT RJ-45 Ethernet and one serial (RS-232 or RS-422)
Max Ports:	See appliances below
Port Rates:	Up to 45 Mbps[4]
IF Interface:	Hughes & Standard L-band **HX50**: Hughes standard TX, L-band RX only
Other:	Terminals are all RoHS compliant

[4] At least 45 Mbps of multicast/streaming traffic, or at least 4 Mbps of FTP traffic, or at least 2 Mbps of HTTP accelerated traffic, or at least 10 Mbps of UDP traffic, or any combination of these with proportional performance.

Bandwidth Management:	Frequency Hopping Static Assignment Dynamic Assignment Hub Signal Cancellation Inbound Spreading (not 50)
Load Balancing:	Yes

Gateway:	
Model:	HX MeshGW
Access:	MF-TDMA with adaptation
Channel Rates:	256, 512, 1024 & 2048 ksps
User Rate:	Up to 9 Mbps
Modcods:	As star inbound channel
Capacity:	Up to 16 TDMA channels, maximum 8 Msps capacity
Expansion:	Modular, rack & stack
Redundancy:	Yes, non-redundant optional

Mesh IDU	
Model:	HX260 and HX280
IDU Ports:	Two 10/100 BaseT RJ-45 Ethernet and one serial (RS-232 or RS-422)
Port Rates:	Up to 45 Mbps
Channels:	Up to four concurrent carriers over 2 Msps
Addl Slots:	See Optional appliances above
IF Interface:	Hughes & Standard L-band

Applications:

IP Protocols:	TCP/IP FTP, UDP Multicast (IGMPv1, 2 & 3), ICMPv4, Telnet, PPP, Unicast RIP v1 & v2 IDRP, VRRP, CIDR BGP VLAN Tagging
Acceleration:	Integral PEP (additional device for mesh channel)
QoS:	Integral on Outbound & Inbound with DSCP Minimum CIR with fixed steps or best effort to maximum (rate limiting) Best efforts services - weighted fair queuing Class-based weighted prioritisation 4 levels of IP traffic prioritisation

IP Services:	NAT/PAT Static/dynamic addressing DHCP server or relay DNS Caching HTTP Acceleration TurboPage, TOS, DSCP, POP, SMTP, ACL Firewall support, Header Compression
VOIP:	Optional
Encryption:	Integrated CA & DES on outbound, optional VPN Accelerator & bi-directional 256 bit AES **280**: FIPS 140-2 Level 2 compliant Enhanced Signalling Security AES-256

Basic Services:	Addressable Data Data Broadcast/Multicast Video Voice Facsimile
Legacy:	SDLC end-to-end (PU4 to PU2.0/PU2.1) SDLC remote, LLC NOC (PU4 to PU2.0/PU2.1) LLC-LLC X.25 XPAD (asynchronous) VeriFone 3200 (Visa) VeriFone 3300 (Visa)

Voice Coding:	CS-ACELP (G.729AB or G.723) H.323 standard
Coding Rates:	8 kbps (G.729) or 5.3 kbps (G.723)

Indicative Pricing:

Hub	
Redundant:	~$200,000
IF Chain:	~$70,000

VSAT	
HX50 Ku-band:	<$1,000 (0.98m/2w)
HX50 C-band:	<$3,000 (1.8m/2w)

Mesh Gateway:	
Non-redundant:	~$40,000
Redundant:	~$65,000

IDUs:	
HX200:	<$1,400
HX260:	<$4,500
HX280:	<$10,500

Supply:

Production:	>25,000 units/month
Availability:	Current

Hub Delivery:	30-60 days ARO
VSAT Delivery:	30-60 days ARO

HX Product Discussion:

The HX System was officially released in June 2006 as a platform designed specifically for smaller networks with a high quality of service requirement. Hughes took the basic structure of the larger HN system of the time – including the DVB-S2 ACM outbound, inbound access schemes and the management system – as the core of the HX. For this reason, observers can be forgiven for initially thinking the HX is little more than a cost reduced version of its larger brother, but this is not the case. Similarly to all the other vendors in the market, it had not escaped Hughes' notice that some companies had been growing strongly in a segment of the market which its own HN System did not address. Specifically, vendors like iDirect and Comtech were selling small, independent systems to private users, integrators and operators in highly specialised vertical niches.

Many made the assumption that the key to this market was the entry price point for the hub system but, whilst this is part of the equation, it is not all, or even the largest part of it. The ability to deliver high levels of guaranteed service in a much more granular way that large scale enterprise systems need, or can even cope with, is one key feature and this was possibly the largest task that Hughes set out to deliver in its HX System. As a consequence, despite the fact that the company had a great deal of technology which could simply be lifted out of the HN System, most if not all of the QoS software systems, including the algorithms, needed to be completely re-designed. The company also wanted to raise the maximum transmit rate of the remote terminal and to design an architecture that was both low cost and yet scalable. Traditionally, Hughes has been highly focused on maintaining backwards compatibility in its systems, but as the HX system was targeted at new markets it was released from this constraint and had a clean slate on which to start.

As a consequence, when launched the HX offered an almost unique combination made up from the advantages of highly scalable, efficient, low cost technology taken from a proven and successful product coupled with a hub system and IP architecture designed from the ground up and incorporating several other high-end networking features. These include optional 256 bit AES encryption and significantly expanded quality of service capabilities with the ability to set service guarantees by individual remote terminal and specific application. These include:

- Constant bit rate providing a uniform transmission rate to avoid jitter in applications such as voice and video.
- Minimum committed information rate (CIR), guaranteeing the throughput of a connection, with fixed steps to a maximum limited rate.
- Minimum CIR with best effort to a maximum limited rate.
- Best efforts services - weighted fair queuing.
- Class-based weighted prioritisation.

QoS is also tied to an operator-defined priority queue which sets four levels of IP traffic and allows the system to prioritise and rate limit the least critical traffic in an ordered fashion.

The HX terminal originally came in three versions, but today there are four terminal types:

- **HX50**: operates with the standard Hughes proprietary RF range, has one serial and two Ethernet ports.
- **HX90**: adds support for Ka-band.
- **HX200**: replaced the HX100 and HX150 and differs from the HX50 in that it can support higher symbol transmission rates (up to 6 Msps versus 1 Msps) and comes in an enclosure which is both stand-alone and rack-mountable. It is able to operate with either the Hughes proprietary saturated RF unit or industry standard linear L-band BUCs. The terminal can also support spread inbound channels as an option (which requires additional equipment at the hub) and has the ability to take a GPS reference for mobile services.
- **HX260**: is where things become really interesting because the terminal supports all the attributes of the HX200, but adds a fully featured mesh capability.

- **HX280**: is the "Rolls Royce" of the range, incorporating all the features of the HX system as standard as well as several specific additional capabilities. These include spreading and other mobility functions, AES256-based FIPS 140-2 cryptographic security and Enhanced Signalling Security which protects all data, management and signalling traffic.

A great deal of work was also done in the initial design to simplify and integrate hub sub-systems with the aim of reducing the cost and size of the NOC. This was achieved by combining the IP and satellite gateways, consolidation of ports and reducing the number of servers. The HX incorporates a standalone, frequency scanning burst demodulator – the Configurable Demodulator System (CDS) – able to support multiple inbound channels across a defined frequency range. The CDS operates up to 10 Msps with a start-up licence of 2.5 Msps upgradeable to 10 Msps – with each able to demodulate up to 9 channels simultaneously, all of which can be configured with different modulation and FEC rates. Not only does this approach bring the total cost of ownership for an inbound channel down substantially, it also further enhances Hughes' AIS feature. Maximum inbound channel rates of 6 Msps allow carrier rates for the star element of a network of around 9 Mbps. The development of the CDS brought even more potential to the HX than it did for the HN because it is the main foundation for the technology which underlies the HX mesh networking abilities.

When we first reported about the HX in 2008 the direction and ambition that Hughes had for the platform was clearly laid out. However, the mesh feature surprised even us with its level of functionality and cost effectiveness. Hughes announced the HX260 at the beginning of 2009, re-entering the mesh market for the first time in some years. However, there could not be more difference than between the old TES mesh DAMA system and the HX. The HX platform is designed to operate not just as a full mesh, peer-to-peer network, but as a multi-star or hybrid network. As previously mentioned, the system uses the CDS technology as its basic building block, although for mesh a 2 Msps unit is used rather than the 2.5 or 10 Msps units available for the hub. The HX260 demodulator incorporates the same technology as a hub station CDS which allows it to receive and demodulate up to four channels simultaneously, each with different data rates, modulation and FEC. Thus, a network can be quickly set up, controlled ultimately by the HX hub, with any-to-any connectivity between HX260 remotes.

The comment that, by definition, a mesh system can also run in a star configuration is commonly made. However, in most cases whilst this is possible, it is rarely practical due to the cost of the mesh remote terminal and the lack of a large outbound carrier at the central site. Efforts to address this by other manufacturers have usually involved an overlay DVB-based channel, but often require a completely separate VSAT IDU with the obvious cost implications – in effect the solution is two systems. Indeed, Hughes used exactly this approach with its combination of the TES and PES – the HES – in the early 1990s. By contrast, because the HX began life as a star system, it has all the attributes required already built in. Additionally, it has a range of low cost star terminals – the HX50 and HX200 – that can be integrated seamlessly into a hybrid mesh/star solution.

The HX has another trick up its sleeve, however, with a separate gateway option. An HX mesh gateway terminal consists of a Traffic Manager (two for a redundant arrangement) and

up to eight mesh units (based on the CDS technology) – HX260 routers – which together can support 16 Mbps of capacity running up to 32 channels. The system can start small with a Master Traffic Manager and a single HX260 (CDS) and grow incrementally, adding redundancy if required. Several mesh HX gateways can also be used in the same network. This allows multi-star networks to be deployed in an extremely cost effective manner because the list price on the HX260 modem is only $3,500. The HX mesh solution requires an external appliance to support TCP/IP PEP for a connection, but it does incorporate most of the other IP services from the star configuration.

Of almost equal importance, the combination of the CDS and Hughes' release of its own hub modulator, has allowed the company to re-package its IF channel hub hardware components. From a point a few years ago where a new IF chain would effectively require an operator to purchase another hub, Hughes is now able to provide this capability for around $70,000 – making it the first vendor at the time to meet iDirect's strategy head-on with an alternative product. The HX system was originally targeted towards operators focused in highly defined market segments, such as the maritime stabilised business, oil & gas, mining, embassy networks and multi-national corporate segments. It has also firmly targeted the demand for high speed satellite backhaul circuits from the GSM operators and the military's need for highly customised mobile terminals capable of supporting multi-megabit mission critical applications – this is clearly the role for which the HX280 was specifically designed. However, in many ways the HX has also become the workhorse for more generalised enterprise networking for many operators.

Mesh is often requested by potential users and can even be a requirement for participation in an RFP, but it is quite common that it is never actually implemented. It was perhaps the multi-gateway/multi-star capability using the mesh gateway on the HX that opened up new areas of opportunity because an operator is able to terminate traffic from an HX VSAT at different gateway locations depending on the performance and cost available at that site. So, for example, an operator in West Africa could (satellite coverage permitting) operate a local gateway in Africa supporting corporate intranet traffic, a gateway at the AIX for internet and a gateway in New York for voice termination. During our research we have seen a latent demand for this type of network from companies and organisations ranging from hospitality and insurance companies to GSM operators and government departments. By definition, a country where VSAT is the only viable alternative for internet access, also has huge demand for domestic connectivity from the same sites. Until recently, the technology and systems certainly existed to provide these types of services, but the cost per site was simply prohibitive, running at $20,000 or more. Hughes is not the only company to have a platform capable of mesh/star/multi-star operation, but it has a fully featured solution and a competitive price point.

When first launched, the commonality of technology between the HX and the HN caused some confusion in the market as customers struggled to understand the differences between the two platforms other than the fact that the HX had a lower entry price point. However, the combination of small start-up costs and a DVB-S2 ACM outbound channel, especially in a market struggling with rising capacity prices across the world at the time, a real lack of satellite capacity in some regions and tight credit restrictions almost everywhere, proved to be an attractive one. The system offers many of the advantages of the HN in that the HX50 terminal is priced similarly to the HN7700 due to the fact that it comes from a

heritage of huge manufacturing scale. The HN system is also very efficient in its use of compression, Hughes' performance enhancing proxy (PEP) and adaptive inbound selection (AIS) as well as its ability to reduce a non-active remote terminal's bandwidth requirement to zero. The other important point to note is that, though positioned as a platform for small networks, ultimately the HX is able to scale up to the same levels as the HN and does not represent a dead-end when an operator's business reaches a certain size.

Since its initial launch, Hughes has added further to the HX's capabilities. The platform now comprises a large share of Hughes' international sales and development of the system has been generally faster and more adaptable than its larger siblings, the HN and Jupiter. The addition of the HX90 brought support for the latest adaptive LDPC inroutes. Mesh multicast is also incorporated with dynamic links created on the detection of multicast traffic. Hughes has also improved the ability to set up videoconferencing between different sites with a single screen set-up. The initial entry cost for an operator has not been ignored either and the HX comes with a minimum outbound capacity of 768 kbps expandable in 500 ksps steps, allowing a service provider to start operations with a minimal amount of investment in satellite capacity and then grow in a much more scalable fashion.

The HX has emerged as Hughes' go-to product for mobility and military markets. It supports traffic switching between beams – a necessity for maritime, aeronautical and other mobile services – as well as global roaming, allowing terminals to transition between different hubs based on the same NMS. A new advanced waveform was introduced in early 2013 which enabled Ku and Ka-band communication through rotary wing platforms – helicopters – on a variety of commercially available airborne antennas. In addition, the HX TGW100 transportable gateway provided for a compact quick deploy hub able to support star and mesh links for small networks and there is also a compact card configuration of the HX280 designed to allow integration by third parties into specialised terminal configurations, such as lightweight man-packs. This system is targeted at the military segment, but other customers including civilian security, digital SNG providers or even operators which need a very fast deployment might also find a use.

The platform fulfils the promise that Hughes made for it when it was first launched and has become a fully-rounded product for operators in the specialised vertical segments. It took a while for the HX to gain traction with the customer base, but then acceptance and adoption showed a marked sales pick-up and the product was a tremendous success for Hughes which sold 40 HX NOCs within the first year of its release. The HX was the first new platform Hughes developed that appears to have had its design origins driven from the demands of the international market rather than the domestic US, but there are applications and potential customers in North America also. In this, as in other areas, there have been some surprises for Hughes also as unanticipated sources of demand are uncovered. The HX's comms-on-the-move and military capabilities also opened up segments that Hughes has not been strong in historically as it focused on larger volume opportunities.

Without question the HX system breathed new life into Hughes' ability to address the total potential market rather than just the medium to large scale opportunities. It also made the Hughes product suite much more attractive to smaller operators who were able to enter service with less upfront investment, grow different service offers incrementally, flexibly and cost-effectively and yet have the potential to scale up to serve massive networks if required.

Operators who have bought the system, several as a replacement or service platform upgrade to competing products Hughes has targeted, tell us the HX's capabilities are impressive and it delivers exactly the kind of service for which it was designed. What is more, many operators look for some kind of technical differentiation and, as a product with a strong heritage, the HX offers this as well as the security of stability. If there is one big question it is what will happen to the HX as all of its unique functions and features are gradually integrated into the latest Jupiter system. On the one hand we think it unlikely that Jupiter will incorporate mesh capabilities (although this is not an impossibility) and this will retain a level of attractiveness for the HX, but on the other, the simple fact is that Jupiter has significantly advanced many areas – efficiency, capacity, throughput and virtualisation to name a few. Consequently, our prediction is that the HX will continue to be supported and will find the odd niche in which it fits perfectly, although in the longer term the future lies with the Jupiter platform.

The following tables combine sales and customer data from the JUPITER and HX platforms with previous Hughes systems including the HN, DW and PES products.

Operators:

Own Service: Hughes has four service operations: HughesNet in North America for Enterprise, Government and Consumer in the United States; Hughes Europe in Europe; the Hughes Communications India venture in India; and Hughes do Brasil in Latin America which now runs both enterprise and consumer services.

N America	
Canada	Galaxy Broadband
USA	NSS
Canada	Telesat
USA	USSC
Canada	Xplornet
Europe:	
Spain	Abertis
Russia	AltegroSky
Russia	Amtel Sviaz
Russia	Crosna
Ukraine	Datagroup
Russia	Gazcom
Czech	GiTy
Russia	GTNT
Russia	IPNet
Turkey	IS Net
Russia	KB Iskra
Russia	MegaFon
EMEA	Nynex
Russia	Orion Express
Poland	Pagi
Romania	RaRTel
Russia	Roilcom
Russia	RSCC
Russia	RTComm/Rostelecom
Turkey	Superonline
Russia	Telematika-Net
Italy	Telespazio
Poland	TTcomm
Turkey	Türksat
Russia	UCC
Russia	USI

L America:	
Colombia	Anditel
Argentina	Arsat
Peru	Avantec
Mexico	Axesat
Bolivia	Bolsat
Latin America	BT Latin America
Honduras	CGI
Bolivia	EnTel Bolivia
Brazil	Hughes Americas
Latin America	Level 3
Latin America	MNLA
Bolivia	Pacific Telecom
Mexico	Pegaso Banda Ancha
Brazil	Primesys
Venezuela	Redescom CA
Mexico	SCT/Telecomm
Argentina	SPTI
Mexico	SSL Digital
Colombia	Telecom Colombia
Argentina	Telefónica Argentina
Mexico	Telmex
Panama	Ufinet
International:	
EMEA	Avanti
EMEA	Bentley Walker
Global	BlueTide
Global	Global Eagle
EMEA/AS	Hughes Europe
Europe/L Am	Telefónica
Europe/L Am	Ufinet
EMEA/C Asia	Yahsat

Asia:	
Kazakhstan	2Day Telecom
Malaysia	Baycom
India	Bharat Electronics
China	BTA
China	CITIC Guo An
Indonesia	CSM
Azerbaijan	Delta Telecom
China	GWSat
Vietnam	General Pacific
India	Hughes India
China	HughesNet China
Kazakhstan	Kazteleradio
Myanmar	KBZ Gateway
Korea	KT Corporation
Indonesia	Lintasarta
Malaysia	Maju Nusa
Indonesia	Metrasat/Telkom
Malaysia	Numix
Australia	Orion/IPStar
Indonesia	Primacom
Indonesia	Satkomindo
Myanmar	Seanet
China	Shanghai Jianhua Satellite
Korea	SK Telecom
Japan	Sky Perfect JSAT
China	SVACom
China	SVC
Indonesia	Tangara
Malaysia	Telekom Malaysia (TSG)
Indonesia	Telesindo

Africa	
Egypt	Alkan
Botswana	Botswana Telecom
Kenya	CommCarrier
DRC	CyberNet
Nigeria	DCC
Nigeria	DOPC
Ethiopia	ETC
Gabon	GabTel
Angola	Global Telesat
Gabon	Internet Gabon
Africa	Internet Solutions
Africa	iWay Africa
DRC	Microcom
Nigeria	NIT
Nigeria	Protocol Solutions
Cameroon	Saconets
South Africa	Telkom SA
Madagascar	Telma
Nigeria	Telnet
Tunisia	Tunisie Télécom
Africa	Vodacom
Middle East:	
Kuwait	Gulfsat
UAE	IPDish
Iran	Iran Telecoms Company
Iran	ISC
Saudi Arabia	NoviaSat
Oman	Omantel
Saudi Arabia	Skyband
Saudi Arabia	STC

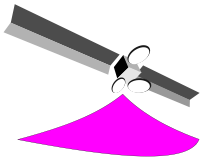
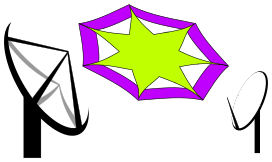
Business:

The HughesNet platform has been a major success for Hughes with over two million units sold into the enterprise market and HNS' own HughesNet consumer offering now supporting over one million subscribers in the United States. In total, HNS has manufactured significantly in excess of 5.8 million units since launching its first VSAT product over 30 years ago. The table below includes all shipments to the end of 2016:

Interactive Star VSAT Customers	*Enterprise*	*Consumer*	*Band*	*All Shipments*
North America	1,121,203	3,528,521	Ku/Ka/C	**4,649,724**
Latin America	241,671	69,217	Ku/C	**310,888**
West & East Europe	270,782	33,362	Ku/Ka/C	**304,144**
Asia/Pacific	328,507	29,216	Ku/C	**357,723**
Africa	107,584	-	Ku/Ka/C	**107,584**
Middle East	71,126	-	Ku/Ka/C	**71,126**
Total Shipments	**2,140,873**	**3,660,316**		**5,801,189**

7. HughesNet VSAT Services

7.1. HughesNet American Enterprise Services


Systems & Facilities:

Star:	Hughes, HT, HX and HN systems Spaceway HN9000/9500	***Hubs:***	Detroit, Michigan Germantown, Maryland[5] Las Vegas, Nevada[6]
Mesh:	Hughes, HX260 Spaceway HN9000/9500	***Satellites Used:***	EchoStar, Intelsat, Spaceway, Eutelsat, SES
Frequency:	Ku & Ka-band C-band for international	***Service Area:***	North America and surrounding regions
Other:	Managed hybrid VSAT/terrestrial services, MSS L-band	***Install, S&M:***	Specialised arrangement

Commercial Factors:

Growth:	<5% for North American enterprise services (2015); consumer ~6% in subscriber growth 2015	***Capacity:***	~ 50 transponders plus Spaceway (10 Gbps) and Jupiter-1 (120 Gbps) Jupiter-2 (200 Gbps)
Staff:	~1,500 (N America)	***Revenue:***	~US$300m for North America enterprise services (2015)

Business:

Hughes operates the largest shared hub enterprise service in the world and the largest satellite consumer service in the world – in both cases by some margin. The HughesNet consumer service was reported to have 1.03 million subscribers as of Q2 2016 and the company is believed to currently have over 200 major enterprise customers on its various shared hub facilities not counting its SME broadband customers, accounting for around 170,000 sites in service. In total, with SME broadband and supported dedicated systems Hughes supports over 225,000 VSAT sites as part of its North American VSAT service. The vast majority of the company's sites are located in the United States, but HNS also supports

[5] Germantown hosts the HughesNet consumer service and one of the Spaceway gateways. The enterprise services hub is primarily used for backup, disaster recovery and engineering services, and therefore shared services are mainly customer networks which await final deployment to a dedicated or third party operator hub.

[6] Las Vegas is the primary gateway location for Spaceway.

customers in Central America, the Caribbean and Canada from its operations in the United States. The table below breaks out the company's active VSAT sites by vertical segment, but all of HNS' networks in service are known to COMSYS.

Hughes' North American enterprise business has been growing over the last five years, but this is primarily a result of the company's strong push into hybrid managed network services, rather than pure VSAT. Nevertheless, a great many of the company's long term clients have renewed their VSAT networks and a growing number of customers now have the HughesON HAN (High Availability Network) in which VSAT is deployed as the backup connection. VSAT remains a core component of Hughes' US service business, but now essentially divides into two – as part of a more complex total solution in which the VSAT plays the role of either augmentation, extension or connection redundancy; or, as the primary means of delivering a service for a complete network usually driven by the need for a specialised application, such as media delivery, security or mobility.

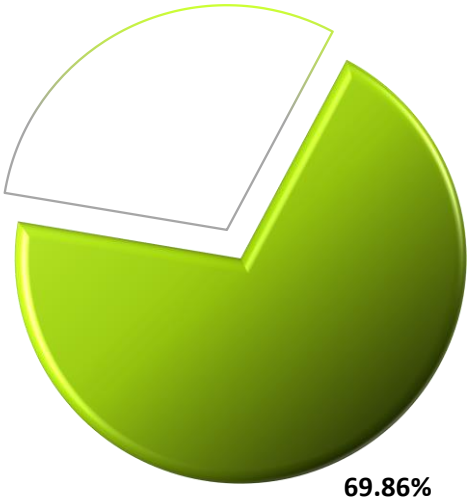
Interactive Star VSAT Customer	Sites
Financial/Banking	1,443
Gas/Convenience	8,556
Government/Military	3,219
Information	4,947
Lottery	105,000
Manufacturing & Distribution	1,332
Other	458
Retail	32,405
Services/Broadband	57,137
Travel/Hospitality	2,667
Utility	9,395
Total	**226,559**

2015/16 did see the company continue to sign new VSAT customers, although pure satellite solutions tend to be small networks and the larger deployments are either extensions of existing networks or part of a hybrid solution. Spaceway also continued to play a role with new networks for security and monitoring networks. Companies that have extended or upgraded their network over the past two years include those in the retail, utility, lottery, agriculture and media segments including some big names like Lowes Hardware, CVS, TJX, and Sherwin Williams. Overall, the North American service business achieved single digit growth rates in 2015. The largest service customer by far, IGT (GTECH), continues to rely on Hughes to operate its network which has now encompasses more than 100,000 sites across the US.

Alongside VSAT, Hughes' enterprise services business now has several large big-brand customers with terrestrial connections only, including clients like Body Shop and Gap. The company makes extensive use of fibre, cable, DSL and 3G/4G cellular services for most of its major customers today and currently supports over 50,000 terrestrial connections in addition to, and usually in combination with, its VSAT services.

The consumer market has emerged over the past ten years as the key driver in the company's North American business. Satellite-based consumer internet services are now a two horse race in the United States between HughesNet and ViaSat which has seen a see-saw of high and low growth as each company has quickly saturated the bandwidth available to it. Currently Hughes informs us that Jupiter-1/EchoStar XVII (which is only four years old) is almost full and it is now waiting for Jupiter-2/EchoStar XIX which is due for launch later in 2016 and to enter service at the end of the Q1/2017. Jupiter 2 will carry 50 per cent more capacity than its predecessor and Jupiter-3 is now in the planning stage.

Performance:



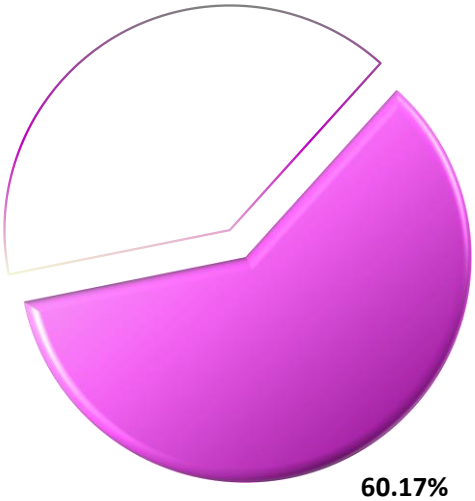
USA Enterprise TDMA Market Share

Hughes Network Systems has maintained its position as the leader of shared VSAT services in North America – head and shoulders above its nearest competitor. As we have commented in our previous reports when a company dominates a market to the extent that Hughes does – holding nearly 70 per cent of the managed enterprise VSAT business – it becomes hard to imagine that it can grow its share much more. Its progress is inexorable and its customer list is a testament in itself. Its nearest competitor has about a quarter of the number of sites Hughes has in service and the second largest player on a global basis after Hughes in the United States is …. Hughes in India! HNS' aggressive pursuit of the service business has been a key element of its business strategy for some years now – it was the first to recognise the change in the market as demand switched from private networks to shared solutions and it adapted quickly. This was no small task for an engineering-based company, an issue some of its competitors continue to experience. We have seen the company constantly modify its approach to the service business, rarely perfectly, but always at the head of the market. Spaceway entered operational service in April 2008 and, even almost ten years later, has some of the most advanced features of any multi-beam Ka-band satellite. On-board processing supports star, multi-star, mesh and point-to-point connectivity and allows the company to address market segments that were previously unreachable, although as previously commented, these networks tend to be small and Spaceway's primary use is consumer.

However, it is really the company's leverage of its position in the enterprise market and the expertise its managed VSAT service platform allowed it to build over 30 years of leadership which now carries it forward. Everything from network engineering and program management to sales channels and solutions consultancy have contributed to a hybrid managed services solution that competes strongly against even the largest carriers in the United States. Rarely does the company see other VSAT providers in network bids – Hughes' primary direct competitors are companies like Verizon and AT&T – and this is often where its experience in managing end-to-end application-led solutions which originated in its VSAT service platform, gives it a decisive advantage.

The company continues to outperform in all aspects of the business - new sales, major upgrades and contract extensions – and its momentum and expertise make it a hard competitor to beat. 15 years ago, HNS was primarily a hardware vendor - and today it is clearly a service company which still leverages its deep and proven engineering and technology development capabilities to maintain its competitive edge. As the market leader since the industry's inception Hughes Network Systems has been charged with almost every fault imaginable by its various competitors at various times, but the results can be judged on their own merit – dominance of this magnitude does not come from doing things wrong.

Hughes was the instigator of the satellite consumer internet market more than 15 years ago and has led the way ever since. The entrance of the company's only major direct competitor, WildBlue, only served to raise the awareness of satellite broadband. As a result, the entire market potential grew and this benefited all players. The Jupiter-1 satellite and accompanying Jupiter VSAT system significantly raised transmission rates and IP throughput on the terminal and we expect similar advances with Jupiter-2. As of end-2015, Hughes' market share of the satellite consumer internet subscribers in the United States had hit 60 per cent – up from 54 per cent two years previously. The performance of Hughes' consumer business has been even more impressive than its enterprise services, growing almost 14 per cent in net new subscribers in 2014 and over 6 per cent in 2015. At the end of 2015 the company had over one million subscribers on its consumer platform (including some of its SME customers) although 2016 is expected to flatten now that the satellite is essentially full.



USA Consumer Internet Market Share

The strength of Hughes' business is now showing through in a number of ways. ViaSat has also grown its subscriber base fast, but on the back of wholesale agreements with EchoStar, DirecTV, AT&T and NRTC, and this has resulted in a much lower ARPU than Hughes. In addition, since the acquisition by EchoStar and the launch of Jupiter-1/EchoStar XVII, Hughes has added both Dish and DirecTV to its sales channels. Having started using conventional Ku-band capacity from Intelsat and others, today only a handful of subscribers are not on its Ka-band spacecraft with most using Jupiter. The HughesNet service has been extremely successful with consumers, prosumers and SMEs and the biggest question today is how easy it will be to bridge the gap before Jupiter-2/EchoStar XIX is launched. HNS' HughesNet consumer service shows the value of its strategic positioning as the company is able to carry its consumer service through the resources that it has in place for its enterprise business which, in turn, feeds off the volume generated in the consumer business. Once again, it appears that Hughes holds all the right cards.

Additional Information:

Hughes Network Systems LLC (HNS) is a wholly-owned subsidiary of Hughes Communications Inc. (HCI), itself a wholly-owned subsidiary of EchoStar Corporation. EchoStar acquired Hughes – which had been traded on the NASDAQ, but substantially controlled by the Apollo private equity group – in February 2011 for $2 billion. EchoStar's primary business is the manufacture of digital television set-top boxes, management of Dish's OTT Sling service and capacity sales on its fleet of satellites. The company is listed in the NASDAQ under the stock ticker SATS and is part of a group, which includes DISH network, controlled by Charlie Ergen. Apollo had acquired HNS through SkyTerra from the DirecTV Group, in a complex series of deals which finalised in November 2005. Since its formation more than 30 years ago,

Hughes has had the same management team, virtually unbroken with the exception of a few retirements, even through all of the various transactions the company has undergone between 2003 and 2011.

HNS has a wide-ranging business in satellite equipment manufacturing and services. It manufactures a range of VSAT products based on the HN7000S, HN9000, HX and HT systems, the latter of which now operate on the latest HG200 DVB-S2X platforms released in July 2016, launched its first Ka-band, spot beam Spaceway satellite with coverage of the United States in 2007, followed up by the 120 Gbps Jupiter-1 (EchoStar XVII) satellite in 2012, and operates leading VSAT service businesses in North America, Europe, Brazil and India. EchoStar reported revenues for Hughes' business in 2012 of $1.35 billion with its various service businesses – the biggest of which is the North American service covered in this section – accounting for the largest proportion of this. EchoStar no longer breaks out the Hughes service revenue detail, but COMSYS understands that the company's North American enterprise services have consistently accounted around 18 per cent of all Hughes' revenues.

HNS operates its services from three shared hub locations, two of which are located in Las Vegas and Detroit. The third facility is located in Germantown - running temporary services for networks before they are moved to their final destination, in addition to serving as an engineering and test hub. HNS also offers 24-hour control and monitoring services with Hughes staff located at the customer site for customers with private hub networks. Installation is sub-contracted to a multitude of installers and remote maintenance is handled by Qualxserve, previously known as Wang. HNS has an in-house installation and maintenance management team which manages the company's field service sub-contractors around the country. All sub-contractors are trained by HNS and must be certified on HNS equipment. The field service team is tied in electronically to Hughes' Operations Systems to improve efficiency and effectiveness.

At the inception of the VSAT business in the early to mid-1980s, Hughes targeted the market for dedicated hub systems whilst others designed and sold their systems to serve in a shared hub environment. Hughes got it right - it was the private hub customer that formed the bedrock of its sales through the 1980s and into the beginning of the 1990s. However, the market began to change and the trend towards outsourcing and focusing on core business began to take effect in the United States as it had done in Europe. Hughes shifted gears and the company moved inexorably into the provision of services rather than hardware in the US. In many parts of the world Hughes remains a very hardware orientated business, but in the United States and other key markets the reverse has become the case. The old charge that Hughes was simply not interested in small networks because it was out to sell boxes cannot be justified and Hughes itself vehemently denies that this was ever the case. In fact, we believe it probably was a valid point in the early days, but it is certainly not true today and has not been so for many years now.

Hughes' service and hardware businesses form a positive cycle of technology and solution development. The company has consistently introduced new offers based on its latest technology from the DW1000, which enhanced the support of multimedia applications for the PES platform, to today's HN9000, HT9000 and HG200 systems. The HT-series is based on the Jupiter Technology platform and brought significantly increased performance for the

consumer service on the Jupiter-1/EchoStar XVII satellite. In mid-2016 the company released its next generation system, the HG200, which incorporates DVB-S2X and substantially increases the throughput capabilities made available on the forthcoming Jupiter-2 spacecraft. The hardware products side of the business is inherently tied to customer applications because the HughesNet platform – indeed all TDMA VSAT systems – interfaces directly with the customer's applications and networking equipment. However, in the United States, Hughes has been moving proactively to incorporate new technologies into its offerings so that it is able to add greater levels of value to the services it provides. Its enterprise product suite also encompasses the HN9000 and HN9500 Spaceway system as well as its multi-service HX platform.

This integration of applications has moved into the mainstream of HNS' core service strategy and the company works with various providers of content, vertical industry specialists, software companies and application providers as part of its service platform. Whilst corporate networking retains primary position in the company's business, Hughes increasingly believes that it has to provide a fuller service based around a suite of value added solutions in order to maximise the potential of its business. The company plans to ensure that its value proposition is feature rich to the extent that one of its customers will buy networking and access services, but will also buy into a seamless solution which will deliver key applications, ranging from audio and video delivery systems to network technology innovations and security features. Indeed, it is evident that Hughes will take on business that could be seen as unrelated to its core, yet brings in high margin incremental revenue and further cements its relationship with its customer. For example, the company provides the WiFi networking and guest internet support services for Best Western Hotels. This is an activity that is certainly peripheral to the main business, but one that integrates well with the large VSAT network and media services it manages for the hotel chain and provides another reason for the customer to value Hughes as a partner able to provide a suite of integrated solutions.

This process is in active implementation, not just in North America, but also in HNS' other major service businesses in Europe (Hughes Europe), Brazil (Hughes do Brasil) and India (Hughes Communications India), and the company works to leverage the expertise it develops in one market to penetrate another. This is not an easy task for what once was once an engineering focused company, but the service mind-set has taken hold and Hughes' North American business is almost completely service orientated. Hughes set its future strategic direction in place with its ambitious Spaceway project, first proposed in 1993. After years of frustration, disappointments and delays, it was a real relief to see Spaceway-3 in commercial service and supporting both consumer and enterprise customers.

In its core enterprise networking business, the company does not target its service at any particular industry sector. It segments the business into two – those customers who have a primary network requirement for a VSAT service that cannot be adequately fulfilled any other way for which the competition is other VSAT system operators, and those that simply want a network solution, for which the primary competition is usually terrestrial service providers. In the past frame relay services were the primary terrestrial competitor for high quality, enterprise service, but today MPLS delivered through terrestrial broadband, such as bonded DSL-based IP/VPN services and dedicated T1 links, is the major competitive alternative being considered by customers as these technologies approach the service

quality and service delivery levels demanded by enterprises, mainly driven by the capabilities of MPLS. The company responded to the increasing interest in DSL services by introducing HughesNet Managed Network Services, an integrated broadband offering which incorporates its VSAT service with the best terrestrial services in a fully managed solution. Initially this only embraced DSL, but this quickly expanded and now includes leased lines as well as the whole range of wireless access services including EVDO, GPRS, 3G and 4G/LTE.

Hughes provides three major service options within Managed Network Services: maximum landline, maximum satellite, and price optimized. The latter provides a broadband managed solution by combining favourably priced ADSL and satellite broadband. Enterprises that desire the advantages of a satellite network, such as multicast, uniform service characteristics and rapid deployment can select the all-satellite option. Hughes is leveraging its industry-leading network management and service delivery expertise successfully into the fast growing managed network services market and, with its current VSAT-based enterprise business and is believed to rank in the top five of providers and comparable with AT&T and Verizon in terms of managed sites.

As the bandwidth supported on terrestrial services has risen, whether this be copper to fibre or 3G to 4G, and coverage has become more ubiquitous, so too has the use of the terrestrial infrastructure in preference to satellite. Whilst satellite continues to maintain some unique advantages, it has increasingly become less attractive to many enterprises as a primary solution and Hughes has responded to this by refocusing its strategy to position its North American enterprise business as a platform-independent managed network solution. However, VSAT experience, technology and service all retain a key role in the Hughes offer. At the experience level, Hughes has always had to manage end-to-end connections and application performance for its customers – after all, VSAT provides an independent, single point of contact solution with some unique characteristics that can only be controlled by the VSAT service provider. So, Hughes' products have always included a variety of features which help management of key elements of the network connection and application performance and this is leveraged in the company's service.

VSAT technology also plays a big role in Hughes' ability to deliver on its commitments to its enterprise customers. In an all-VSAT network, Hughes is able to manage service delivery to each individual port, but this is not the case for a terrestrial connection so the company developed the SR-series of devices – essentially a VSAT IDU capable of interfacing with a number of different terrestrial alternatives and supporting the same management capabilities that a VSAT connection provides. However, with a wide variety of different connection types and often erratic performance, terrestrial connections require additional levels of control and enhancement and so Hughes has developed a number of "Active" technologies as part of its HughesON business services. Three technologies – ActiveQoS, ActiveBonding and ActiveCompression are embedded in the HR4700 which evolved from the original SR-series. The HR4700 supports these Active functions in a security device manufactured by Fortinet, one of the leading vendors in the provision of enterprise protection including things like firewalls, IPS, application and endpoint control, intrusion detection and data leak protection.

Networking methodology is constantly evolving and, as one of the few companies that both provides service and develops its own technology, Hughes is in a unique position to address

and respond to these changes. A big movement today comes from Software Defined WAN (SDWAN) which moves WAN management and configuration to the cloud and removes the requirement for expensive, proprietary devices at each site. SDWAN is considered to be a revolution coming to networking and Hughes has been developing its own capabilities in this area and has already begun deploying this with several customers including Gap and Springleaf. The capability will be expanded to incorporate a wider range of connection types in the future. The company has also developed ActivePath and ActiveClassifier which will be incorporated into a new HR device and released in the latter part of 2016. ActiveClassifier examines the flows into the router and places data into different queues depending on the requirements and ActivePath creates intelligent multiple paths and application level policies and selects the best connection for any particular application.

The continued increase in bandwidth requirements is well documented and enterprise customers in the US are up at the front of this trend. Hughes informs us that it is not unusual for a customer to demand a minimum connection speed of 10 or even 20 Mbps currently – something that cellular or DSL simply cannot support. Along with its Active functions, Hughes is working on solutions that will incorporate its next generation Jupiter-2 capacity – a step forward for VSAT in that rather than just filling the roles of either extension or backup, it would augment and upgrade a network solution, allowing for customers to access 20 or even 50 Mbps downloads. ActivePath and ActiveClassifier will be part of this, assessing latency requirements and application types to route certain types of traffic over the appropriate connection and enabling a unified service. The Jupiter HTS capabilities promise to add significantly to Hughes' unique position in the market, but the company informs us that multicast remains a critical element in many customer deployments and so widebeam capacity will continue to be an important part of any solution. Whilst MPLS is able to offer some multicast functionality it cannot meet the scalability of VSAT. Hughes believes that its strong position in VSAT and the technologies it has incorporated in its solutions give it a unique advantage in the managed services market and this has already proven to be the key decision driver behind some recent large contract awards.

Even in circumstances where the customer selects a terrestrial solution, HNS has found that a good proportion of customers remain prepared to pay for the functionality and utility which VSAT brings as an overlay. Most large scale enterprise networks sold today now take a secondary rather than a primary connection role, but Hughes has maintained a great many of the enterprise clients it has on VSAT and sold several networks over the past few years where VSAT backs up a primary terrestrial network. This is part of a service it terms a High Availability Network or HAN, and may make use of one or more different technologies. It will, for example, provision a network with bonded DSL backed up with 4G, although this is not as diverse as a terrestrial/satellite combination. The task of selling a large customer with a distributed enterprise network on a VSAT solution has always been challenging simply because satellite is not mainstream – everyone knows the phrase "no one ever got fired for choosing AT&T" – but customers with existing VSAT networks have kept with the technology almost wholesale because they clearly see the value and have demonstrable results, some over many years of use. Both Hughes and its nearest competitor, SageNet (Spacenet), have had a very good track record in maintaining their long term customers and Hughes numbers big names, including Sherwin-Williams, Rite Aid, Bevmo and SpringLeaf, with VSAT-based HAN services.

The company informs us that there is also a very strong play in augmenting terrestrial locations by using interactive VSAT solutions to provide broadcast/multicast services with an error-check and monitoring capability to support media applications like training, product publicity, in-store advertising and staff television – the latter is a product Hughes sells as Break-Room TV. Obvious uses of VSAT for overflow and traffic off-load as well as back-up and disaster recovery have become vital for many organisations and even more important as enterprises have begun demanding tertiary networks – not just one alternative connection, but at least two. In these networks, there is little question that VSAT will be one of the technologies deployed. The company continues to believe the demand for these types of applications is strong and will remain so, with the diversity which VSAT brings, a strong and growing argument now that security and redundancy have been more firmly placed on the corporate agenda.

Some of the other major advantages of VSAT networks are that they can be deployed very fast, the mean time to repair is low and the capabilities of the product grow constantly. Hughes works with subcontractors to provide installation, maintenance and repair services and it maintains a close watch on monthly statistics which are generated (it informs us that this is a senior management overview responsibility) to monitor call-out rates and response times - all of which are said to be decreasing. A few years ago, the company took a hard look at the quality of service it was providing in these areas and found itself wanting. As a consequence, it introduced a web-based Extranet service which allows customers to monitor the status of their installations and repair call-outs, view trouble tickets, obtain real time status updates and even open new trouble tickets. HNS informs us that this service is well regarded by its customers and that it dramatically cut down the calls to the helpdesk - freeing up resources and improving the first level support to troubleshoot real-time problems. The company also points to its long experience with VSAT networks and the expertise which it has developed from its current customer base. For example, it claims that it has probably seen more applications, protocols and customer problems than any other VSAT operator and it is therefore in a better position to assist its users.

Hughes' VSAT product line has been constantly advanced over the years with greater features, improved efficiency and more power. The release of the 7000 series was an important one for the company and this has been followed by the HN7000S (DVB-S2) in 2006, the HN9000 in 2010 (adaptive LDPC), the HT1000 series in 2013 and, in 2016, the HG200 (DVB-S2X) series. Jupiter Technology forms the basis of the new system and the HT1100 terminal is designed around a Hughes-designed ASIC named Sahara. This uses a new wideband waveform, capable of supporting channels of 200 Msps or more with modulation rates up to 32APSK and IP throughput rates greater than 100 Mbps. For those who understand these things, Sahara is a megagate high-speed CMOS SoC with a multicore processor. For those who don't, this effectively means that the HT1100 has much more memory and processing capability than current generation terminals and is able to deliver hugely improved performance to meet the demands of today's users where the available bandwidth is often dominated by high speed video and third party networks which can overwhelm the lower rate, mission critical applications, such as POS. The HT system provides data rates able to deliver these services, but it is the AdvancedQoS capabilities on the HR4700 that ensure mission critical applications are prioritised. Hughes tends to shy away from talking about PPS (Packet per Second) performance, but from the 5,000 PPS that the HN series supports, COMSYS understands that the HT terminal supports rates of 60,000

PPS or more. Additionally, the HT uses Hughes' latest generation of integrated ODU which is not only smaller, lighter and more streamlined than previous generations, it only requires a single IFL cable helping to make the VSAT easier to install.

DSL may be cheap, but it is not an easy service to deploy and many users have found that carriers are unable to precisely define the level of service that can be provided at any particular location without actually installing the DSL modem. Enterprises can find a planned DSL service is unsupportable by the existing infrastructure and then face delays and unplanned expense in finding and installing an alternative. Additionally, rates and throughput are rarely predictable depending, as they do, on the load across the entire network. Hughes informs us that the capability which the HN, HT and HR family platform brings, coupled with the assurance that a connection can be delivered with guaranteed features and within a defined timeframe, has captured the interest of many customers that had previously been sold on DSL as the only solution. As proof of this, it has signed several customers who had been convinced that DSL was its only viable option before they tested the HT.

HNS clearly stepped back and designed an enhanced product which has the needs of the corporate customer in mind. HughesNet comprises a set of service plans based on the HT system. There are six "Enterprise Plans", four primary services and four "Access Continuity Plans" for backup services, which are pre-packaged to support specific sets of applications and service levels. The company greatly simplified the sales process for itself and its customers, who find the packages easier to understand and to use as a base to build additional capabilities into as they require. The conditions which HNS offers to its enterprise customer base are now more differentiated from its consumer services by structured packages defined by SLAs, QoS and the software suite supported in order to better focus on the specific needs of the company's core enterprise customer base at a basic level. The company also raised the game even more with Spaceway's unique capabilities and a series of service-based initiatives, including a new VNO service platform, based on its HX platform.

Spaceway was originally planned with an enterprise focus and therefore has a design which was intended to significantly expand the available market for VSAT services. Small businesses with a few tens of sites which have found the cost of backhauling their data to a hub site prohibitive with a traditional VSAT service are able to configure a private network within the system itself, networks can be created within networks and bandwidth intensive point-to-point applications become viable. Spaceway is part of the line-up of products and technologies in the HughesNet service portfolio in the United States. Hughes has designed a range of service plans mostly which mirror the current HughesNet consumer and enterprise plans supported by the HT system. However, Spaceway offers end-to-end Class of Service capability, which is incorporated into the service offerings that are designed to look very similar to terrestrial MPLS services. Customers select an ingress (transmission into the network) data rate and designate prioritisations by traffic type.

Spaceway's capabilities opened up new addressable markets for VSAT services, but the system ultimately became dominated by the consumer business and, with its onboard processing flexibility, provided a major competitive advantage for HughesNet. Nevertheless, Hughes targeted enterprise offerings at the midmarket in the United States with Spaceway providing a platform to address smaller users with a converged range of products providing

managed VPN (as part of a closed user group), point-to-point links (for applications such as video conferencing), direct connections with other Spaceway users (such as a security monitoring and controlling CCTV cameras) and disaster recovery. All of these services can be provisioned with different classes of service, landing at different locations and at different data rates. A number of networks have been deployed ranging in size from a handful of sites to several hundred – for example, the IGCN (Inter-Governmental Crisis Network), supports HD videoconferencing on demand, some state Homeland Security networks have been implemented and FEMA used the system during Hurricane Sandy. The system allows T1 access to be dynamically allocated between sites – something that no other technology can provide without permanently assigning bandwidth to the network. Hughes informs us that it has interest from customers that are looking for a diverse back-up for their MPLS networks, others that require a replacement for T1 connections as well as enterprises that favour a private solution that is totally separate from the Internet. Spaceway's capabilities bring greater flexibility and almost liquid bandwidth to any application that has an ad-hoc need for instantly switchable high data rates. Various video applications, increasingly deployed in IP form, are a natural fit for the Spaceway service.

A combination of strategies to address the needs of the mid-market and related franchise opportunities remains a strong priority at Hughes and the past few years have seen progress. Opportunities within the franchise segment remain attractive and the company has had some encouraging success in this area which it targets with direct sales rather than through partners. It has some advantages in this because it already serves the core corporate needs of some very large brands like Yum!, Chevron, Denny's and ConocoPhillips. A number of large enterprises have been selling off their corporate sites leading to an increase in the amount and size of franchisees to the extent that some have described them as "the new majors".

Aside from technology, if there is a secret to the company's success in the US market for both shared and private hub business, it is its approach to sales and marketing. Hughes has over 20 sales people across the country whose job it is to follow the major accounts in their area and build relationships and knowledge with each of them. It operates primarily in a geographical organisation, but it also has specialised sales teams for specific areas of business. When an account comes up for renewal, whether it is specifying a VSAT service or not, Hughes is already positioned and informed. A specialist technical sales team is then sent in to close the sale in combination with the sales person. Thus, it is not uncommon for Hughes to sign contracts based on RFPs that its primary VSAT competitors never even see. All of the other operators are either locally based and industry focused or, in the case of the main manufacturers, only have a small group of two or three sales people. Frankly, Hughes' professional approach marks it head and shoulders above the rest and it is no secret that it is the model that Spacenet adopted after being acquired by Gilat.

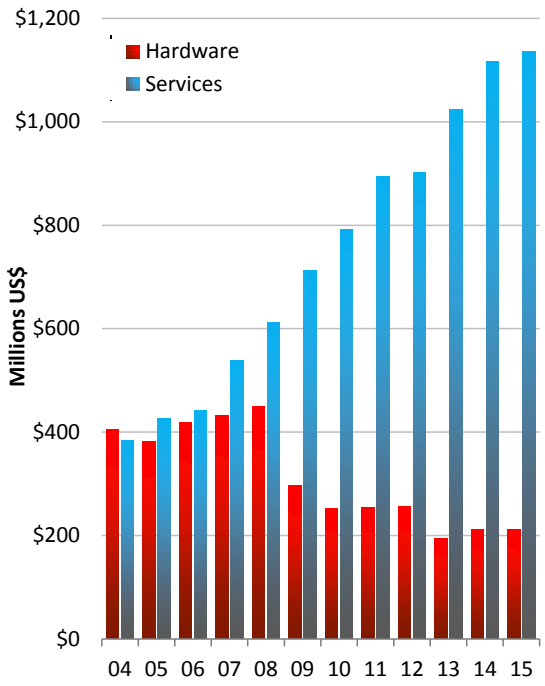


Figure 35 - Hughes Service & Hardware Revenues 2004-2015

Hughes' organisation in the United States is now inherently service oriented, with the culture now focused on service revenues, not the number of terminals. In fact, service has become an overriding corporate strategy, with the development and production of hardware seen primarily as a means to deliver on the services it sees being demanded and obtain a competitive advantage over its largest rivals, now companies like Verizon and AT&T. This is illustrated publicly, at least to some extent, in the company's last published revenue breakdown between hardware and services which saw hardware dominating in the early years, a 50/50 split between 2004 and 2006 and then an ever growing proportion from service which accounted for 75 per cent of revenues by 2010 – a trend we believe has continued since then.

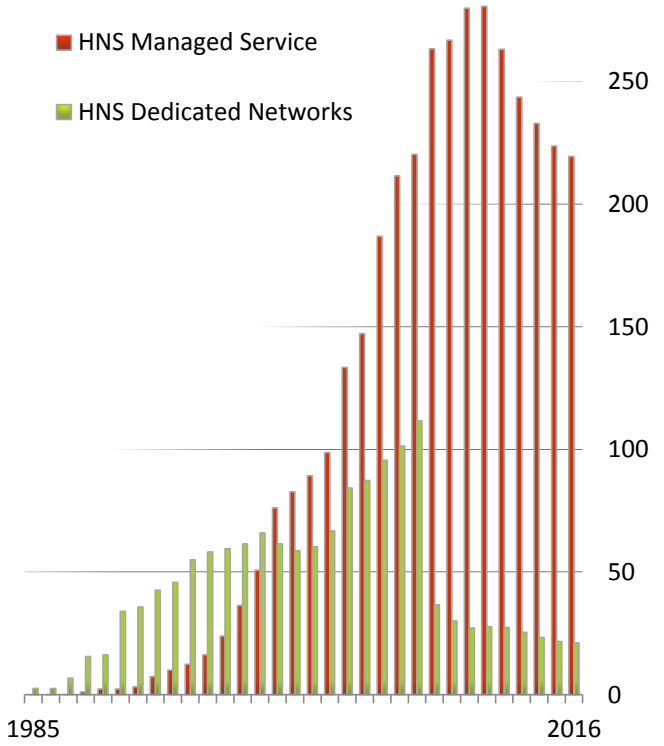


Figure 36 - Hughes Sites in Service in the US, Managed versus Dedicated

Figure 36 illustrates the same point, but in numbers of sites in service. Between 1995 and 2010 the company's business in the US grew much more strongly in its managed services portfolio as compared to the private networks in operation. With the move by GTECH to place its dedicated hubs under Hughes' management, the company suddenly had ten times more sites supported on its own shared service than on its once numerous customer-owned and dedicated hubs. Bear in mind that these figures do not include any equipment Hughes has sold to other shared hub operators in the US. Whilst the past few years have seen a decline in the total number of enterprise VSAT sites in service this is no different from what the vast majority of VSAT operators have been experiencing across the world. However, a big difference does exist – many of Hughes' clients still remain with the company, but now rely on Hughes' terrestrial integration solutions more than satellite. For example, Yum!, which has been a Hughes customer for almost 15 years and which once had more than 6,000 VSATs deployed now has fewer than 200 and yet Hughes continues to serve the same number of sites for the company through its hybrid

managed services. This clearly says something about Hughes' performance and its foresight in evolving its service strategy.

2007 saw Hughes begin diversifying its enterprise services business in North America. For many years, the company focused on providing large scale corporate WAN services to businesses with many sites scattered across the country, spending little attention on the smaller, yet higher value niche segments of the market typified by more granular quality of service, higher committed data rates, more specialised application integration and other features, like mobility. Hughes first addressed this segment of the market when it introduced the HX system in 2007. The HX is a platform based on the HN, but with a completely different QoS engine and various other features, such as the ability to use third party RF and support for spread spectrum and mobility. Service initiatives coupled with several key partnerships are designed to leverage the increased functionality of the HX in several targeted verticals. These include the aeronautical business where Hughes provides service to Global Eagle (Row44), maritime and offshore O&G VSAT service primarily with Bluetide and products designed to address the land-based drilling market, through other partners and various civilian and government initiatives. Hughes has been selling its service with transportable auto-deploy antennas for several years now, but more recently it has been working with different types of mobile antenna systems ranging from stabilised maritime antennas from KNS, Cobham and Intellian to low profile comms-on-the-move (COTM) systems from the likes of RaySat and General Dynamics. In the future it plans to add its Ka-band Jupiter-2 capabilities to these solutions and has publicly stated its intentions to develop a dual band Ka/Ku aeronautical antenna which will be deployed with its latest HG system to enable this service.

In 2012 the company launched its High QoS Service, a high capacity managed service which allows for any type of customer – whether this be an end user, third party operator or specialist VAR – to operate a high QoS network based on dedicated capacity. A variety of pre-packaged services which range in rate from 128/512 kbps to 1/5 Mbps are supported, but the VNO is able to configure their own service profile if desired. Running on three satellites – G18, Horizons-1 and Satmex-6 – from a hub located in Las Vegas, the High QoS service offers coverage from Alaska's North Shelf across the continental US and down to southern Argentina. We understand that this initially saw good growth in the land-based drilling market, but in line with every other operator in the highly pressured O&G business, this segment has declined substantially. Hughes tells us that a number of other operators and specialist VARs have signed up to the service, some of which take an active role in the management of their network – which is assisted by the HX ExpertNMS that is bundled into the offering – whilst others focus on sales, marketing and serving the remote sites, leaving operation of the NOC to Hughes. Customers have the advantage of being able to buy as individual links all the way through to large networks and full visibility is provided, allowing them the ability to provide monitoring, reporting and troubleshooting tasks without the burden of any capital outlay.

The HughesNet consumer service is dealt with later in this section, but Hughes has aggressively gone after the more demanding SME and SoHo sectors with a VAR program and is working with various vertical industry specialists to expand its sales channels to address more granular markets made up from SMEs and even SoHos and attempting to standardise its service products to allow greater scalability. It continues to believe that a large

opportunity remains with the "middle market" – networks of between 10 and 100 sites – but real penetration has remained elusive and the company's strategy now hinges on its VAR and VNO offerings.

In the traditional business, Hughes has managed to capture prime position in most of the major segments. In the fast food (quick service restaurant or QSR) segment it has sold networks to Carl's Jr, Jack-in-the-Box, Pizza Hut and Denny's amongst others. In the gas/convenience segment it provides services to many of the major downstream franchises and in the retail segment it serves many major names including CVS, Rite Aid, Sears and Walgreens (which will have been a Hughes customer for 30 years in 2017!). Every win placed the company in a stronger position as new network opportunities emerged until it came to dominate the segment – a strategy that Hughes pursued with aggression for many years. Growth of VSAT as a primary solution has essentially stopped, but as the company's strategy has evolved with the market's demands for hybrid solutions it continues to retain many of these customers. The issues with some large enterprise businesses revolve around the percentage of company-owned versus franchise stores, the former being far smaller in number than the latter, but traditionally the part of the business which makes central decisions. However, with the trend of selling off corporate retail sites mentioned above, the decision making process has begun to shift away from the brand owner. In addition, as the technology has evolved, so have the potential applications which range from debit card authorisations and standard back office tasks to automated menu updates and kiosks. The company believes that its customisable web portal allowing online ordering and fulfilment for the connection of an individual franchise is one of the drivers behind its success in this area. Its HughesNet Managed Network service has also helped it retain its strong presence in this segment.

The almost wholesale move by enterprise customers to IP and browser-based applications has also driven demand for much higher data rates. Hughes believes that its consumer initiatives, first through DirecPC and now through its HughesNet services, have allowed it to bring significant cost advantages to the enterprise market through the enterprise derivations added by its HT system. As a result of the major upgrades and renewals that customers have undertaken over the past few years, the HN and HT systems now account for more than 90 per cent of all the terminals Hughes operates under its managed services. Hughes has managed very successfully to defend its long established customer base – with several renewals of both its shared and dedicated accounts over the past few years and extensions, both in terms of number of sites and applications supported. Important accounts that have been upgraded and extended over the past two years include CVS, Lowes, Denny's, Sherwin Williams and Delhaize.

Another area of interest is business IPTV and digital signage with many retail customers having some form of active project. In early 2008 Hughes announced its acquisition of Helius, a specialist applications provider that focuses on the IP video market. This followed a process of integrating Helius' technology into Hughes' managed service infrastructure to support digital signage and other IP video applications. The results were a considerable success with several thousand sites being sold during the first half of 2007, laying the basis for the successful bids to provide the SSA and GETN networks in 2008. In 2010 Helius was fully integrated into the Hughes organisation, becoming the Hughes Solutions Group and taking responsibility other related capabilities, such as WiFi solutions and WAN optimisation.

The Solutions Group has had some success selling managed management communications, employee engagement, content delivery, training and distance learning applications into the enterprise market in a customer penetration strategy that is able to cost justify a VSAT platform, just as a VSAT network sale can open the door to a media service. IPTV networks have increasingly favoured an interactive solution as delivery of content to storage devices at remote sites for later use requires acknowledgements and checks to ensure reliable receipt.

Helius had developed a hardware-based solution – the MediaGate Router (MGR) – to host its media services and Hughes has further developed this platform to act as a Linux-based virtual machine and, after initially calling it the Hughes Branch Server, in 2013 the product was re-branded as the HS3400. Additional networking features and functionality are provided through the previously mentioned HR4700 and all are bundled into the HughesON Managed Network Services solution suite. A good customer example of this service is Cabelas, a small, 35 site retailer that has deployed a system both at the back – for upgraded break-room entertainment for staff – and the front of the store, for digital signage. Another important area for the media side is employee retention – something that a successful internal communication system can considerably influence and help reduce staff churn which, in turn, can save big retailers millions of dollars. One of the company's key customers in this area is the national retailer, Kohls.

Variations of network solutions – access continuity, high availability and optimised networks, all value propositions that combine the use of VSAT and terrestrial – are also growing in demand. The company's DSL solution was an intense learning curve as it discovered that issues that can be relied on with a high degree of confidence in its VSAT service are a long way from being the same in the terrestrial world. VSAT has a solid dependability and cost structure, but around 90 per cent of Hughes' proposals currently involve some element of terrestrial infrastructure and considerable resources have been spent expanding the coverage of its DSL options and integrating its service with suppliers. It has also integrated DSL routing capabilities into its HN indoor unit allowing it to deploy the same modem with the same management features to different customer sites regardless of their primary connection.

Hughes Network Systems has led the VSAT market since its inception. The company dominated the systems supply side for many years and moved smoothly into a full service model - hardly breaking stride in the process. Today, the sheer size of its enterprise service business raises issues of long term customer management and ongoing resource allocation for which the company has faced criticism in the past. We believe that Hughes' review of its business 15 years ago was a very beneficial exercise for the company and its recognition of the problems and subsequent positive actions to correct these issues with its increased post sale services and facilities was critical and has formed the basis of its corporate philosophy today. The company's path towards a service culture, as opposed to its hardware foundation, has continued to develop, but it remains an engineering company at its core. This is no bad thing because its technology truly drives its competitive position and gives it some unique advantages.

In terms of competition, Gilat was always present through its Spacenet US service subsidiary, but this changed somewhat in 2014 when the company was sold to Sagenet, a managed

terrestrial service integrator. Since then, SageNet's presence in the VSAT market has declined substantially and although it continues to maintain several large customers and operate many tens of thousands of sites, it is rarely seen in the wider enterprise network bids. As Spacenet, the company tried to refocus on more generic managed services and it even developed a product – the Prysm Pro – that has little or no relation with VSAT services. However, as innovative as it tried to be, it always lacked both the scale and resources of Hughes. It did though, manage to profit from competitive customers desire to avoid placing orders with the supplier of their main competitor. The lottery business is a case in point – with GTECH as its customer, Hughes was virtually excluded from other lottery customer bids. To be fair, Spacenet did a good job with the large lottery networks it supplied although we understand that many of its sites have now converted to a cellular solution. Nevertheless, Hughes clearly had to pay for its success with GTECH. SageNet remains very firmly number two in the US enterprise VSAT market in terms of the number of sites it operates, but it has no real hope of ever substantially closing the gap.

Whilst SageNet continues to participate in some key large enterprise segments, it has been trying to step around head-to-head battles with Hughes for much more than five years and now both companies tell us that they rarely see each other in direct competition. ViaSat had an enterprise managed networks offer branded Immeon, but as an engineering-based company it struggled with the whole concept of service. During 2010 the company finally gave in and, after weeding out the worst elements of its subscribers, sold the business to a long-time partner, X2nSat which now operates around a few hundred sites for the remaining customers. The one other player that has emerged and is now arguably Hughes' largest competitor is Verizon, which seems to have integrated VSAT into its solutions – a rare occurrence for a terrestrial carrier the size of Verizon. Ironically, the company first entered the VSAT business when it was MCI and ran a service based on a Hughes hub!

One interesting point that is likely to become very important over the next few years is the fact that Ka-band and spot beam satellites are probably going to grow to become a critical element of delivering high bandwidth connections – minimum of 10-20 Mbps as previously mentioned. If this trend does indeed take hold (as we believe it will), then as one of only two players in the US market with HTS satellites, Hughes' unique position will be further reinforced. With no other option available to extend high bandwidth service into poorly connected areas, the likes of Verizon, AT&T and Comcast will probably be forced into finding a deal with either Hughes or ViaSat. ViaSat has been slowly building a specialist corporate service on its Exede/ViaSat-1 consumer internet platform to be sold by specialised VAR and operator partners. This service is now running, but we do not think there to be more than a few hundred sites in operation, not including the Yonder aeronautical and military service and KVH's maritime service which run on the same ArcLight global hub infrastructure. However, the aeronautical market is one in which Hughes and ViaSat will come head to head, especially as both plan to make use of their next generation of Ka-band satellites in this segment.

Hughes' move to upsell its position in the networking business was a natural one and the company has substantially developed the scale and sophistication of its service over the past five years. This is clearly now the future for HNS' enterprise service business in the United States and whilst its VSAT/terrestrial site ratio is currently around 4:1, this is clearly changing – it was 5:1 three years ago. COMSYS has long held the view that, of all the potential

providers, VSAT operators have a far greater skill set and longer term expertise than almost any other company to exploit the opportunities for application outsourcing and content contribution in many of its forms. As the largest and most successful operator, it therefore follows that Hughes occupies the best position to achieve success with applications-based solutions and we believe that not only has it seen some real and significant progress since 2011, it represents a significant upside for the company going forward and really shows how the advantages and expertise developed in the VSAT services arena can be leveraged.

The precise reasoning behind EchoStar's acquisition of Hughes was the subject of much debate, but Hughes moved quickly to inform the market that there would be no great changes in its approach to its business and this has generally proven to be the case. EchoStar is more guarded in the information it reveals about its business which gives less in the way of visibility, but it is clear that Hughes' management continues to provide the vision and leadership that were the hallmarks of the business before the change of ownership. Whilst there have clearly been areas in which EchoStar has contributed to Hughes' development, these have mostly been seen in the consumer side of the company's activities. By contrast, we see Hughes' contribution to EchoStar as being of far greater range and worth with a great many of Hughes resources now being extensively used by its parent ranging from its HR functions to its long term, established presence in Brazil. EchoStar is now one of Hughes' sales channels, but surprisingly it also remains a sales channel for ViaSat's Exede product and DirecTV is now a distribution partner for HughesNet – both results that would have been hard to predict five years ago. It is also interesting to note that, based on EchoStar's investment calls, Hughes now contributes pretty much all of the combined company's growth.

From the earliest days, HNS was prepared to take calculated risks in a venture in one area of the market based on its strength in another. Spaceway and Jupiter were two further steps in this process representing on the one side a visionary project which has the potential to really revolutionize the VSAT market and, on the other, a commitment to provide the lowest cost bandwidth possible for an ever-demanding consumer market. It is wonderful to see that the company's vision and innovation has not changed and that it continues to pursue projects that push the envelope and offer revolutionary new concepts. The best and highest profile example of this was the announcement of Hughes' investment and participation in the OneWeb LEO project. Promising high bandwidth, low latency global coverage with a low earth orbit constellation of 648 satellites by 2020, OneWeb has the potential to dramatically change the current satellite market. Whether the project meets all of its targets remains to be seen, but Hughes is developing its network and gateway system and will also be a service partner. The COMSYS view is that it is most likely that OneWeb is first deployed in the enterprise segment of the market than the consumer, but regardless of this, Hughes will be a critical element in the company's success both in the US and other international markets where it has a strong service presence – India, Latin America and Europe.

HNS is an impressive business whichever way it is viewed. The company has led the market in terms of sales, services and technology for over 30 years and it is no mean feat to maintain a leadership role whilst also sustaining high levels of customer satisfaction and account retention. The company's US service business has not only managed to hold its ground, but pull away from its competitors under extremely trying economic conditions. This is partly due to the business' strength in depth from engineering to sales, but also to the

carefully considered and targeted investment course its management has steered during both boom and bust years. Commitment to the staff, the technology and the business are all traits we see in Hughes management.

The enterprise networking market in the United States continues to be a hard one as price pressure mounts and new terrestrial solutions address some of the vulnerabilities which VSAT technology has been able to exploit in the past. It is not uncommon to hear the view that satellite services will soon be relegated to remote regions where fibre will never reach. However, year on year, Hughes has managed to prove that VSAT services can both survive and prosper in one of the most advanced and competitive telecoms markets in the world. Whilst it is true that VSAT is much less frequently now considered as the primary networking option for most enterprises, Hughes has successfully exploited its market leadership in the satellite market to build a major managed services solutions business and maintained both its customer base and its use of the technology as a unique selling point.

The HN platform raised the company's capabilities in 2005, in 2006 the HN7000S further increased both performance and efficiency, in 2007 the HX brought new QoS features, in 2008 Spaceway introduced amongst the most advanced networking features available to any communications medium, in 2010 the HN9400 raised the standard for efficiency and processing yet again and in 2016 Hughes was the first to bring a TDMA DVB-S2X system to the market with its HG200 gateways and HT2000 terminals. What is all the more impressive is that most of these product platforms are based on the same hardware architecture, giving Hughes massive advantages in terms of manufacturing scale, CPE cost, operational experience and service interoperability, not to mention R&D.

In the broader context of all managed services, Hughes' current enterprise business, which manages 220,000 sites and well over 300,000 connections, ranks alongside the largest carriers in the United States. Additionally, the company provides a unique combination of technology and service delivery capabilities which allows it to service small, highly specialised mobile applications to some of the largest distributed enterprise networks in the world. It has achieved what it has through a combination of technology development and service delivery, balanced with a keen appreciation of the price points demanded by enterprises. Its management and strategic decisions however, have been the ultimate key to its success and many difficult decisions which it had to take in the past are validated by the dominance and success of the company's business today. With Jupiter-2 now on its way, Jupiter-3 in plan and OneWeb developments ongoing the future prospects pipeline is full. Not only has Hughes managed to stay ahead in terms of consistent leadership of the market, it has also built a huge upside into its future with a vision and a tenacity that is showing sophisticated solutions to complex networking and catalysing growth in its North American managed services business.

7.2. HughesNet Consumer Services

Hughes pioneered satellite broadband services to the consumer with the launch of its one-way, high speed DirecPC service in 1996. The service was largely a learning experience for the company, but still reached almost 120,000 subscribers at its peak. The company began to work on the solutions to the problems identified by this first service with a two-way version which was eventually launched as the DW4000 system. By 1999, in the heat of the Internet and telecom boom, there began a race between Gilat and HNS to bring a two-way consumer Internet access service to the US market. Gilat launched its huge 10,000 site trial during the first part of 2000 and announced its StarBand service in November of the same year. Hughes seemed in no hurry to react to StarBand and, whilst its competitor cobbled products together to get to market, Hughes finished the development of the DW4000, ran a small 500 site trial and commercially launched the HughesNet service in June 2001, perhaps no more than a few months after the SkyBlaster 360 was deployed.

The HughesNet consumer service had several major advantages over StarBand. It has always been an integral part of Hughes Network Systems and can therefore take advantage of all the resources and synergies available from a company with the largest VSAT service and hardware business in the world. It could learn from the experience gained from the DirecPC service, it had an established dealership network to tap and it had a large subscriber base as potential upgrade customers. The company had already signed up several large partners for the service which now boasts approximately 1,000 resellers in the US, Canada, the Caribbean and Central America.

StarBand's early mover advantage really backfired as it was forced to swap out many of the interim units it had in the field and the company quickly lost momentum as Gilat itself ran into financial difficulties. Nevertheless, the economics behind a two-way satellite Internet access service business using standard Ku-band FSS capacity are as real for HughesNet as they are for StarBand. Considering the rivalry which has always existed between HNS and Gilat, it was interesting to note that one of the few things that both CEOs of the two companies agreed on was that a service of this type needed to be able to load 20,000 users on a 36 MHz transponder. In neither case was this the outcome and, although both companies avoid talking about their experiences in this area, the general belief is that the actual subscriber loading that was achieved was closer to 12,000. This means that both had to work hard to control operational costs, automate as many processes as they could and enhance bandwidth efficiency wherever possible. Of course, this issue was rendered moot when Hughes' 10 Gbps, multi-spotbeam, Ka-band Spaceway-3 satellite was brought into commercial service in 2008 and then followed by the Jupiter series of spacecraft that began in 2012.

As financial market conditions worsened through 2001, Hughes' strength in depth made a telling difference because HughesNet was been able to maintain its momentum whilst StarBand stagnated and declined. Like StarBand, Hughes rationalised its business, introduced better and more efficient CRM, OSS and automated online ordering systems and concentrated on reducing the service's cash drain. By 2003 it informed us that HughesNet was financially neutral. In 2004 we believe that it actually began to generate cash as customers maintained their service past the initial contractual 12 months and the business

reached a critical mass. Hughes was able to leverage its existing resources to take the burden off other indirect costs and, whilst active marketing was cut back significantly, it did enjoy the benefit of advertisements on its (now ex) parent's DirecTV network to sell the service.

Given these factors, it would have been understandable to expect growth of the service to have slowed to a trickle and perhaps even to have stopped as new additions were eaten away by churn of the existing base. This was the case at StarBand, but the HughesNet service continued to grow strongly. The DirecPC one-way or "Classic" service was discontinued as an active offer at the beginning of 2002 and HNS increased the price of the service and introduced incentives as part of its active encouragement to its original DirecPC customers to move or upgrade. DirecPC was shut down in 2004 – although we were aware that the final hard-core users looked like they would have to be forcibly removed! By the end of 2015 the company had exceeded one million HughesNet subscribers and had more than 350,000 customers than its nearest rival, ViaSat's Exede service, despite supposedly having less bandwidth on its satellites. Some of the HughesNet subs are high-end business broadband users we classify as part of the company's enterprise service.

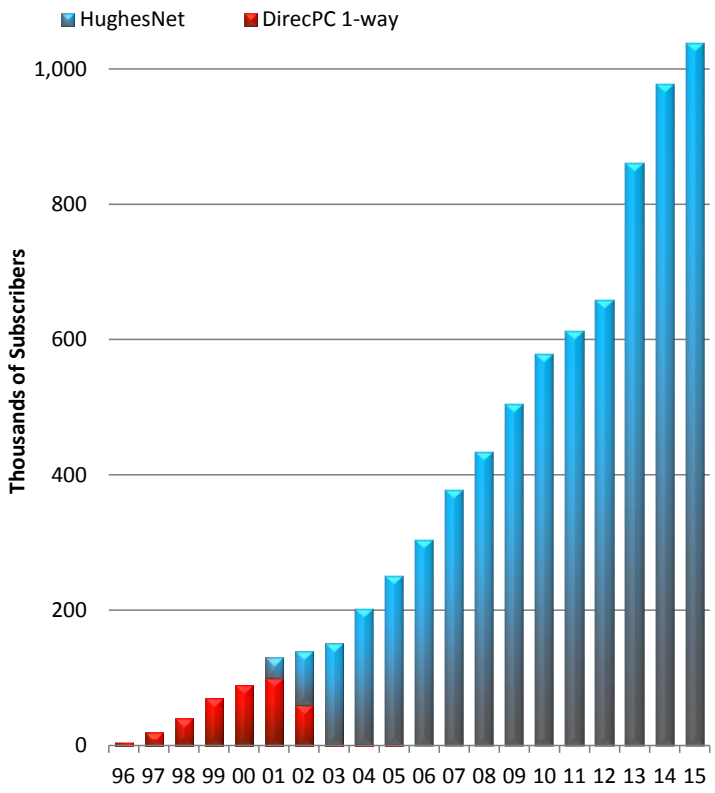


Figure 37 - Estimated DirecPC/HughesNet Subscriber Growth to end-2015

Monthly subscriber additions have varied widely year by year as the available capacity became more saturated. At its last peak when Jupiter-1 came into service in 2013 the company was adding new subscribers at rates of about 20,000 per month, but this has since slowed to virtually zero leaving the company to sit on its hands and wait for the advent of Jupiter-2 in 2017. ViaSat faces the same saturation issues on ViaSat-1 and is kicking its heels until ViaSat-2 comes into service.

We always had our doubts about the long term viability of a consumer targeted satellite broadband service based on standard Ku-band space segment. We have good reason to believe, however, that Hughes' consumer service began to generate cash in 2004. It took the muscle of the market leader to achieve this and, to our knowledge only StarBand managed to emulate this on a much smaller scale for a short while – Gilat reported that StarBand generated a positive EBITDA of just under $1 million in 2004, but it saw continued decline over the next ten years and was finally shut down by SageNet in 2015. However, Hughes benefits in many more ways than the isolated instance of a consumer service. To begin with the manufacturing

volumes, consumer service demands have a positive cost implication across all of the company's VSAT product lines which, as previously mentioned, are all based on the same software architecture and basic hardware components. Additionally, these shipments are relatively predictable, unlike the enterprise business which remains very project driven, which also leads to lower manufacturing costs. With the HughesNet consumer service, HNS' quarterly shipments are believed to have consistently achieved run rates of around 70,000 VSATs, giving the company a huge edge over the rest of the market.

In 2005, the primary HughesNet consumer platform was upgraded to the HN7000 model and in 2006 DVB-S2 ACM capability was added in the form of the HN7000S, bringing major increases in bandwidth efficiency. This came just in time, because by 2006 WildBlue's Ka-band service, based on a frequency re-use spot-beam satellite, was beginning to achieve traction in the market and Hughes was able to respond with sharper pricing plans, higher transmit speeds and more bandwidth allocation. We had expected WildBlue's ramp-up to be faster and have an adverse effect on Hughes' service, but neither turned out to be true. It really wasn't until 2006 that WildBlue began to add subscribers in any kind of quantity and only by around mid-2007 did it exceed Hughes' monthly net additions. Indeed, as WildBlue began marketing its service, the effect was to raise awareness about satellite broadband generally and this also helped lift Hughes' sales. The truth is that subscribers really don't know or care about the underlying technology, making their purchase decisions spontaneously or for reasons unrelated to the service itself. Nevertheless, with its bandwidth costs substantially lower than Hughes as a result of both its satellite technology and the fact that it owned its own spacecraft, WildBlue's service was always likely to overcome Hughes' Ku-band offer.

Of course, this all changed with Spaceway which not only brought similar Ka-band spot-beam technology to HughesNet and the benefits of satellite ownership to Hughes, it added considerable flexibility to Hughes' ability to manage the capacity with its ability to reconfigure bandwidth coverage across its footprint. Whereas, with its fixed design, WildBlue was forced to suspend service in several high demand areas as its beams were filled up. The on-board processor in Spaceway by contrast, was able to assign between zero and 400 Mbps to each uplink cell whilst the satellite only concentrates its 24 440 Mbps downlink beams where traffic is routed.

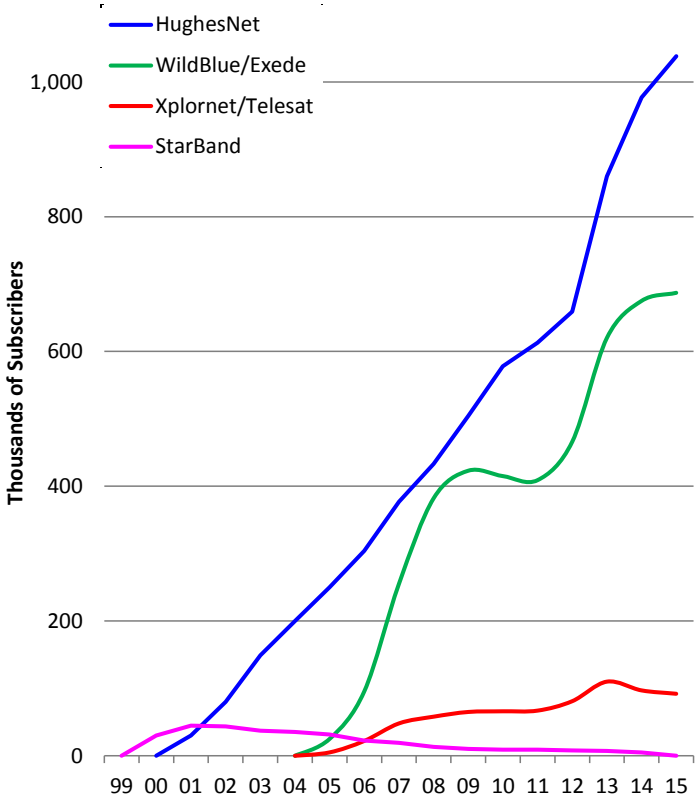


Figure 38 - North American Consumer VSAT Subscriber Service Growth Comparison

If ever there was a graphic illustration of the need for Jupiter-2 (EchoStar XVII) and ViaSat-2, Figure 38 is close to being the one (it would only possibly be better if, rather than subscriber growth, it charted bandwidth sold). The abrupt halt of WildBlue's growth is evidence of the insatiable demand for internet access and the slowdown of subscriber growth for both Hughes and ViaSat as their satellites ran out of useable capacity is very evident in 2010-12 and now in 2016. What is also particularly interesting is the absence of any kind of impact on Hughes' subscriber growth when either WildBlue launched or ViaSat's Exede service began on the new ViaSat-1 satellite. Ironically it was the launch of Spaceway that impacted Telesat's services in a far greater way. Following the launch of Spaceway, which extended the HughesNet service into Canada based on an agreement with Xplornet, Telesat's major reseller at the time, Xplornet went on to contract for all of the Canadian Ka-band capacity on Jupiter-1 and ViaSat-1 and has since migrated most of its original Anik-F2 customers to these platforms.

Hughes has also had to manage a complex series of transitions. From a point when the company was reportedly adding two Ku-band transponders per quarter to feed its subscriber growth and had close to 100 transponders in service, Spaceway took up the load and was believed to have been serving over 500,000 consumers at its peak in mid-2012 when Jupiter came into service. So the tricky balancing act that required the consolidation of remaining Ku-band subscribers to release whole transponders back to the satellite operators was clearly accomplished. With the launch of Jupiter-1 (EchoStar XVII), Hughes then had to free up capacity on Spaceway to allow for the upgrade that came with its Gen4 service and leave room to grow in the regions of the country not covered by Jupiter-1. Today, we understand that the vast majority of subs are on Jupiter-1 and that only a handful of subscribers are maintained on Ku-band – an option that has been retained in order to ensure that any obstacles to using Ka-band, such as blocked views to the satellite, can be circumvented by using an alternative Ku-band satellite.

In terms of the consumer's viewpoint of these transitions, the only change has been for the better. In mid-2008 Hughes raised download speeds to a minimum of 1 Mbps on all of its services rising to 3 Mbps on its top plan whilst maintaining the same prices. Along the way, as a result of the broadband stimulus award from the US government – Hughes was the only satellite provider to get a national award which, at $58.7 million was three times higher than any other – the company was able to offer free equipment and activation to over 106,000

households. In late 2012 following the launch of Jupiter-1, the company announced its Gen4 service which more than tripled maximum download speeds and bumped monthly volume thresholds up. Currently it has a range of plans for consumer and business customers running from the basic service of 5/1 Mbps and 10 GB to the highest offer for business users of 15/2 Mbps and 40 GB.

The company periodically runs limited introductory discounts and rebates, but interestingly, both Hughes and ViaSat believe there to be a huge untapped demand for satellite-based broadband services and there is therefore little incentive to reduce pricing to encourage greater levels of growth. Indeed, the opposite is probably true, lower prices could unlock demand which neither company could meet without building more capacity. Back in 2013 we stated that, with the growth that Hughes was experiencing for its Gen4 service, the biggest question was whether Jupiter-1 and Spaceway combined would have enough capacity to maintain the service before Hughes next satellite, Jupiter-2/EchoStar XIX, is launched bringing a further 200 Gbps in 2017. The answer now is evident – no!

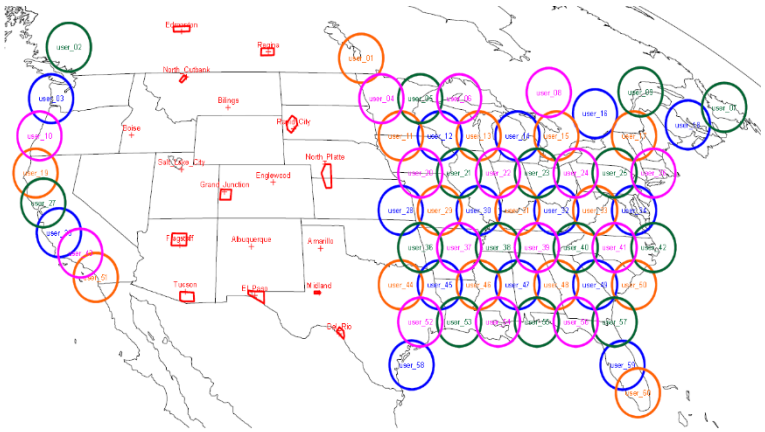


Figure 39 - Hughes Jupiter-1 North American Coverage

With more than ten times the capacity of Spaceway focused on the high demand areas of the United States (see Figure 39), Jupiter brought 140 Gbps and enabled Hughes to significantly enhance its services for the consumer market. With forward service plans delivering up to 15 Mbps, VSAT broadband service can, perhaps for the first time ever, provide a service that meets or exceeds the capabilities of DSL in many areas. The idea of being able to compete with DSL, attractive as it might be to some, is not something that Hughes thinks is either necessary or smart. It believes that enough demand exists within the estimated 15 million unserved households in the US to more than fill the Jupiter satellites (and ViaSat combined) and that provision in DSL-covered areas only leads to higher churn rates.

Both companies have announced intentions for additional consumer-focused, multi-spot beam satellites. As mentioned above, Hughes expects to launch its next generation, Loral-built Jupiter-2/EchoStar XIX satellite in 2017 and ViaSat's Boeing-built ViaSat-2 satellite will also go up in 2017. Alongside Jupiter-1 entering commercial service, Hughes had deployed a new set of gateways for its new consumer VSAT system, also known as Jupiter. It will now be in the process of building out a new set of additional gateways for Jupiter-2 and, whilst Jupiter-1 uses the HT1100 terminal, Jupiter-2 brings the latest HT2000 and HT2000W terminals to the market. Both systems use a powerful Hughes-designed ASIC which support wideband waveforms, capable of supporting channels of 200 Msps or more with modulation rates up to 32APSK and IP throughput rates greater than 100 Mbps. The latest HT2000 system with the HG200 gateways adds the more efficient DVB-S2X to the outbound channel – the first commercially available S2X platform which was released in July 2016. The system has proven that it has more than enough horsepower to sustain the growth in consumer

service demand that has been experienced and which is increasingly driven by high speed video streaming applications. At the same time, the platform carries a strong suite of QoS capabilities and during 2013 Hughes took advantage of this when it launched its VOIP consumer service.

As mentioned under the section covering Hughes' enterprise business, the precise reasoning behind EchoStar's acquisition of Hughes was the subject of much debate. It is now evident that the biggest impact has been on the consumer side of the business – the addition of DISH Network's distribution strength to the HughesNet service has increased sales presence and helped growth. EchoStar itself has been very active in the Ka-band world, having launched several satellites with Ka-band payloads, and has long flirted with the idea of a satellite broadband consumer business. It clearly has a strong focus on consumer markets and a deep expertise in media-related businesses and DISH has subsequently bundled its DTH television service with the consumer internet access service of its sister company. Some industry analysts believe that the days of high growth are largely over for the major DTH platforms in the US and that the internet and video-on-demand will become increasingly important giving Hughes a key role in the future development of DISH Network's business.

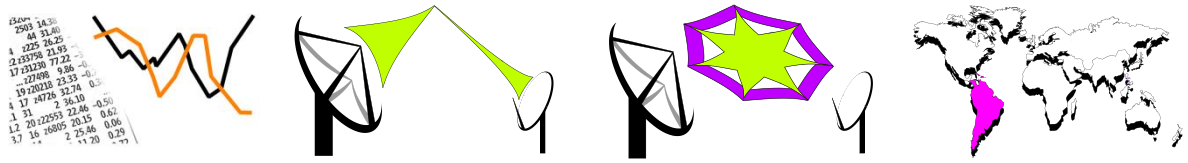
At another level, EchoStar is known to have international ambitions. To date, these have been mostly confined to hardware supply, but Hughes has a strong service presence in several key markets – India, Brazil and Europe. For several years Hughes has been evaluating the prospects for a Jupiter-like Ka-band satellite for India and a similar prospect for Brazil was talked about following DISH Network's acquisition of an orbital slot over the country. Since then, Hughes India continues to bang its head against ISRO and the regulatory restrictions that the Indian government has perfected after the British started the process! However, Hughes do Brasil has now launched its own consumer service based on a hosted Ka-band payload deal on the Eutelsat 65 West A satellite which was concluded in 2014. This capacity brings 24 Latin American spotbeams, of which 16 cover most of the Brazilian population, and over 24 Gbps of capacity. The service, based on the latest HT/HG platform, was launched in mid-2016 and is being closely watched by many players not least because Hughes is the one company most believe that can really prove if a viable consumer market exists outside of North America.

Hughes do Brasil has informed COMSYS that it has extensively leveraged the expertise and lessons learnt from the company's consumer operations in the US, tweaking some aspects to fit local needs, but also avoiding anything that has proven to be a mistake. More information is available in the Hughes do Brasil section. Mexico is another area of consumer service expansion that will open with increased coverage from Jupiter-2. Our understanding is that the approach in Mexico is likely to be allied with local partners and that negotiations and planning for the new service is well underway. With a Latin American consumer service now underway and India stuck in the mud for the time being, Hughes' next step in the consumer market, other than continued expansion in the US and Canada (with Xplornet), is less than clear.

In summary, the HughesNet consumer service expended a considerable amount of Hughes' resources in order to get off the ground, but the company has been able to leverage the benefit across many of its business lines and it is one of the major reasons it has, what we

believe to be, the lowest cost to manufacture in the business. The long term experience as the leading vendor in the VSAT market, its leading TV set-top box business (sold off by News Corp. in 2008) and its first foray into satellite internet services with DirecPC gave Hughes a grounding and capability to walk what appeared to be the impossible tightrope towards a long term, viable and sustainable consumer business. Over 15 years the HughesNet consumer service has been grown into a business with over one million subscribers and probably more than $650 million in revenue. What is more, there has been a positive cycle of reinforcement from technology and service developments in the enterprise business into consumer service platforms and back again which has delivered market leading VSAT systems – the company has always seen its position within the hardware business as a critical competitive advantage for its services strategy and it has delivered on this promise with its latest HT platforms. Hughes' achievement really has been monumental both on its own account and on behalf of the industry.

7.3. Hughes do Brasil



Systems & Facilities:

Star:	Hughes, Jupiter/Jupiter2 Hughes, HN7000/7700S Hughes, HX Hughes, DW6000
Mesh:	Hughes, HX
SCPC:	Comtech
Frequency:	C and Ku-band
Other:	MSS L-band services

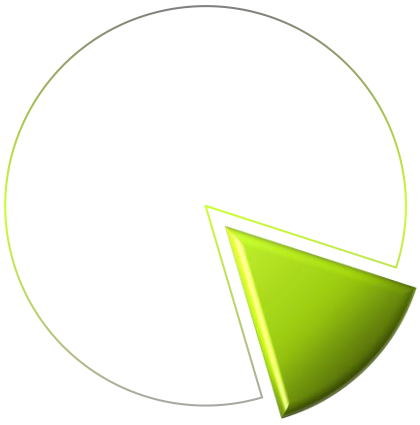
Hubs:	São Paulo, Brazil Manaus, Brazil
Satellites Used:	Intelsat-9, 1R and G28, Eutelsat 65W
Service Area:	Brazil and the Americas
Install, S&M:	Third parties

Commercial Factors:

Growth:	~5% (estimated 2016)
Staff:	~60 plus subcontractors

Capacity:	~700 MHz
Revenue:	Not disclosed

Business:



Brazil Enterprise TDMA Market Share

SCPC Business	Total	TDMA Business	Total
SCPC Circuits:	40	TDMA Installations:	~14,000
SCPC Customers:	>5	TDMA Customers:	>35

Hughes do Brasil informs us that, as of the end of 2016, it served almost 14,000 sites for both end-user and operator enterprise customers. It also operates small business broadband services sold through a network of resellers in Brazil which account for about 15 per cent of this total. The company's operator customers include Telefónica, Oi (formerly Telemar) and Copel Telecom (which outsources 800 broadband sites for the State of Parana's schools to HdB). End-users include Votorantim, Ipiranga and Martines Group. At the end of 2016 we believe the company had a 16 per cent share of the TDMA enterprise VSAT market in Brazil. The company also provides approximately 40 high throughput SCPC GSM backhaul links to mobile cellular service providers in support of the extension of their networks, as well as supporting a number of other mobile and utility customers with L-band MSS services.

The company's most recent and high profile announcement was the launch in July 2016 of its HughesNet consumer service. In early 2017, about six months after commercially launching the service, Hughes announced that it had reached approximately 40,000 subscribers and was adding approximately 500 new sites per day. The take up it has experienced has significantly exceeded previous satellite consumer initiatives from other operators and is performing well with a high level of customer satisfaction.

Additional Information:

Hughes do Brasil (HdB) is a wholly-owned subsidiary of Hughes Network Systems LLC, the largest manufacturer and service provider of VSAT systems in the world. Following an acquisition during 2011, Hughes itself is now owned by EchoStar Corporation. HdB was formed in 2002 and is Hughes' service business in Latin America. Since the launch of its service, Hughes do Brasil has grown fast – from 1,600 sites less than seven years ago to around 14,000 today. HdB moved into its headquarters location in São Paulo in 2006 and currently employs approximately 60 staff supporting sales and marketing as well as some operations plus it makes use of a similar number of subcontractors.

During the 1990s HNS focused on hardware sales in Latin America, selling its products through a number of strong partnership agreements. The company established close relationships with all of the major telecoms carriers in the region as well as most of the strongest independent service providers. In particular, Primesys (a full subsidiary of Embratel) is a key strategic provider of services on the Hughes platform and the two companies have stayed loyal to each other for almost 14 years. Through its partnerships, HNS built a large market share in the continent, but by 2001 several factors were beginning to come together which meant that the established order was fast disappearing. Many of the major VSAT providers had been lured by the prospects of terrestrial services which were substantially deregulated across the region from 1998 onwards and this began to undermine their commitment to supporting VSAT solutions as they invested heavily in fibre infrastructure.

The collapse of the tech market, and the economic downturn which followed, consequently caught all of these companies off guard and several went bankrupt. Coupled with a lack of willingness to invest on the part of many of the smaller service providers, Hughes re-evaluated its approach in the region. The company has long had a strategy of moving its business more towards a service base and with leading service operations in Europe, India and the United States, Latin America was another logical step. The path had not been so clear in previous years not least because the existing regulatory barriers and a lack of appropriate space segment. With deregulation allowing new licences and PanAmSat achieving landing rights for Ku-band capacity in Brazil, the way was open for HNS to establish its own service as a natural progression of its business.

Hughes do Brasil applied for its own licence at the end of 2002, having already discussed various partnership possibilities with several potential companies. Rather than re-invent the wheel it negotiated an agreement with Impsat (now Level-3) in Brazil to host an HdB-owned hub at its teleport site in São Paulo. Consequently, a DirecWay hub was brought into operation in Brazil in the first half of 2003 and Hughes began marketing its own service in

the country based on Ku-band capacity on Intelsat's IS-9 satellite. The company subsequently opened its own teleport and NOC facility in Barueri (in the suburbs of São Paulo) and moved its hub operations a little later. Whilst the base platform exists in Brazil and customer care support functions are provided from there, use is also made of the company's systems infrastructure in the US. Initially, the service was only sold in Brazil, but the company also supports some of its customer networks in surrounding countries.

In terms of marketing in the major enterprise sector, Hughes both sells its service directly and through a number of relationships which include Telefónica, Oi (formerly known as Telemar) and Level-3 – all of which target the large corporate and government organisations. The company always considered that it might also package a service for the SME/SoHo customer to be sold through VARs and this was a strategy which it finally embarked upon in 2004. It recruited a number of resellers and continues to sign up new ones, especially where it can see they can add significant value in a specific vertical segment. Hughes continues to maintain its managed broadband access business which enjoys very low rates of churn as several of its key resellers have established successful strategies to penetrate both large accounts and individual users. It was the agriculture sector that provided the main demand in previous years as the requirement from primary producers picked business, fuelled by the growth in demand for fuel products, especially ethanol for which Brazil is the world leader in both technology and production. The vast majority of agricultural users are, of course, rural and there is a recognition that they have to employ the best technology in order to remain competitive. Value added services are also important for these customers and HdB informs us that its resellers do not simply pass through an internet access service - many also integrate VPNs and VoIP services. However, as the economic situation in Brazil deteriorated from 2011 onwards, so sales in the SME broadband segment have slowed and whilst this remains a significant part of Hughes' business, it cannot be said to offer the same near-term potential that it once did. With the depressed economy in Brazil over the past few years, some telecoms companies (including reseller businesses) have struggled stay afloat, but HdB informs us that it still has several successful partners which continue to grow.

Hughes Brasil has continuously maintained its technology lead in the market over the years and has upgraded its service platform as its parent has introduced new products. The latest Jupiter2 system was brought into service during 2016. This incorporates the most recent iteration of DVB-S2X which was at least six months ahead of every other system, and brings greater bandwidth efficiency. Back in 2006 it introduced the HughesNet HN7000/7700S system, incorporating DVB-S2 ACM which was also a few years ahead of its competitors. The bandwidth efficiencies this brought in the capacity-constrained Brazilian market at the time gave the company a large advantage until the other vendors caught up. Hughes has also expanded its service portfolio over the years and in mid-2011 the company was awarded a license to provide mobile satellite services by Anatel, became a reseller of BGAN services and deployed a new hub antenna of 9 meters connected to a HX VSAT platform designed to support mobility applications in its teleport in São Paulo.

HdB has successfully managed to continue Hughes' success of the past where it was very strong in sales to the largest sector of demand – the banks. HNS systems are in use at seven out of ten of the country's largest banks and three of these – Itau, Santander (former ABN-Amro) and Banco do Brasil now use HdB's service through Telefónica and Oi respectively. Additionally, other major banks, such as HSBC, have also migrated to HNS's system through

other operators. A consolidation between two of the major banks in 2009 led the company to expect a growing requirement for ATM and back-up networks. This expectation came to fruition in 2009 and service to connect ATMs, particularly off-branch facilities installed by third-party independent ATM operators, provided a robust area of growth until the economic situation started to deteriorate. Brazil has a relatively unique system whereby the banks maintain a large network of independent representatives, often local business people with an existing retail premise. These representatives number in the tens of thousands across the country and manage the local banking requirements for the population, processing payments, bills and other transactions – reportedly handling as much as 40 per cent of all financial movements in Brazil. Hughes built an offer for this potential opportunity and began targeting this segment of opportunity from 2009 onwards. Another, similar segment of the banking business is the practice of placing small bank branch facilities in the offices of major enterprises. Known as PABs (loosely translated as "banking point of service"), these facilities are valued by large corporations as a staff benefit, but often require some element of network extension to reach.

The operators of ATM services spent a good time waiting for the arrival of competitively priced cellular data services, but as these services were deployed it became evident that their reliability is highly questionable. In some instances a GPRS service might be half as reliable as a VSAT connection and as the independent ATM operator's revenues are directly tied to the number of transactions completed, this was found to be completely unacceptable and highly detrimental to a business case. As a result, these companies turned to VSAT services and HdB was highly successful at selling its value proposition for this application until a combination of the poor economy and a need to reduce costs led some customers to deploy GPRS systems with multiple SIM cards able to swap between services depending on the availability. Nevertheless, Hughes informs us that demand remains and it continues to connect many thousands of ATMs and bank branches through its partners, although the segment is not quite as buoyant or as extensive as it was few years ago.

The same can be said for the cellular backhaul market from the VSAT operator's point of view. Between 2008 and 2012 most operators, including Hughes, won a considerable amount of business serving the four major cellular operators – Vivo, TIM, Claro and Oi – all of which had to connect around 500 cities each following Anatel's decision in April 2008 to award GSM licences tied to a universal service obligation (USO). However, after a good run for the VSAT operators, the MNOs began to take their VSAT networks in-house and business dropped off substantially. From several hundred dedicated SCPC sites, HdB now operates around 40 although it has also sold private hub systems to some MNOs. Exactly the same scenario happened in Pakistan, but a few years ago the MNOs came back to the VSAT operators and now most cell sites in that country are operated by the domestic VSAT operators – so it's possible the same might happen in Brazil.

The retail segment was an area Hughes identified early on as having potential and it found some good business, selling networks to the likes of Martines Group. Most of the company's retail clients have retained their network and grew strongly in the years up to 2015 before slowing in 2016 as the country's economy took a dive and saw a decline for the third year in a row. As the hopes for some economic recovery take hold, consumers have more money to spend and retailers resume their expansion across the country Hughes believes that the retail segment is likely to re-emerge as an area of expansion and that, along with support for

telcos and their universal service obligations, this will present future opportunities. In 2005 the Ministry of Education introduced new regulations for digital inclusion which catalysed the demand for IDL and brought many opportunities with both state and private educational institutions. HdB sold networks both directly and through partners to several state school projects, universities and colleges as well as privately funded ventures, leveraging the increased data rates on the HN7000S platform and its ability to support video, VOIP and data in a triple-play. It went on to capitalise on this success, but the abuse by private companies in the educational sector caused the government to reign in the activity and instead Hughes has found more opportunities in serving the USO obligations imposed on major carriers for regional school networks.

Hughes has also tended to focus more on state projects than the major central government networks because the former are usually more rationally administered than most of the huge national programs some of which often become ridiculously competitive. Hughes has well-advisedly avoided some of the incredibly low pricing which has been seen in some of the reverse auction processes which are common in the government segment. This, we believe, is a good strategy because many of these projects look to be obviously loss-making. Despite the fact that these government programmes have often been a major areas of opportunity, new projects as well as network upgrades and extensions have been so aggressively contested that Hughes decided it simply didn't make economic sense to pursue these contracts. There have been many examples of this over the years, but the most recent one was for the antennas, gateways and up to 60,000 terminals for Telebras which ended up going through three bids as awards were cancelled. By all accounts the complexity of the requirement caused a misunderstanding from some of the bidders. The last result was cancelled for the third time in early 2017 and Hughes looks smart having kept its distance. Additionally, some of Hughes' major competitors have undergone massive highs and lows as projects like GESAC, Correios and Caixa have been won and then lost a few years later. Few would dispute that the government requirement for satellite networking will always remain high in a country as large and diverse as Brazil, but with the political scandals, high unemployment, high inflation and high interest rates, have all conspired to tighten budgets and bring financial constraints, resulting in projects being delayed or cut back. On a positive note the number of sites Hughes serves associated with distance education has grown.

The introduction of first the HN7000S and then the Jupiter platforms has helped HdB to position itself to serve the growing need for video, VOIP and bandwidth intensive data applications now being implemented by customers in other segments, including banking and retail. Since 2012 there has been an upsurge of centralised applications based on ERP systems, such as SAP and Oracle, which has brought with it an increased network criticality. A loss of connectivity brings application downtime and the loss of real business, so the need for back-up and secure networks has grown with the introduction of these ERP systems. In some instances HdB has been successful selling the primary network to these customers, in others it provides a secondary overlay network. Some retailers have initiated digital signage systems and Hughes provides two networks to the largest supermarkets in Brazil – Carrefour and Pão de Açúcar – through CerejaPRN, a specialist in retail media networks. These are high throughput and demanding applications which need to move a heavy volume of data to remote locations and Hughes believes they will continue to drive market demands towards satellite.

For many years, Hughes do Brasil had little interest in the consumer Internet access market – no doubt after observing the crash and burn of initiatives from the likes of Star One with its EasyBand service and others over the years. Telefónica's Media Networks business (MNLA), which is a major wholesale distributor of satellite pay TV services and one of the largest satellite internet providers in the region, committed to the nine Ka-band spot beams on Hispasat's Amazonas-3 satellite in 2012 and, in mid-2013, selected Hughes's Jupiter platform as the ground segment for the service. This service now covers selected high density areas of demand in Brazil, Mexico, Argentina, Chile, Colombia, Ecuador and Peru from gateways located in the US and Chile, managed and operated by Hughes. Some countries, such as Chile and Peru, are known to have solid demand, but Brazil has not been one of them.

Hughes' parent, EchoStar, has been known to have international ambitions for some years and, in 2011, successfully bid through Hughes do Brasil for two orbital slots although its plans were more orientated towards television services than consumer internet access. Then, in 2014 Hughes struck a deal with Eutelsat, committing itself to the entire 24 Gbps of Ka-band capacity on the company's 65 West A satellite that was successfully launched in the first half of 2016. From 2014 onwards, HdB set about establishing a consumer and small business-focused satellite internet access service based on 15 years of its parent's tremendously successful HughesNet US consumer business coupled with its own local knowledge and market connections.

Following the operational opening of the Eutelsat 65W A satellite, Hughes announced the inauguration of its HughesNet consumer service for Brazil in July 2016. Based on the most recent Jupiter2 platform and leveraging extensive consumer experiences and lessons, Hughes do Brasil has established a network of resellers designed to sell to both consumers and SMEs. Three service plans are now being sold for each of these segments starting at R$249/month (~US$75) for a 10/1 Mbps connection and 15 Gbytes of peak volume complimented by 20 Gbyte of off-peak volume data. For sure, prices are not as low as HughesNet in the United States, but there are reasons for this that can't be avoided – import duties close to 100% on hardware and monthly VSAT service licence fees at least 15 times higher than for other wireless services. HdB (and all of its competitors) are lobbying hard to change this and whilst it has been a known inequality for satellite services for many years, there is a hope that the authorities might finally be understanding how this disadvantages rural users.

There have been no successful unsubsidised satellite consumer services outside North America and with now over one million subscribers on its domestic US HughesNet service, there is little doubt in anyone's mind that if Hughes doesn't make the cut in Brazil, no one can. As a consequence, HdB's HughesNet initiative in Brazil is being closely watched. Initially the company kept its cards close to its chest, not least because several large competitors, including Yahsat and Telebras, are about to enter the fray in the next 12 months. However, in early 2017 the company announced that the service had reached 40,000 subscribers and was growing at rates of approximately 500 new users per day – a take up of almost 15,000 subscribers per month. The company informs us that the whole infrastructure set-up in terms of technology, operations, billing, customer management, reseller network and logistics is solid and successful. At the end of 2016, HdB said the service was considered to be good and stable and the feedback from customers has been very positive. Since then, COMSYS has also had independent reports from actual users

expressing their satisfaction in terms of both the quality of service and the bandwidth delivered as well as the reliability in harsh weather conditions. Clearly HdB has managed to combine its local knowledge with a new team of people bringing consumer television and internet experience to the table and, in the company's own words, the "priceless experience" of the US business.

Once again, Hughes has revealed a future path of opportunity – this time for consumer internet services in developing markets, not just for its own business, but for the market as a whole by finally proving that they are a viable proposition given the right business model and expertise. The company has shown that success is not simply based on terminal pricing and space segment, but a complete and well thought-out service, sales, distribution and management strategy. Admittedly the service is still in its early days, but Hughes has eclipsed every other attempt to establish a successful consumer service via VSAT. In addition there is more to come because the company's Jupiter-2 satellite is now in service and as well as its US capacity, it has added coverage over Mexico, Colombia and several countries in Central America and the Caribbean – so there's more to come.

In general, the company believes that the Brazilian enterprise market has matured to a state that the high level value proposition that it sells in the United States can be relevant locally and it clearly aims to bring the same to the consumer market. On a general level, the company informs us that demand for data in terms of speeds and volumes has continued to increase and so whilst the average size of the networks it has deployed has fallen in terms of the number of sites, some of these contracts require disproportionately large amounts of capacity. From a small business, which is now demanding internet connectivity at rates up to 4 Mbps, to a back-up application for a large enterprise, which specifies rates for the VSAT business continuity solution equivalent to those it uses on its terrestrial connections, the need has risen across all segments of the market. Hughes tells us that it typically encounters demand for data rates that are between two and ten times that of just a few years ago.

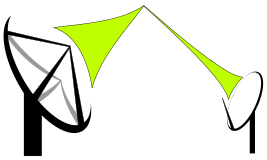
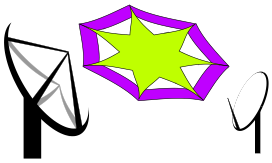
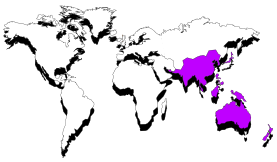
The telecoms market in Brazil continues to be intensely competitive at all levels. Hughes believes that the demand for VSAT is still evident and that, even with the large terrestrial build out in the south of the country and the ensuing price war that followed, a smart VSAT provider will be able to sell its value in coverage and reliability. HdB believes that as the manufacturer of its system and the fact that it is competitively positioned in terms of both its support infrastructure and its space segment costs, it is amongst the most competitive of all the operators of broadband satellite systems in Brazil today. As such, its largest competitors are the major terrestrial providers and cellular operators – Telefónica/Vivo, Oi, Brasil Telecom, TIM and Embratel.

Hughes believes that Brazil continues to offer plenty of potential for both enterprise and consumer VSAT services for the foreseeable future. Brazil has seen many of the carriers grow and decline their focus on the VSAT business over the past 15 years, in part due, no doubt, to their dependence on large government contracts that come and go. This is a vulnerability that Hughes do Brasil does not suffer from in the same way as it is far more focused on the enterprise and telco segments. From what COMSYS is able to see, the government remains committed to use of satellite, but the political and economic situation will have to change before this potential can be realised once again. With its head-start of almost a year over its incoming competitors in the consumer segment, Hughes is once again

ahead of the curve and we have little doubt that it will continue to push the boundaries and maintain its competitive edge. As more HTS capacity is launched over Latin America, satellite services generally should gain ground, but few people seem to understand that success is dependent on much more than bandwidth cost – sales networks, distribution partners, customer management and service focus are just as important if not more so in many instances.

In the enterprise segment Hughes do Brasil continues to believe that its major differentiator is that it is a VSAT services operator, not a carrier with a vast amount of terrestrial infrastructure and a minor interest in satellite. As a result, it can maintain its focus and position itself as a partner to many carriers who have neither the expertise nor the desire to invest heavily in the technology. Brazil has been a real success story for Hughes and through careful and intuitive management, the company has grown from nothing to eclipse former leaders in the VSAT networking business. Hughes do Brasil has managed to maintain its discipline and focus on the commercially viable contracts rather than chase the huge, headline-grabbing deals. Now it has a major bet on the table with its HughesNet consumer play – and we believe that most would place their own bet on Hughes being the most likely operator to finally make satellite consumer internet access a reality. Actually, now so much has been achieved with its subscriber growth, the odds must have fallen so low that placing a bet wouldn't yield that much in winnings!

7.4. Hughes Communications India

Systems & Facilities:

Star:	Hughes, Jupiter/Jupiter-2 Hughes, HN9260, 9460 Hughes, HN7700S, 7740S Hughes, HX90, HT1300
Mesh:	Hughes, HX260
SCPC:	Comtech
Frequency:	Extended C and Ku-band
Other:	Hughes, HN9200S for one-way satellite services. Terrestrial MPLS and Wireless VPN, managed network and internet data centre services. Systems integration services

Hubs:	Gurgaon (near New Delhi) Hyderabad Manesar (near New Delhi)
Satellites Used:	GSAT-16, GSAT-18, NSS-11 & NSS-12
Service Area:	India
Install, S&M:	Hughes

Commercial Factors:

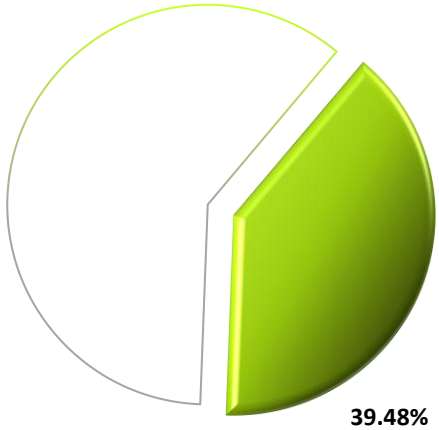
Growth:	~14% growth (2015)
Staff:	~200
Capacity:	~290 MHz
Revenue:	~US$50 million (estimated)

Business:

SCPC/Mesh Business	Total	TDMA Business	Total
SCPC Circuits:	~42	TDMA Installations:	106,548
SCPC Customers:	~300	TDMA Customers:	~190

Hughes Communications India (HCIL) is the most successful of the Indian VSAT operators with around 106,500 star data VSATs in service as of June 2016. In total, Hughes has delivered over 190,000 VSATs to India for shared, private and operator customers. Its service is the largest in the country. The company currently has over 300 enterprise and government accounts which include companies and organisations like State Bank of India, HDFC Bank, UFO Moviez, Real Image Media Technologies, Central Bank of India, Vodafone, ICICI Bank, ITC, Sony India, FIS Payment Systems, Reliance Industries, the Bombay Stock Exchange, Bank of India, British Gas, Diebold Systems, C-Edge Technologies and Tata Communications along with government customers such as Indian Railways, Indian Navy, NIC, ONGC and various State governments. Mesh services, based primarily on the Hughes HX system, and SCPC links using Hughes and Comtech modems account for a further 50 sites

and more than 10 different customers, including cellular backhaul networks for Vodafone, Aircel and other major GSM operators.



India Enterprise TDMA Market Share

As of the end of 2015, Hughes India was the market leader for shared hub services in India – a position it has held for more than five years in a row – accounting for almost 40 per cent all the TDMA VSATs in service.

In addition to its shared hub service, HCIL has also sold and supports several large private star VSAT networks for the likes of ISRO (Edusat), Indian Railways, Indian Defence (NavyNet, NEWN, BSS), the Ministry of Home Affairs (Polnet), Bharat Petroleum, the Ministry of Health (IDSP), ERNET, ONGC and others. These dedicated customers, or "captive" networks as they are known in India, amount to almost 12,000 sites. As with its star data business, the company has also sold and supports several large dedicated DAMA and SCPC VSAT facilities. These captive networks account for an additional 600 sites with clients including the Indian Navy, the National Thermal Power Corporation, Defence Communications Network and Indian Navy.

Additional Information:

Hughes Communications India Limited (HCIL) is a majority-owned subsidiary of Hughes Network Systems of the United States (the world's largest manufacturer of VSAT systems) which owns 71.17 per cent of the company. Following an acquisition during 2011, Hughes itself is now owned by EchoStar Corporation. Originally begun as a joint venture with Escorts Limited, Hughes had considered entering the Indian VSAT service market as far back as 1989 and formed an agreement with Escorts because it appeared aggressive and willing to move forward. Some time was spent lobbying for a licence to operate, but it was not until August 1994 before everything was finalised and a licence was granted. The company's licence allows it to operate data services and non-interconnected voice services with both star TDMA and mesh SCPC technologies. All of the satellite service licences have been extended over the past few years to allow operators to offer hybrid terrestrial and satellite networks, but the prohibition on international services remains with the exception of the deregulation of direct international Internet gateway links in 2000.

Since its founding, HCIL has been at the forefront of innovation with VSAT services in India with its introduction of support for ERP applications during the mid-1990s to opening up new segments in managed services, digital content delivery, premium education services and rural multi-service kiosks from mid-2000 onwards and, most recently, its innovative use of bandwidth has allowed it to contain costs for its customers as well as maximise what has become a scarce resource in India. Hughes India is uniquely positioned in the country as the only major service provider which relies solely on VSAT services as its primary business revenue generator and, as such, the company has done more than any other service provider to stretch the boundaries of conventional thinking for the technology's capabilities.

Not only has this maintained the momentum of its business, but it has kept the Hughes brand at the forefront of the customer's mind.

Naturally the company initially installed its own ISBN/PES system based on a nine metre, extended C-band antenna operating with the INSAT domestic satellite system in Gurgaon near New Delhi where Hughes had already established its Hughes Software Systems (HSS) business which was sold off by DirecTV following the acquisition of Hughes by News Corporation in 2004. Hughes subsequently set up another telecom software services company in India named Hughes Systique in 2006, which works closely with HCIL. HCIL's VSAT business currently employs approximately 200 direct staff responsible for all aspects of the business ranging from sales and marketing to hub operations and service and maintenance. The company maintains 22 primary service centres[7] and 280 secondary service centres directly and handles all service and maintenance tasks. It also operates a full-fledged Diagnostic and Repair Centre in Gurgaon to offer quicker turnaround times for customers saving them inventory and repair costs. Following the opening up of Ku-band services by the Government in 2000, HCIL installed a 9.3 metre Ku-band hub system, also at its headquarters offices in Gurgaon and subsequently a further Ku-band hub plus an extended C-band hub in Hyderabad. It now provides extended C-band and Ku-band services on its Jupiter, HughesNet HN and HX DVB-S2 platforms.

From the start, the company always intended to offer MCPC and mesh networks and, following the award of its mesh networking licence at the end of 1996, it installed a TES system to complement its PES system. This service was marketed aggressively both as a demand and permanently assigned solution and helped alleviate the initial market demand for voice connections. There was also a significant amount of requirement for clear channel data links as well and HCIL used its own UMOD and TRES systems to provide these types of links as well as modems from Comtech and Radyne. Initially these DAMA and PAMA services grew very strongly for the company, but growth rates began to tail off a few years ago for all the operators as new terrestrial facilities have been laid and prices have fallen for leased lines. From 2010 onwards HCIL added Hughes' HX260 and HX280 mesh products to its portfolio to enhance its value proposition for particular niche applications and several of its long-term customers on its older systems (which have proved extremely reliable) have been converted and upgraded. Hughes has been pursuing opportunities in the specialised segments of this market – military, media and cellular backhaul links being some examples – with its HX platform. It has proposed and deployed Comtech solutions on a few occasions, but the company primarily focuses on the network flexibility, high data rate capabilities and cost advantages that the HX brings to the value proposition.

With the initiation of marketing activities, Hughes saw high levels of interest. It was the first to market and quickly signed several accounts - the most important of which was Hindustan Lever. The company has subsequently gone on to build the service significantly year-on-year. The number of terminals on its shared service has grown consecutively, despite the fact that at one time several large hosted networks for major customers transferred to private hubs due to changed regulations that favoured this – something that swung back a few years ago. Nevertheless, the company continues to support some important customers with examples including the Indian Navy, which operates an advanced satellite

[7] Delhi, Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Pune, Nagpur, Ahmedabad, Lucknow, Guwahati and Chandigarh.

communications network connecting 280 ships, submarines, planes and ground stations; Indian Railways, which operates a dedicated system supporting over 1000 sites; Reliance Industries, which operates a captive hub for its retail businesses with over 2,500 sites and the Ministry of Home Affairs which now has 1,000 VSATs on its system for the police forces. HCIL often provides the management, maintenance and oversight of these networks, but they do not come under the shared hub service numbers that all of the operators report quarterly to the regulator, the TRAI.

Hughes initially expected that the primary demand would come from the financial, government and manufacturing sectors of the market and it believed that it would be able to sign up to 1,000 sites within the first three years of operation. These predictions were largely proven out - most customers did come from the manufacturing and distribution sectors, often led by MNCs driven by ERP-related connectivity. The number of sites provided to the financial sector has always grown at a healthy rate, but the last few years have seen exceptional demand. Many of the country's largest banks renewed and extended their networks significantly during 2010 and 2011 and continue to do so, some of which have even replaced terrestrial networks with HCIL's VSAT service due to poor performance of the terrestrial service.

However, from 2012 onwards a huge impetus has come from the government's desire to increase the level of services and connectivity offered to rural areas. Over 70 per cent of India's population lives in 600,000 villages, beyond the reach of facilities in the 2,000-odd towns and cities that house the remaining population, and the government has a number of programs to extend the level of services available to these villages. This takes the form of encouraging the expansion of the bank ATM networks as well as investing in 100,000 kiosks to provide access to G2C (Government to Consumer) services ranging from education, eGov, telemedicine, banking and rural BPO. HCIL has adopted a leading role in partnerships targeted at fulfilling this mandate and has 10,000 broadband centres planned along the same design as its successful Fusion kiosk business venture.

During 2008 and 2009 many of the bids for banking networks were run through a reverse auction process, severely depressing prices, and HCIL took a selective approach when bidding for these opportunities. Instead it concentrated its efforts on the core applications in the banking and insurance areas and informed us that it managed to both sell value and maintain margins via this strategy. However, a much greater demand for service to ATMs emerged, catalysed by the government's decision in mid-2009 to rescind the need for banks to apply for permission to establish an off-site ATM. ATM fees were also reduced and this encouraged the entry of third-party, independent ATM operators such as Diebold, Euronet, Fidelity and FSS, creating an explosion of demand for connectivity. With revenues from a site dependent on the number of transactions conducted, the need for the reliability of VSAT has been critical and many of these companies proactively negotiate with landlords for roof rights in anticipation of a VSAT installation. Along with this, HCIL worked with the Ministry of Finance to set up 27,000 off-site "brown label" ATMs in an effort to expand coverage to 100,000 ATMs and to ultimately ensure that most of the country's smaller towns and villages were connected. By 2013, we understood that around 100,000 ATMs were connected and we are informed that this number has now risen to 180,000.

The demand for ATM connectivity has declined over the past year or so because the government program has now ended, but the banks continue to expand their coverage and the ongoing expansion of this segment typically runs between 10,000 and 20,000 sites annually. A greater opportunity is currently being seen in the requirement for upgraded branch communications as banks are now beginning to upgrade their systems and demand more bandwidth. Branch connections are the largest part of most VSAT operators service revenues and with customers now looking to double their data speeds this could bring further growth. Hughes informs us that over half of India's banking activity is already conducted over VSAT systems which have proved to be both more reliable and more cost effective than any alternative solutions. Indeed, the past few years have seen competitors in many areas of the wireless industry, such as WiMAX and CDMA, withdraw from the market as their services suffered from a lack of reliability and business models failed. At the same time, VSAT services have been picking up the pieces and extending the services available with a proven and commercially viable solution. This latest series of initiatives in the banking sector has provided a follow on from the initial massive growth for brokerage networks and commodity exchanges during the 1990s that stalled from 2008 onwards as the stock market declined in India. These once large networks have declined in size and many of the original deployments now only provide back-up as opposed to primary service.

Alongside the financial segment, HCIL has targeted other opportunities in areas where satellite does not compete head-to-head with the terrestrial services or, if it does, it carries a significant advantage. A good example of this is the company's digital film distribution service for the Indian film industry. Hughes provides connection for 90 per cent of all the cinemas in India and estimates that 95 percent of Indian film industry revenues are carried by its distribution services. It delivers 12-14 Gbyte MPEG-4 movie files between 25 and 30 times a week to 3,500 UFO Moviez cinemas in India. During the bid for this particular contract, it emerged that an offer from one of the terrestrial providers was more than three times that of Hughes. Initially this was a one-way network, but during 2008 this was upgraded to two-way to take advantage of the efficiencies brought by Hughes DVB-S2 ACM platforms, but also to extend the use of the network to support applications including ticket and licence fee settlements. The company also now distributes 70 GB MPEG-2 movie files to 2,500 Real Image cinemas, having originally installed the network to support advertising, and serves almost 6,500 of a total of 7,500 total cinemas in India. Real Image cinemas is also exploring using the JPEG-2000 standard for superior encoding of movies over their satellite network. HCIL was the first company to deploy a DVB-S2 ACM platform in India and believes that the efficiencies of this HughesNet platform have been instrumental in its ability to significantly tap the potential of the video-based market.

As the terrestrial infrastructure in India developed in both reach and capability, Hughes sought a strategy that would allow it to both maintain its long term customers and open up new opportunities. Initially it focused its attention on the provision of managed hybrid satellite/terrestrial networks in much the same way that its sister operations have done in the United States and Europe. It began by offering an MPLS service, named HughesNet Connect, with access speeds up to 2 Mbps supporting defined quality of service by application, based on its own high-speed terrestrial backbone network with IP nodes in 20 key urban areas and an agreement with BSNL, the dominant domestic operator that controls around 80 per cent of the DSL market in India. It continues to maintain about 1,000 sites,

mostly for retail customers in urban areas, but the approach has since been abandoned in favour of a different strategy.

The company turned its focus towards teaming with major carriers and positioning HCIL as their expert satellite partner able to provide a reliable and rapidly deployable solution for network extension. Despite the fact that the terrestrial network has improved dramatically, the last mile is still a problem and remains "essentially RF" - i.e. some form of wireless service which, unless it is satellite, is almost always profoundly unreliable. HCIL has taken a stance of carrier neutrality – working with any of the major carriers and integrators even if they also have a satellite-based service. These have included Wipro, Infosys, HP, TCS, Reliance and Bharti. The company has leveraged off its own experience of providing hybrid solutions and designed its offer to look and feel like an MPLS service, making it easy for carriers to understand and integrate into their own offerings. Despite this, it took a large effort to convince these partners that VSAT technology was a viable, cost effective and capable solution and it embarked upon a series of road-shows which successfully demonstrated a proof of concept. This paid off and the strategy has been a major success, allowing Hughes to ride along with the sales resources of much larger operators and integrators and maintain its own brand and identity. In essence, the company's foresight that hybrid services would come to dominate purchase decisions by major enterprise customers has proven to be correct and it has adjusted its strategy to maximise the potential that this has brought, rather than marginalise itself as a smaller, niche alternative telco. Most recently it has developed its own wireless CPE and launched a managed wireless service called HughesON, accessing multiple different cellular networks to extend coverage in suburbs and smaller towns in order to extend connectivity for the likes of retailers, gas stations and restaurants.

The past few years have seen come major changes in the Indian VSAT market as private enterprises, in particular Reliance, Bharti and Tata, have developed their own independent terrestrial infrastructure following deregulation. Increased competition across all aspects of the telecom market in India has been marked with huge price pressure and a significant increase in the quality and coverage of fibre-based, wireless and mobile services in the major urban areas. Naturally this has reduced demand from business segments that are primarily urban-based – notably the emerging retail business – and Hughes has taken steps to address this. The emerging threat to VSAT solutions in the transactional market from packet data services offered by the mobile operators which we reported as evident in our previous reports has largely withered on the vine as mentioned above. Although these services are cheap, they are not able to offer the quality of service that VSAT can support and providers have largely closed down or pulled back from this market. In the longer term, Hughes considers that 4G and 5G services might evolve to present a greater threat, but with the sheer size of India and the cost of deploying an infrastructure capable of covering its geography, this looks some years off.

Around 2009 HCIL carved out a significant business niche in the provision of cellular backhaul links for most of the major GSM operators in India. The company successfully signed several large deals, the largest of which was with Reliance for 275 links. HCIL aggressively chased the potential from this segment, although government regulations conspired to slow roll-outs to a crawl with links taking up to five months to commission. By 2009 it had successfully deployed several hundred links, but government concerns over security issues in

the national cellular network caused the sudden imposition of draconian clearance regulations for all imported equipment. Licences were unilaterally modified to add a liability of $10 million for every breach in certification found during import or during six monthly audits, which were also required. All this, coupled with the continued deployment of new towers, fibre and microwave connections which slowly eroded the existing satellite links, conspired to render the segment worthless to pursue and the number of satellite backhaul sites fell dramatically as a consequence.

Despite this and the potential competitive threat from cellular services, some ambitious plans to grow coverage might actually bring a significant opportunity to Hughes. The increased interest in 4G and 5G roll-outs are expected to bring new opportunities because whilst fibre deployment is progressing quickly, the sheer size of the country means that satellite will be an essential component of extended rural cellular coverage. We understand that the government is now supporting some large 2G/wireless projects for as many as 5,000 sites in the north-eastern parts of the country as part of its Digital India USO program. There are plans for some large network deployments from commercial mobile operators which will almost certainly require VSAT and the fact that Hughes is one of only a few companies with a licence to provide cellular backhaul services positions the company well. The company is already in active discussions with Reliance Jio to support a planned 4G project with satellite backhaul services.

The retail segment of the market, which had been growing strongly with restaurant chains, convenience stores and gas stations all developing and expanding their businesses, has stagnated somewhat since the economic crisis began at the end of 2008. Retail chains had begun to expand, with well-known brands as well as indigenous businesses opening shops across the country. Two of the largest of these, Reliance Retail and the Future group, are Hughes customers. Although the retail segment was expected to consolidate and has not expanded much since 2009, it remains in its infancy with huge potential possibly amounting to 100,000 sites or more across India in time. Foreign investment remains limited to single brand retailers such as Benetton, Body Shop and Adidas, so the likes of Tesco and Wal-Mart have to find local partners and the roll-out of these and other stores can be painfully slow. However, further de-regulation in this segment was announced in 2015 and this is expected to encourage greater foreign investment which should re-energise the growth of organised retail chains. The online lottery business, which was expected to be a big area for growth not so long ago, has withered as paper lotteries, able to survive on much lower margins together with Government regulation have undermined their viability and Hughes' business in this area effectively ceased a few years ago.

For some time now HCIL has believed that the whole VSAT value proposition is beginning to look far more comparable to the application-based solution seen in the United States and Europe than with the typical developing market pure connectivity offering seen in the past. Whilst the company believes that there is some way yet to go before credit verification becomes a mission critical application in the retail points of presence seen in other countries, such as gas stations, other transactional networks, particularly ATM networks, have generated demand as they have become a feature of the modernisation of banks in the country. Hughes has implemented credit verification networks for top retailers like Trent, Shell and Reliance Retail by tying up with various leading banks of the country. The banking and rural network segments are where most of the volume has been driven from since 2008,

but crucially many large bids depressed prices just as the rush into the commodity exchanges did during 2007. This is the primary reason that many of the VSAT operators have only managed to maintain their service revenues rather than grow them despite an increasing number of sites in service. Initially caught somewhat by surprise by the willingness of some of the more aggressive operators to drop prices, Hughes has responded by leveraging the depth and breadth of its customer base and the applications it supports. This has taken the form of intelligent management of bandwidth, sharing resources whenever possible and rolling peak usage across different times of the day enabling the company to be extremely cost competitive in its pricing as an entry strategy, followed by upselling of value added services. Once again, this builds on earlier investment in value added services and integrated network and application solutions. Recently in 2015, HCIL has created an indigenous product called Hermes, which integrates a virtual branch platform along with the Hughes satellite modem. This enables it to run value-added applications like acceleration (in a tie-up with Riverbed Technologies), e-Learning applications, content delivery applications and so on. There were close to 600 Hermes appliances deployed as of December 2016 by the company.

The company first began to develop a Managed Service offering with an ASP strategy – something it described as the "extended enterprise" over ten years ago. This encompassed not just connectivity and reach, but also a high level of value added services. HCIL gradually moved its emphasis from the Internet *per se* and more towards the provision of integration and management of services and applications. Applications-based services provided in-house and on a dealership basis for third party application providers, were first initiated in 2000 based on HCIL's core VSAT technology as well as the data centre the company constructed in 2001. The latter provides hosting, housing and back-up services for its customers with the usual data centre facilities including firewalls, intrusion detection and emergency power. As well as offering this as an additional service for its networking customers, the company also markets it as a standalone product. In early 2011 HCIL announced a Cloud computing initiative with Microsoft, hosting various mass-market applications like Exchange, SharePoint and OCS. In addition to this, it also began to develop its own application-centric service products, one of the first of which was global education.

Whilst working with the some of the leading corporate organisations in India, Hughes assessed the potential of technology-based education and training via satellite. In 2002 the company established its Global Education business which was targeted at the commercial market, serving corporations and working executives providing premium management and technical education from the premier institutes of India. The Global Education business has grown consistently ever since its inception and now has close to 30,000 students as its Alumni. Currently Hughes has academic ties with more than 6 premier institutes in India, having recently tied up with India's leading management school – Indian Institute of Management, Ahmedabad. Through this business, Hughes runs an end-to-end distance education business that includes not just the technology delivery of management education, but also the sales and marketing of these programs to various senior working executives from leading Indian and multi-national companies. The success in education applications has opened up new market segments for the Enterprise Networks business, attracting large educational service providers, tutorial companies and universities to the company's managed education infrastructure services.

Hughes' enterprise market expanded substantially through the Government of India's EDUSAT project through which interactive distance learning is supported at various universities and associated colleges and institutions and its partnership with EDUSAT was further expanded in early 2013 with a 3,000 site schools network for the Government of Punjab. The private sector also joined in technology-based interactive learning systems and large private education services companies like Educomp and Everonn started their services on the HughesNet platform and commercial enterprises, like Maruti Suzuki, now also operate their live training programs across Hughes' services. Currently Hughes manages education services through VSAT at more than 3,000 institutions and learning centres across India, as well as the provision of a captive network on its new Jupiter platform for ERNET that it won in 2016.

Education has also become a primary focus of the company's Fusion retail kiosks. Originally aimed at addressing the consumer market, "HughesNet Fusion" internet access centres were introduced by Hughes in 2004 based on a franchise model. This took a little more time to develop as HCIL was keen to ensure it had a strategy able to produce a sustainable business for its franchise partners and the company found itself on a steep learning curve as internet access services alone proved insufficient. As a consequence, Hughes focused on education and learning as the leading business strategy. Some of the innovative areas which were introduced included English courses, local billing and payment facilities for cellular and utility services, railway ticketing and tie-ups with low cost airlines. These initiatives allow a franchise to develop a range of products from air and rail ticketing, mobile pre-paid top-ups, vocational interactive education courses in addition to internet access.

In previous editions of this Report, the big emerging opportunity for satellite broadband services in the country was the Government of India's drive towards eGovernment projects, particularly connectivity for schools, community centres and rural business. The government's support is often dependent on a long term viable business model and VSAT, coupled with strong value added services, offers one of the major elements in achieving this. However, the earliest network projects were subsequently dwarfed by the private-public initiative (PPI) to roll-out 100,000 common service centre (CSC) kiosks, where citizens can check things like their tax status and land ownership documents (G2C). The same kiosks were also envisaged to deliver a variety of Business to Consumer (B2C) services in the rural areas helping the rural community connect with mainstream India. These services were to be deployed at a state level with partial funding of certain elements of the network by the federal government. With very few exceptions, the opportunity in each state came to be defined by a public/private partnership proposed by companies like SREI, 3i Infotech and Comat. By any other standards a large number of sites were rolled out – Hughes, for example, deployed around 7,500 sites for several of these companies. However, the CSC projects have not been as proliferate as has originally been hoped for, but with the Fusion business today enabling delivery of a variety of B2C services at around 400, mostly semi-urban, locations it is the most solid foundation for the government's ambitions. Fusion forms the basis for HCIL's success in its partnership to roll-out 25,000 kiosks to provide these G2C services.

Satellite broadband services to small businesses and institutions have been another area that HCIL has explored. Just like its major competitors, the company actively moved into this segment a few years ago, only to find itself wrestling with thousands of customers whose

main aim was to get as much bandwidth as they could for as little as possible. Having grown its subscriber base to almost 800 sites, the company took a hard look at the viability of some of its customers and, during 2008, began to terminate service with those that were clearly abusing the fair access policy as they shared the connection between multiple end-users. This was just part of a general tightening and upgrading of the business and the technology platforms that HCIL embarked upon at that time and included some struggling enterprise accounts. Customers with marginal business cases were encouraged to look elsewhere for services cutting almost 4,000 sites from the shared service. At the same time, HCIL began to replace its older systems with the newer HN7000/7700S DVB-S2 systems, choosing to invest in the upgrade itself based on the bandwidth savings it was able to achieve and the reduced cost of a consolidated operating platform. Today, the vast majority of HCIL's customers use its latest platforms and are able to take advantage of higher data speeds and better throughput.

The lack of capacity in India is seen as the core weakness for all potential areas of growth. The company believes that part of the problem the market faces with satellite internet access services is a lack of scale – something that is a function of the price of the service. Availability of bandwidth has been another aspect of this limitation, especially as the Indian government has been extremely protective of its own satellite infrastructure through ISRO (Indian Space Research Organisation). Some Ku-band coverage from foreign satellites was licensed some years ago, but this recently took a major turn for the worse with ISRO deciding to "close the skies" and order all operators to migrate their services to Indian satellites by 2018 – a massive and expensive logistical problem which will require site visits and repointing of over 200,000 VSATs. Arguably India has also been behind the curve on the development of high-throughput spot-beam satellites.

After several years attempting to penetrate the Indian market with its low cost, high throughput, Ku/Ka-band spot beam IPStar satellite, Thaicom was finally granted access in 2011 and teamed up with BSNL which now has around 20,000 sites deployed using the IPStar VSAT platform. Thaicom was forced to open its gateways to allow alternative operators to invest in its own ground segment if they chose to and HCIL considered this as a potential way to bring down prices with a view to re-launching its SME broadband initiative. However, it has decided that the hardware investment required – effectively a hub for each of 16 beams – simply could not be justified. In an alternative approach, the company's parent, EchoStar, is known to have international ambitions and for several years Hughes has been lobbying for a licence to launch a Jupiter-like Ka-band satellite for India. Nevertheless, despite the company's ambition, enthusiasm and complete belief that a strong Ka-band satellite service will be essential to move the VSAT business forward over the next few years, the renowned levels of Indian bureaucracy and entrenched indigenous interests have conspired to keep the plans of Hughes and others on paper.

However, now we come to another sequence of Hughes' major achievements that look likely to propel its leadership of the business even further. First off, it was clear that BSNL's use of the now pretty ancient IPStar VSAT platform was a big limitation to its progress and, following an RFP for a new generation system, it was of little surprise that the latest generation of Hughes Jupiter platform was selected in 2016 alongside an agreement for the two companies to partner in selling the service. When COMSYS talked with IPStar about this deal, the company professed itself very happy with the fact that the government-orientated

BSNL had managed to bring in the commercial enterprise savvy of HCIL. The Jupiter2 system has currently been deployed and the link-up between BSNL and HCIL will almost certainly benefit both companies. A good example is the fact that BSNL is the only Indian telecoms company of which we are aware that is authorised to provide satellite-based mobility services and, with Hughes' existing global contract with Row44/Global Eagle bringing real experience to the table, this opens up another major potential area of opportunity for the partnership with the domestic airlines.
But there's another "however" to all this! ISRO is due to launch its own HTS satellite in 2017, GSAT-11, which will bring 12 Gbps of capacity to the market. An RFP was issued for the ground infrastructure and the Jupiter2 system from Hughes was, once again, selected as the system platform. This all places Hughes in a highly dominant position in relation to the application of high-throughput satellite capacity over India. Leaving aside the benefits of such huge system hardware sales, with increasing demand for greater levels of bandwidth from the segments of the market discussed above, including the banking, media, government and cellular backhaul industries, these wins look likely to place Hughes in an extremely strong position for future growth opportunities.

India is a very dynamic market for VSAT, but there appears to be no end to the amount of large scale opportunities that HCIL foresees for its business. Along with the growth in banking, ATMs, media content, distance education and backhaul, there are large potential contracts for smart grid applications from the big utility companies (many of which are already Hughes customers) and connectivity for up to one million schools. In the meantime, some of the unique capabilities of the HX platform – multi-gateways, hybrid star/mesh and scalable expansion for high bandwidth, high QoS networks in a low cost package – have also opened the door again for the company to participate in the systems integration business. In one sense HCIL never left the SI business, but at a practical level the age of its TES and TRES products left it relatively inefficient and uncompetitive. The HX changed this dynamic considerably and HCIL found itself with a competitive advantage and opportunities in the defence, oil & gas, government and mobility areas.

As a result, turnkey network provision and systems integration has emerged as a strong business for HCIL with significant contract wins in the defence sector with the Indian Navy and Army. These contracts have large mobility components to them with connections to ships, submarines, aircrafts, vehicles and soldiers. Very often they require highly customised solutions and integration with specialist antenna systems – an area of expertise that Hughes has been developing for the US DoD market for some time now. HCIL brings the Indian component to this activity and the HX units have been ruggedised and conform to Indian MilSpec JS55555. HCIL has also built close alliances with specialised system integrators and Defense contractors like BEL, ECIL and HCL Infosystems. This is a highly competitive segment of the market, but once again, just as it does in the ATM and carrier markets, the company partners with some of the well-established military and government system integrators. With its own internal R&D capabilities and the full support of HCIL's parent in Germantown, the company has successfully bid for several network requirements with customers ranging from Homeland Security to the National Railways and State e-Government networks. Whilst this is not a service business in the strict sense of the word, support contracts can extend up to 10 years making this a highly attractive niche.

HCIL now has over 200 different large enterprise customers on its various managed and private (captive) VSAT services accounting for over 100,000 individual sites. Its customer list is a Who's Who of India and spans a range of different industries that gives it both scale and an important position from which to leverage its newer business initiatives. HCIL believes that this along with its strong brand name in the enterprise market and its ability to capture and retain customers is the main reason that its terrestrial partners have given it the support that they have. The company has also evolved its business model to rent, rather than lease or sell the VSAT terminal. This allows many customers - particularly banks - to speed up decision-making and commit to operational, as opposed to capital expenditure. As an added bonus, HCIL benefits from longer contract terms – often up to five years – and a much stickier service. At the same time, management has spent time to ensure that operational, as well as sales, staff have direct links to customers. This has streamlined problem resolution and dramatically increased the levels of customer satisfaction that HCIL periodically surveys.

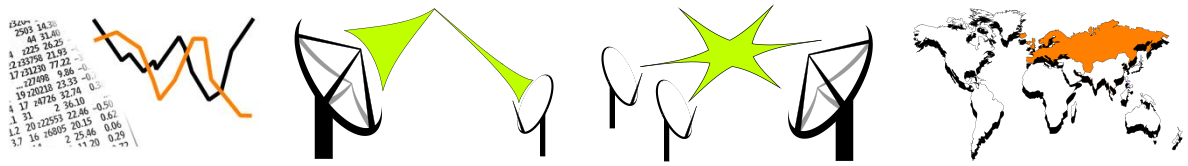
From a competitive perspective, the big three operators have clearly begun to squeeze the marginal players out and even HCL and BSNL look minor players next to them. As volumes grow, the smaller operators are left with considerably less scale and buying power and only prospects for a fraction of the business. Five years ago, the danger for HCIL was that it would also find itself in a weak position versus the major carriers, but 2011 saw the company begin to turn this situation around with its customer-neutral carrier extension strategy. Hughes is keen to point out just how committed it is to the Indian market. Its main parent has been a long time investor in the country and Escorts is a well-established conglomerate in India. Additional unique selling points are the fact that HCIL has the considerable experience and expertise of Hughes Network Systems' various other shared hub operations in the United States, Europe and elsewhere to draw upon. In addition, its close links to the manufacturing process ensures software development is continuous and it has developed some uniquely Indian alternatives for the demand it sees including an HX solution with a virtual platform able to support branch operations. It continues to work on adding technology features to its VSAT platforms, both with its parent's engineering department in the US and its own technical resources, and will no doubt have some major influence on some of the added capabilities of the latest Jupiter2 platform.

The company believes that VSAT solutions will continue to grow in India because they are independent of the public network and, importantly, the technology provides a single point for network management, control and responsibility – one of the attributes it is able to sell to both other operators and major customers. It believes that the growth in applications which will increasingly require reliable connectivity across all of India and the technology's falling cost of ownership will help drive this growth. The biggest immediate concern for HCIL is the lack of available bandwidth, but with its recent wins with BSNL for IPStar and ISRO for GSAT-11 may well prove to be the solution to this problem and boost Hughes even further in terms of its leadership position in the market. This would hardly be surprising considering that Hughes has undoubtedly been the most innovative, progressive and adaptable of all the VSAT service providers in India and has a very talented management team which has leveraged its parent's technologies to synchronise with the unique needs of the Indian market.

In summary, it is hard to see how HCIL could have managed its business much better or achieved much more. The company has faced up to, and largely held off, some major competitors by staying at the forefront of the business, always pursuing opportunities with aggression and being willing to push the edge of the market and technology's boundaries. During this time the market has undergone a continuous evolution and HCIL has adeptly managed its way through these changes. Acquisition has not really been a major option for the company during the consolidation of the business in the country because HCIL is the only major operator of the Hughes suite of products and so it has grown its business organically, purely based on focus on the core capabilities of the technology and its inherent expertise. Some would also argue that, even as the leader in the VSAT services industry in India, HCIL is disadvantaged by the fact that it does not have the carrier facilities enjoyed by Tata and Bharti. However, we believe that the converse is true and that the company is able to feel confident in the long term prospects for its business because VSAT technology is a core element of its product portfolio and one which it is able to manipulate as a platform and control probably better than any of its competitors. VSAT services and the experience of managing both applications and networks for a large customer base establish HCIL as a valuable partner for any network provider and the recent agreement with BSNL is strong evidence of this.

Of more importance, though, is the fact that HCIL has been innovative in its pursuit and development of value added applications which it is able to support and sell through its platforms. It is perhaps this which is the single largest differentiating factor for Hughes over its rivals, all of whom seem to be slowly migrating their interest away from any real reliance on VSAT as a pure connectivity solution. Whilst this may seem a natural evolution, by definition it substantially dilutes many of the key advantages which satellite is able to offer certain applications and which HCIL has demonstrated that it can build a business around. The net result is that even as the market consolidates, the individual operators pursue very different strategies. Thus, Hughes increasingly becomes a unique specialised provider with little or no competition in its chosen segments of the business. This was the successful strategy which the company identified to compensate for the decreasing revenues and tight margins in the mainstream VSAT business and now that prices have stabilised and have even begun to increase, its effect will be even further leveraged. A combination of HCIL's willingness to innovate and commitment to both VSAT technology and the Indian market has propelled the company even further in its leadership role.

7.5. Hughes Network Systems Europe



Systems & Facilities:

Star:	Hughes, HN Series Hughes, HX
Mesh:	Hughes, HX260
SCPC:	Comtech
Frequency:	Ka, Ku and C-band
Other:	One way services based on HN7000. Managed hybrid VSAT/terrestrial services, DSL and GPRS. Solaris S-band MSS services.

Hubs:	Griesheim, Germany Fucino, Italy (Telespazio)
Satellites Used:	Eutelsat E7A, E10A, E33A; Intelsat-10, 20, 905; Avanti HYLAS-1 & HYLAS-2
Service Area:	Europe/World
Install, S&M:	Hughes Europe and third parties

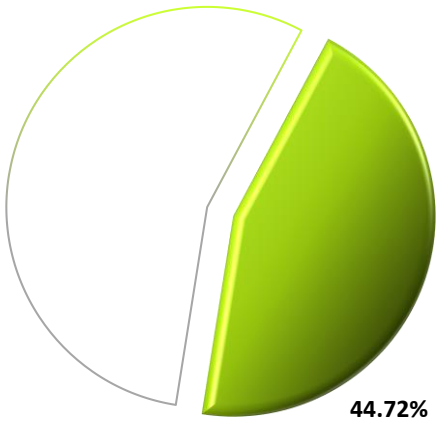
Commercial Factors:

Growth:	Stable
Staff:	~126 (110 for HNS Europe)

Capacity:	~250 MHz
Revenue:	~US$67 million for service & hardware (2015)

Business:

TDMA Business	Total
TDMA Installations:	~36,800
TDMA Customers:	~15 + SMEs



Western Europe Enterprise TDMA Market

Hughes Europe is the largest provider of enterprise VSAT networks and satellite broadband services in Europe. The company currently has almost 15 enterprise accounts with just under 37,000 enterprise sites in service and a small number of broadband subscribers sold through a network of value added resellers. Enterprise reference accounts include Shell, Camelot, Volkswagen and BP. Hughes Europe introduced its own version of Hughes' Unified Broadband service during 2006 and, since that time has signed several major contracts to provide a managed hybrid network solution. Other terrestrial accounts include Avis, BP, Body Shop and Shell. In total, the company now supports almost 50,000 managed sites including managed networks for customers, such as iWay in Africa, from its network facility in Griesheim.

Additional Information:

Hughes Network Systems Europe (Hughes Europe) is a wholly-owned subsidiary of Hughes Network Systems, the largest manufacturer and service provider of VSAT systems in the world. Following an acquisition during 2011, Hughes itself is now owned by EchoStar Corporation. The service part of Hughes Europe was begun as a 50/50 joint venture between Hughes and Olivetti in 1996 as Hughes-Olivetti Telecom. In 1998 Hughes purchased all of Olivetti's shares and renamed it HOT Telecommunications which was subsequently rolled into Hughes Europe as a single operating entity in 2003. Today, Hughes Europe provides both service, based on the Hughes VSAT platforms, and hardware sales. Hughes Europe was started with the intention of offering pan-European interactive VSAT services in the enterprise market and is currently the largest provider of these services in the region. Its horizons have since expanded and it now bids all types of enterprise networking contracts for customers based in Europe, even those with a worldwide network. It also continues to support a Ku-band satellite broadband VSAT service extending into the Middle East and Africa, but the focus in this part of the business has moved towards Avanti's Ka-band service which also leverages the Hughes platform.

The company came out of the starting gate targeting the most obvious market sectors - petroleum retailers, hotels, car rental companies and automotive dealerships, all with pan-European businesses. It largely avoided the retail sector initially which tended to be very fragmented and domestically based, but this became a greater area of business in subsequent years. It was pan-European automotive dealership networks, retailers and government agencies which provided Hughes Europe's core customer base over the first years of its operations. Many of these first customers - GM and TK Maxx for example - were originally leads from the Hughes business in the US, but this again has changed in more recent times. However, this was not the whole story and over the years Hughes Europe has provided networks with European enterprises unrelated to its parent's business, such as the UK Post Office, Tesco and Volkswagen.

Hughes has run its shared hub service in the USA since it entered the business in the mid-1980s, and had participated in service joint ventures in Turkey, India and Mexico, so Hughes Europe was a logical extension and a consolidation of Hughes' position and long term strategy for the VSAT business. The resources at the venture's disposal are really quite substantial - Hughes has a long-established sales and marketing effort in Europe and offices in Milton Keynes (UK), Rome (Italy) and Griesheim near Frankfurt (Germany) staffed by around 110 people. Hughes runs its network operations from its primary teleport site at Griesheim, near Frankfurt, operates a second diverse NOC from Telespazio's major teleport facility in Fucino, northern Italy, and has its European headquarters in Milton Keynes, UK. Its service platform has worked through the various stages of the Hughes products from the PES in the early days to the HN7000S, HN9000 and HX series today. The company's NOC offers multi-lingual support to each of the customers on the service and is staffed 24x7.

At the time of embarking on the enterprise, Hughes Europe clearly believed that the European market had matured to the extent that deregulation had reached a stage which allowed the company to feel confident in its ability to provide service across the continent.

That said, the regulatory barriers continue to present a problem for Hughes Europe and its direct competitors. The issue is far less than it was five years ago, but spectrum rights, licence fees and procedures remain a bone of contention, especially when related to the more recent Ka and S-band services that the company is involved with, and Hughes Europe continues to lobby for more equitable access. Other issues, such as the acceptance of the technology by enterprise users and whether the solution could reach a competitive price point were believed to be either solved or solvable. However, even today, the stranglehold of the dominant operators remains a problem and customers in Europe continue to be more conservative by comparison with their counterparts in the United States.

The decision to begin a service in Europe was driven from a frustration of the slow progress being made by the national operators in the region – PTTs who seemed anti-satellite and happy to preserve the status quo. In the beginning, this move clearly upset some of the company's operator customers. It was always possible that some operators of Hughes hubs might find themselves facing their own vendor in a bid, but there was little that could have been done to avoid that. Over the years this situation has indeed arisen, but to be fair to Hughes Europe the company has mostly targeted the major opportunities in the region, leaving the smaller networks to the local shared hub operators. The major operators which suffered were those which harboured ambitions to provide similar regional service platforms - GlobalOne and Unisource Satellite Services (USS) are the two main ones which come to mind from the past. No one relishes the thought of competing against an operator which is also the manufacturer and this made life particularly hard for USS although the company seemed to find the market hard enough without major competition. Despite the complaints about this situation, the fact is that Hughes Europe did appear to catalyse the market in many ways and it is highly doubtful that Hughes could have achieved the volumes it has without the presence of a committed service subsidiary in Europe.

Hughes Europe's major breakthrough was when it sold a 3,500 site network to General Motors/Opel. This was always likely to be a good prospect for the company as GM was Hughes' parent company and was a Hughes VSAT customer in the USA. Since that time, Hughes Europe has been successful in winning a good proportion of the major accounts which have come up for bid in Europe and has established itself as the leading shared service provider in the enterprise segment in the region with close to half of the enterprise terminals in service in Western Europe. However, the company does have a harder time of things than in the United States. Politics, national alliances and service platforms take on a different meaning in Europe and it has had to fight hard in several contracts, some of which it has lost out to the likes of BT, Astrium, T-Systems, AT&T and Orange/France Telecom. At one time each of these were significant competitors, but today it would only be realistic to rate France Telecom at this level in the enterprise networking market given that Hughes has tended to step back from countries where it has a strong partner, like Telefónica in Spain or Telespazio in Italy.

In terms of its selling points, Hughes Europe has always emphasised the facts that interactive data VSAT services have proved to be extremely competitive with terrestrial services in North America and Europe and that the technology offers greater dynamic flexibility and a proven upgrade path coupled with longevity of service. The company also trumpets its leading market position and the fact that it is more competitive in scale than its rivals. It lays a heavy emphasis on its ability to work with the customer to optimise its applications for the

VSAT technology and contributes intensively in almost a consultancy role to ensure that the LAN and WAN platforms perform to their best - a cradle to grave service. However, for all this vested interest in VSAT technology, Hughes Europe sees its unique value proposition as its willingness and ability to provide a complete, pan-regional managed network service for its customers. The company has increasingly moved to focus its sales on often large and complex multi-national networks where it can leverage its long-established expertise in managing enterprise services down, in some cases, to the application level.

The company has been able to develop a clear understanding of most customers' needs and believes that its expertise in IP networking and software and hardware integration is crucial. In the initial phase, customers are signed up for a pilot network for which they are expected to pay because Hughes Europe, like most others, believes that some level of commitment is required to qualify a customer's interest. On the successful completion of the trial, judged by a number of pre-agreed tests, the full network deployment begins. Hughes Europe contracts to provide a minimum of 99.5 per cent availability - end to end - targets 99.7 per cent and claims to achieve 99.8 per cent. This is measured over three monthly segments and there are penalties tied to non-availability of the service (including hardware down time), so field service response is also critical for the company.

From 2000 onwards the company became more focused on building new business around value added services and proving the benefits which the technology could bring with support for a variety of different applications. These included things like video and data multicasting and music and audio delivery which, Hughes Europe believed, needed to be sold individually into different parts of a customer's corporate structure, obtaining buy-in from each. Largely this was a result of the company's frustration with the lack of vision by many potential users and the conservatism seen in many European businesses. Much of this strategic direction towards a greater emphasis on service based solutions is mirrored in the intentions of Hughes Europe's parent in the US. Hughes Europe is smaller and more nimble than its parent (and arguably has less to lose), but it has what is possibly the most important ingredient - the willingness to take ownership of the project and bring all the elements together in a comprehensive solution from the LAN and WAN to the applications and hardware. We have commented before on how we had been impressed by the level of integration we had seen offered by the company.

This was made manifest in 2003 with the company's network deployment for Tesco, the UK's largest supermarket chain, which supported 5,000 screens at its 100 largest superstores. Hughes Europe's success at Tesco was helped by the fact that it had also been focusing its sales teams on specific opportunities, establishing better processes and disciplines, conducting more training and standardising solutions. The company has tried to bring a more systematic approach and turn one of the European region's largest problems - fragmentation - into an advantage by pursuing a greater focus on exploiting particular vertical segments of the market. The company continues to see potential in the retail sector of the market and believes that its initiatives to bring a richer level of application support to its platform are critical to many key accounts. This did yield some results and, along with Tesco, the company also signed up Asda, another major supermarket chain in the UK. Hughes Europe believes that globalisation is leading to standardisation in operational functionality and that pan-European networking across what have been diverse groups is now in greater demand. It has built more standardisation into its own service products to

meet this need in the form of a single SLA, standard tariffs across the region, a single point of contact as well as standardisation of back-office applications.

A further step in this philosophy came with the company's introduction of a hybrid VSAT/terrestrial solution. Like its parent in the United States, Hughes Europe had been increasingly frustrated by the focus of enterprise customers on DSL solutions to the exclusion of almost anything else. Some large accounts only invited DSL-based providers to bid and so in some instances Hughes Europe was not even able to offer its service. In the US, Hughes had finally decided to address this problem by reselling DSL connections as part of a unified managed solution. Hughes Europe introduced the same service, tying DSL connections back into its management NOC and providing a single point of contact for the customer. In 2006 this led to its successful bid to provide the European network for BP – a major account with many thousands of sites across the continent. We understand that the approach has opened doors where once they would have been closed and, whilst the company cannot claim that contracting with and managing many national carriers is easy, it does allow it to retain ownership of the customer and maximise the use of VSAT technology in a network. Hughes Europe has made great strides in quality control, accessibility, responsiveness and service delivery over the past few years and this has filtered right down into the company's employee base. This has been recognised and commented on by the company's customers.

2006 was a difficult year for the company with a great deal of work done to revitalise the business, work with new prospects and put its Unified Broadband service platform in place. Lead times have always been long in the VSAT business and Europe is probably worse than elsewhere. Some really key deals were signed or set up, but very little led to revenue generation during 2006 itself and the company had to consolidate its resources to address this. 2007 and 2008 saw Hughes Europe reap the results of the work it did during this time. BP for one began rolling out and mid-2007 saw the company sign the largest ever VSAT deal seen in Europe. This network, which now encompasses over 34,000 VSAT sites for Camelot, the UK lottery, is one of the top five biggest networks ever sold worldwide and possibly the largest ever single enterprise contract won at one go. Thus, 2008 was an epic year for the company which managed the massive deployment of the entire network over a 12 month period. With major penalties at all levels, Camelot trusted Hughes Europe to deliver its network in time for its concession that began in February 2009. The company completed the project on time, integrating DSL and GPRS services where VSAT installations proved difficult whilst also managing the changes that came with the closure in late-2008 of the Woolworth retail chain, a large reseller of the lottery. Camelot is a constantly evolving network for Hughes with 2011 and 2012 seeing a substantial expansion of the VSAT portion of the deployment and the elimination of almost all GPRS connections in order to raise availability. Slow but sure expansion of the network has continued and today Hughes Europe supports over 37,000 sites for Camelot.

Whilst Hughes Europe has continued to sign deals in Europe over the past two years these have increasingly been dominated by terrestrial connections as part of a managed service contract. Examples include networks for Deluxe Cinemas, which contracted with Hughes to manage the delivery of HD movies across 3,000 sites, and the Body Shop. Coupled with the terrestrial connections supported for Camelot, BP and Shell, around one quarter of all the company's managed sites now use alternative technologies rather than VSAT. Whilst some

of Hughes Europe's older, pure VSAT accounts have expired, several of its larger customers have renewed and extended their networks as well.

In 2001 both Hughes and Gilat launched consumer satellite broadband access services in the United States. In Europe, Hughes Europe targeted its service offering at small business customers and was the first to begin to build a network of value added resellers across the EMEA region having crafted a series of modular packages in a flexible and yet simple scheme which was easy for a VAR to understand and sell. The company had a considerable degree of success with its approach which was well thought out and which gave it a real first mover advantage over almost all of its major competitors. This was adapted as demand evolved, but as the SME broadband market peaked and growth began to decline as a result of the changes in the Middle East and Afghanistan markets and the advent of Ka-band services, the company began to scale down its activities. From a high of several thousand sites it now supports a few hundred, although in several instances Hughes hosts and manages its previous resellers hubs from its teleport in Germany. A good example of this indirect collaborative sales strategy is evident from the success of Bentley Walker, probably the largest reseller outside the United States, which has managed to maintain its leading position in 2016 despite the economic and political issues across these markets over the past few years. Bentley Walker continues to use 12 HX and HN hubs supporting service across Europe, Middle East, Central Asia and Africa. As far as its own direct wholesale service is concerned, Hughes has pulled back from vanilla satellite broadband in favour of its enterprise solutions business

Despite the slowing interest in VSAT in Europe itself, Hughes continued to believe a European market exists and in October 2009 the company announced a bilateral agreement with Avanti involving the sale of eight gateways and up to 50,000 terminals alongside a commitment to purchase £7.5 million of capacity on Avanti's Ka-band HYLAS-1 satellite. Not only did this give Avanti access to Hughes' expertise and resources of implementing and managing a service, it also brought with it a great deal of credibility for the project. From Hughes' perspective the partnership with Avanti – which has deepened over the subsequent years to encompass gateways, terminals and space segment agreements for HYLAS-2 – brought hardware revenue, but more importantly, its first international Ka-band play. In August 2011, following the transfer of most of Avanti's reseller sites onto the new HYLAS-1 Hughes-enabled VSAT platform from the interim capacity leased from Intelsat, Avanti announced that Hughes Europe had fully allocated its initial capacity commitment and had signed a new contract to expand capacity on the system. With increasing co-operation between the two companies, Hughes Europe sees Ka-band as one of its opportunity areas for future growth and has been actively working on potential strategies in this area.

Another suite of services that Hughes established centres around the HX platform which has been deployed in both Griesheim and Fucino. The HX is based on the same fundamental network elements as the HN, but incorporates a variety of other features – more granular QoS, ability to use standardised RF units, a greater variety of modem types, higher transmission rates and mesh networking (see the Hughes HX description in the System Vendor section of this report for more detail). In Europe, the company has targeted a suite of services that will be sold directly and through value added partners. In the first instance, the HX brings capabilities that enable greater mobility and the company now supports maritime and aeronautical services in much the same way that its parent has done in North

America working with Telespazio, GMC and Bluetide in the maritime segment and with Global Eagle for aeronautical services. Additionally, high-end VAR and VNO products have been introduced on the HX platform. Value added resellers are able to sell pre-packaged services in much the same way as they do on the HN platform that Hughes Europe supports, but the HX allows more customer and site-specific grades of service to be specified. Equally, the VNO offer takes the VAR one step closer to owning and operating their own hub equipment, but in smaller increments based on the same business model that has been popularised by iDirect.

Hughes Europe's greatest achievement over the past few years has been the realignment of its enterprise services business. The business in Europe now looks far more healthy than it has done for many years. Whilst the company was clearly the market leader before, the fierce competition between all the VSAT operators and the terrestrial providers had driven margin from the business of connectivity. Conventional wisdom has been to chase higher volumes to maintain profit levels, but Hughes Europe has begun to change the model towards more value from each network deal. This has been the mantra for several companies chasing high bandwidth links using SCPC and other technologies over multiple regions, but Hughes Europe has been the primary company which has managed to achieve this in the large European enterprise networking business using the end-to-end network management experience gained through its VSAT business to provide complex hybrid networking coupled with application support as opposed to higher bandwidth or reach into remote regions.

Hughes Europe believes that it needs to sell the value of its connectivity capabilities based on the engineering expertise that Hughes as a corporation is well known for. In Europe, Hughes is first and foremost a service company and its future will depend on its ability to harness the power of its networking abilities. The focus has been to build a greater value proposition around its VSAT platform, using alternative terrestrial services to deliver a one-stop shop service where necessary, but maintaining as much control as possible over the network infrastructure. The company continues to believe that VSAT is able to augment terrestrial services, but that its challenge lies in convincing European enterprises of this. It believes that the major areas in which it can effectively communicate this message are the financial and government segments of the market as well as specialised industries including lotteries and other transactional applications. Nevertheless today, the company's integrated solutions strategy, its European coverage and regulatory experience has meant that some of the major terrestrial carriers represent its largest customers.

Another area of interest that has emerged since the acquisition of Hughes by EchoStar is its parent's activities in the S-band satellite market. With an existing payload agreement with Eutelsat on its 10A satellite and the launch of EchoStar XXI which provides coverage of the European Union scheduled for 2016, Hughes Europe has become the headquarters for EchoStar Mobile. Having obtained licences in 28 member states across the continent, EchoStar mobile believes that it occupies a unique position with its 30 MHz of S-band capacity which sits adjacent to spectrum used for 3G services and has good indoor penetration, to partner with and enhance a variety of wireless/cellular services particularly for emergency services. The service, known as PPDR (Public Protection & Disaster Relief) will allow first responders (police, ambulances, etc.) to obtain connectivity via the satellite when cellular systems are either suspended or damaged using wireless systems to extend services

to all emergency service personnel. Hughes has established new uplinks at its own site in Griesheim, Germany; Fucino, Italy (with an extension to its partnership with Telespazio) and Rambouillet, France (with Eutelsat). Whilst Hughes Europe essentially only provides the management and support structure for EchoStar Mobile, there might be possible areas of opportunity in the future.

Hughes' business in Europe is now very much service orientated and Hughes Europe has refocused its enterprise strategy more towards core networking capabilities and stronger application support value propositions. At the same time, it has restructured a hardware and service business which has grown over time, sometimes haphazardly, into a more cohesive operation with mutually supporting units and offices. We believe that management has been particularly adept with its strategy for its business as a whole, adapting its approach in both the internet access and the enterprise networking business. Its push to add managed hybrid solutions and mobile services are two more examples of this and shows that the process is never finished and that the company is prepared to meet the challenges head-on. Hughes Europe sees its Ka-band business activities opening up opportunities for it to enable cloud-based applications for its corporate customers who are demanding ever greater amounts of bandwidth via satellite services. Its hybrid service initiatives have been a real success story with the largest customer, BP, providing a highly rated reference.

The company has retained and extended its position as the market leader and continues to set the pace in the large enterprise networking business. Management has rearranged the company's approach to the market whilst maintaining its primary customer targets with a greater emphasis on the sales process itself and a more forceful value proposition based on satellite technological network strength versus the terrestrial competition. It has also maintained a strong hardware sales role, successfully selling both dedicated small, highly customised, specialised network systems to end users as well as supporting its operator customers in their bids. The most recent example of this was in mid-2013 when Telespazio of Italy won the contract to replace the 3,000 site network for Intermarché, the French supermarket chain with a new Hughes system. The challenge will be how it builds a consistent pipeline in the long lead-time, contract-led enterprise segment. However, having re-built its installed base, re-vamped its service platforms, extended some key accounts and adopted its parent's latest products, Hughes Europe has both maintained its existing business and established new potential opportunities.

8. Reference Customers

The strength in depth of Hughes' customer base can be seen with the variance between some of the largest enterprise businesses as well as the major telcos down to small individual operators and end users in every region of the world.

Enterprise VSAT Customers	*Region*	*Enterprise VSAT Customers*	*Region*
Afsat	AM	Level 3	LA
Alkan Telecom	AF	Lintasarta	AS
Altegro Sky (Sett/Antelsat)	EU	Media Networks	LA
AltegroSky	EU	MegaFon	EU
Amazon Tech	LA	Murphy Oil	NA
American General Finance (AGF)	NA	National Oilwell Varco (NOV)	NA
Anditel	LA	NICN-NSSet	AS
Arsat	LA	NIT Nigeria	AF
Auto Zone	NA	NoviaSat	ME
Avantec	LA	Numix	AS
Avanti	EU	Omantel	ME
Axesat	LA	Pegaso	LA
Baycom	AS	Pemex	LA
Bentley Walker	EMEA	Primacom	AS
Bergen Brunswig	NA	Primesys	LA
Best Western	NA	Protocol Solutions	AM
Bharat Electronics	AS	RosTelecom	EU
Botswana Telecom	AF	RSCC	EU
BP/Amoco	NA	RSCC	EU
BT Latam	LA	RTC (Real Time Communications)	NA
Buckeye Pipeline	NA	RTComm	EU
Camelot/GTECH	EU	Rusat	EU
Celcom	AS	Saudi Aramco	ME
Cisco Systems	AS	SCT	LA
CNT	LA	SeaNet	AS
ConocoPhillips	NA	Sears	NA
Cracker Barrel	NA	Shell Central Europe	EU
CVS Pharmacy	NA	Shell Pipeline	NA
Datagroup	EU	Sky Perfect JSAT	AS
Delta Telecom	AS	Skyband	ME
Denny's	NA	SkyPerfect JSAT	AS
EnTel Bolivia	LA	Sonic Restaurants	NA
ER Net (Educational Research Network)	AS	Spanish Lottery (STL)	EU
Fitel	LA	SPTI	LA
Galaxy Broadband	NA	SSL Digital	LA
Global Eagle Entertainment	Global	Superonline	EU
Globecomm	Global	Telecom Colombia	LA
GTECH	NA	Telefonica Argentina	LA
Hispasat	LA	Telefonica Data	EU
Huascaran	LA	Telekom Malaysia	AS
Hungaro Digitel	EU	Telesat Canada	NA
Imara	AF	Telespazio	EU
Internet Gabon	AF	Telkom SA	AF
Internet Solutions	AF	Telmex	LA
IPNet	EU	Thaicom/BSNL	AS
Iran Telecommunications Company	ME	TS Global Network	AS
ISC	ME	Turksat	EU
ISNet	EU	Ufinet	EU/LA
ISRO	AS	USSC	NA
ITC Limited/E-Chopal	AS	Visa International	NA
iWay	AF	Vodacom	AF
Kazteleradio	AS	Volkswagen	EU
KB Iskra	EU	Yahsat	EMEA
KBZ Gateway	AS	Yum! Brands, Inc	NA
KT SAT	AS	Zimbabwe Schools	AF

9. Hughes Contacts

9.1. Investor Relations & Media www.hughes.com

Judy Blake
Director, Public Relations & Marketing Communications
Hughes Network Systems
11717 Exploration Lane
Germantown, Maryland 20876-2799 Tel: +1-301-601-7330
United States of America Email: judy.blake@hughes.com

9.2. Hughes Sales & Marketing

9.2.1. US & Canada www.hughesnet.com

Mike Cook
Senior Vice President North America Tel: +1-301-428-7083
North American Division Email: mike.cook@hughes.com

Sam Baumel
Assistant Vice President, VAR & VNO Sales Tel : +1-301-601-6384
North America Email: sam.baumel@hughes.com

Sampath Ramaswami
Senior Director, Strategy and Marketing,
Enterprise Solutions
Hughes Network Systems
11717 Exploration Lane
Germantown, Maryland 20876-2799 Tel: +1-301-428-2996
United States of America Email: sampath.ramaswami@hughes.com

9.2.2. International www.hughesnet.com

Dr Vinod Shukla Tel: +1-301-428-5606
Senior Vice President Email: vinod.shukla@hughes.com

Ramesh Ramaswani
General Manager
International Division
Hughes Network Systems
11717 Exploration Lane
Germantown, Maryland 20876-2799 Tel: +1-301-428-2976
United States of America Email: vinod.shukla@hughes.com

9.2.3. Latin America — www.hughesnet.com.br

Delio Morais
CEO
Email: dmorais@hughes.com.br

Rafael Guimaraes — **www.hughes.com.br**
Presidente
Hughes do Brasil Eletronica e Comunicacoes S.A.
Av Brig. Faria Lima, 201 - 7º andar
São Paulo, SP - 05426-100
Brazil
Tel: +55-11-3818-7500
Fax: +55-11-8149-6323
Email: rguimaraes@hughes.com.br

9.2.4. Europe — www.hugheseurope.com

Chris Britton
Managing Director
Hughes Network Systems Europe
Hughes House
Rockingham Drive, Linford Wood
Milton Keynes, MK14 6PD
United Kingdom
Tel: +44-1908-425-300
Fax: +44-1908-425-301
Email: c.britton@hugheseurope.com

9.2.5. India — www.hughes.in

Shivaji Chatterjee
Vice President – Enterprise Services
Hughes Communications India Limited
Plot No 1, Sector 18, Electronic City
Gurgaon (Haryana) 122015
India
Tel: +91-124-307-2547
Fax: +91-124-239-8840
Email: schatterjee@hughes.in

9.2.6. Africa — www.hughes.com

Dharmendra Singh
Regional Director – Sub-Saharan Africa
Hughes Network Systems
Plot No 1, Sector 18, Electronic City
Gurgaon (Haryana) 122015
India
Tel: +91-124-307-2547
Email: dharmendra.singh@hughes.com

9.2.7. Middle East — www.hughes.com

Soheil Mehrabanzad
Assistant Vice President and Managing Director
Middle East and Africa
Hughes Network Systems
HNSISC, Office 1206, City Tower 1
Sheik Zayed Road, Dubai
United Arab Emirates
Tel: +971-4-332-6300
Email: soheil.mehrabanzad@hughes.com

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10. About comsys

COMSYS is a specialised telecommunications consultancy company which was founded in 1982. COMSYS performs a range of consultancy services in many areas of the telecommunications industry, but has concentrated its resources in the field of satellite technology and has developed expertise in business planning, regulatory, administrative, technical, competitive and operational analysis. Clients range from users and governments to operators and manufacturers.

Over the past 30 years we have visited essentially all manufacturers of VSAT systems and most of the world's operators of VSAT systems as part of the primary research we do in the industry. COMSYS is regularly consulted on VSAT industry matters (as well as the satellite communications business in general) by clients both within the satcom industry and outside it (including the financial community, regulators and larger consulting firms). We have also advised clients on present and future markets, mergers & acquisitions, new products, service introductions, application platforms and network procurements ranging in size from 50 to 3,000 sites. On the financial side our figures and analysis of the VSAT industry have been extensively used by Wall Street analysts for many years as well as in filings to the SEC and in support of other financial documents and business plans. COMSYS has been the primary industry advisor or part of advisory teams in the purchases of most of the major satellite-related sales over the past few years, including those of Inmarsat, PanAmSat, Hughes Network Systems, CapRock, Schlumberger GCS, Intelsat and many others.

The company's client list spans the globe. COMSYS has recently worked on a number of projects for clients in Africa, Asia, Europe, the USA and the Middle East. These studies have included issues relating to VSAT network procurements, satellite operator business models, mobile satellite services, technical and marketing assessments and due diligence assistance. COMSYS has earned a reputation for objective, empirical analysis and is known in the industry as a primary source of market information. This reputation has been hard-earned by constant monitoring of the world market through visits to businesses in more than 70 countries.

COMSYS LLP
LONDON
UNITED KINGDOM

TELEPHONE: +44-1727-832288
EMAIL: COMSYS@COMSYS.CO.UK
WEB SITE: WWW.COMSYS.CO.UK

comsys