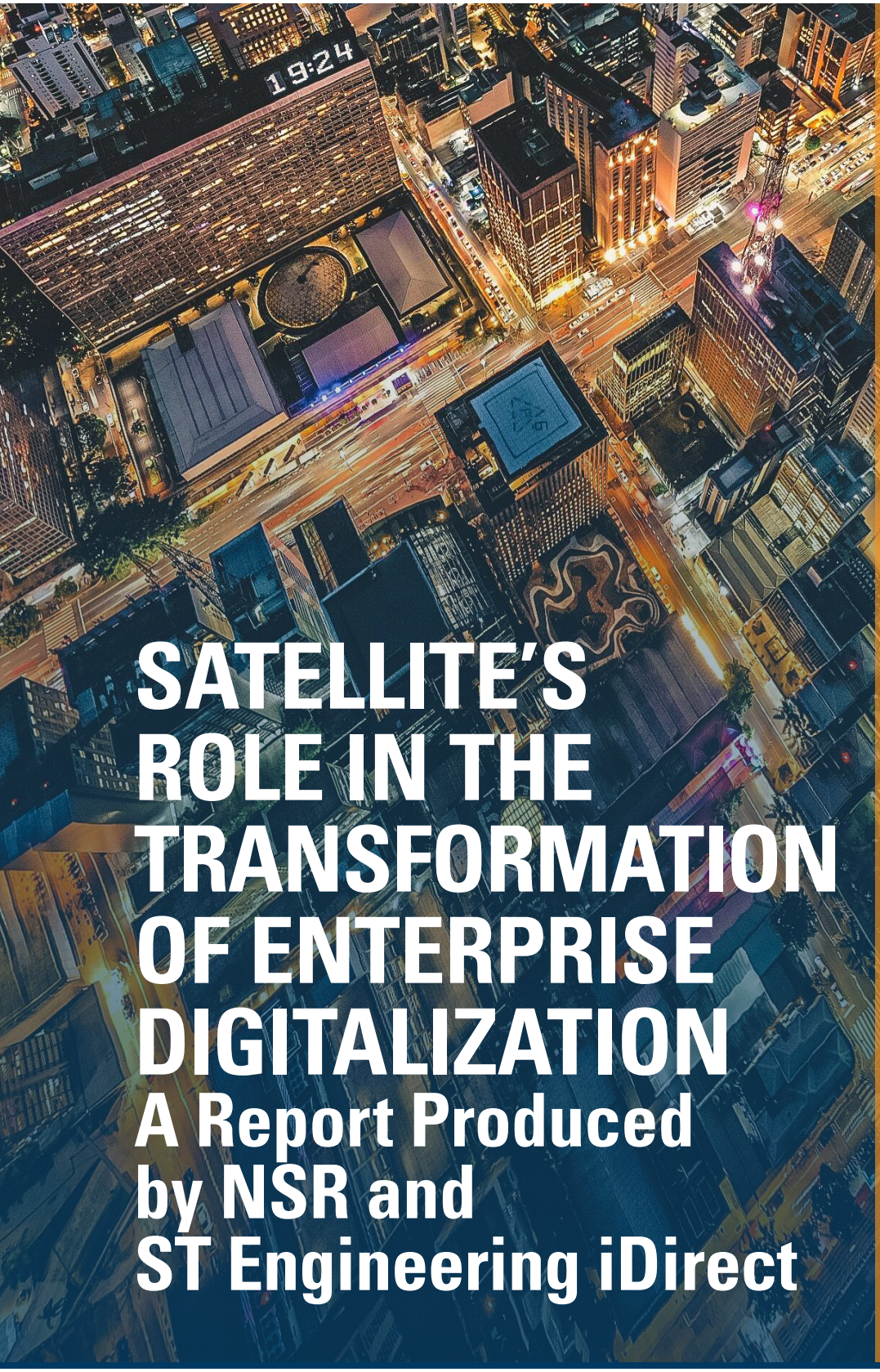

ST Engineering

SATELLITE'S ROLE IN THE TRANSFORMATION OF ENTERPRISE DIGITALIZATION

A Report Produced by NSR and ST Engineering iDirect

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Introduction

Satellite technology has, is and will continue to play a critical role in enterprise markets, particularly for remote and underserved locations. This is evident in the energy sector where satellite communications are often the lifeline, if not the only link, for personnel and critical assets such as those in offshore oil platforms. However, urban centers require satellite connectivity as well, and many industries including retail and banking have adopted satcom solutions as part of their primary mode of communication. Back-up services likewise take up demand for both remote and urban premises.

In today's enterprise world, emerging needs alongside more traditional applications in the energy, banking and retail sectors, are leading to innovative solutions from the entire satellite ecosystem in order to address current and next-generation requirements. The transformation brought about by the adoption of emerging applications such as Big Data Analytics and Cloud Computing are now beginning to impact the satellite sector where services range from Cloud-hosted applications by end customers to Cloud storage/processing. For a growing number of satellite operators and service providers, partnering with big IT and Cloud players helps them drive increased bandwidth usage with existing customers. Enabling technologies both in the space and ground segments need to be developed and deployed quickly in order to keep pace with the innovative disruptions taking place within the marketplace.

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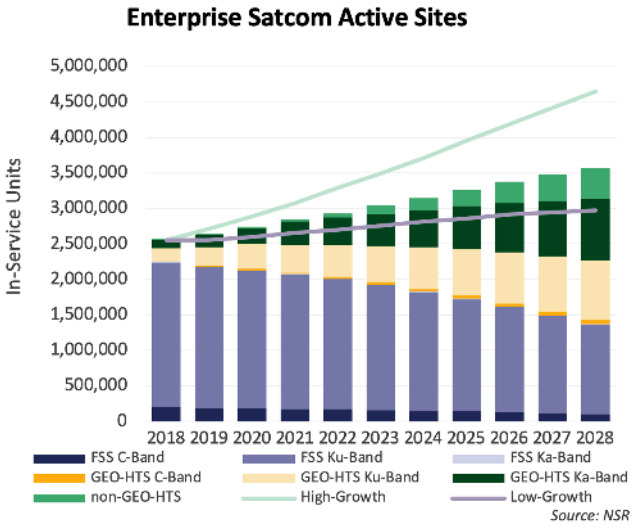
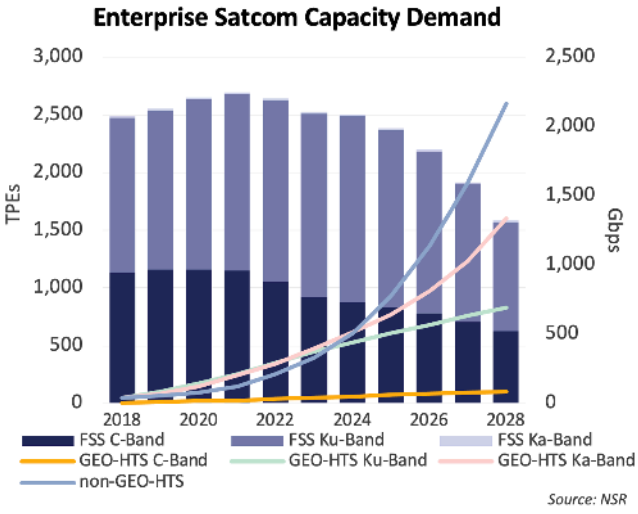
As an industry vertical, the overall market is positioned to exhibit steady growth in terms of the number of sites as well as bandwidth requirements over the long term. Most notable are the increase in HTS platforms, growing at robust levels and replacing traditional FSS platforms over the long term.





Most notable are the increase in HTS platforms, growing at robust levels and replacing traditional FSS platforms over the long term. The transition is driven by evolving end user requirements in terms of data security, technology innovation brought about by cloud-based services and other yet unforeseen requirements that need to be backward-and-forward compatible. The key to enable the transition lies in equipment and this means two things:

1. Upgrades have to be undertaken that both enable traditional services and platforms to continue to be served as well as be robust and dynamic enough to account for future applications.

2. Future solutions need to be technology-enabled to be able to support:
   - SD WAN
   - Data Analytics
   - Edge Computing
   - 5G
   - Private LTE

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Key Trends on Digitization

Digitization has been an ongoing effort by enterprises as part of modernization efforts, creation of efficiency and the delivery of value to customers. Digitization is also a concept of transformation and disruption where the so-called "old ways of doing business" are being replaced or upgraded to modern processes in order to achieve better decision-making and encourage further innovation within the enterprise.

There are five (5) key aspects to the future of digitization. Although discussed independently, these are inter-related with each aspect impacting other elements profoundly in an integrated solution and offering to the enterprise as well as the overall network.

SD-WAN

Software-defined networking in a wide area network (SD-WAN) simplifies the management and operation of a WAN by decoupling the networking hardware from its control mechanism. Its main function is to solve issues surrounding high latency, packet loss, bandwidth limitations, and congestion. As a virtual WAN architecture, enterprises are able to leverage combinations of transport services such as MPLS, LTE and broadband Internet services that securely connect users to applications.

For satellite solutions, meeting SD WAN networking requirements is and will become easier as broadband satellite systems are becoming more robust with HTS solutions in various orbits. Latency is being addressed as well with systems on MEO and LEO improving performance thresholds.

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Enterprises whether in remote or urban locations need to leverage a private network that is layered over the Internet to accelerate data and improve application performance. At a minimum, the enterprise or the network running SD-WAN needs a fat and fast pipe. The good news as mentioned above is that current and future satellites on an HTS platform are capable of these features from simple bent-pipe architectures in GEO to more complex LEO satellites with inter-satellite links (ISL).

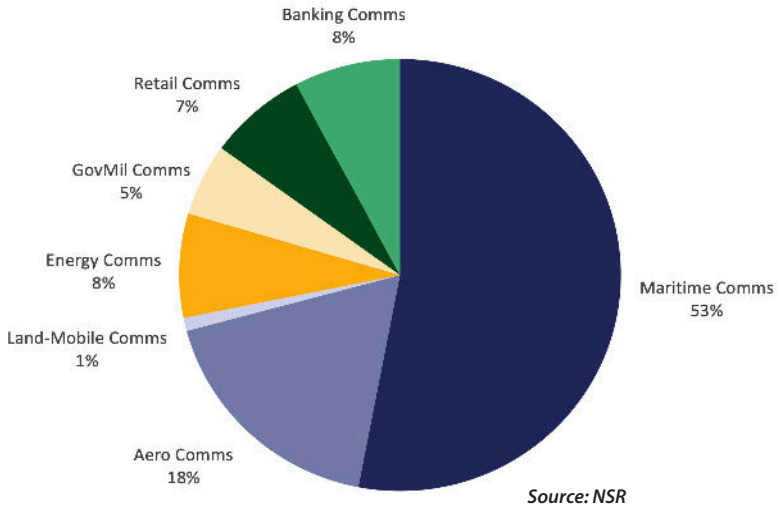
But what about the ground satellite systems? Can current systems solve issues surrounding high latency, packet loss, bandwidth limitations, and congestion? In a word, yes. However, future implementations need to improve performance thresholds as congestion becomes more pronounced due to the volume of data passing through the network that will then exacerbate other problems, particularly packet loss and latency that henceforth lead to limitations in bandwidth performance.

Data Analytics

The satellite industry is currently witness to a transition, as many verticals (especially those heavily dependent on satcom) are adapting to newer and digitalized business strategies. This transformation brings with it many benefits, one of which has been the influx of data analytics applications: raw data is gathered, then inspected, cleansed, transformed and modeled in order to discover useful information that leads to better decision-making and conclusions. Such applications, enabled in tandem by the growing adoption of cloud computing services, help optimize business performance and the bottom lines of various players in the satellite ecosystem.

In the world of satellites, the long-term gains of business agility and IT flexibility are key drivers for data applications being rolled out by both established and newspace players. Meanwhile, the adoption of such solutions by satcom customers requires a streamlined delivery process, one made possible by virtualization and cloud-based services. For a growing number of satellite operators and service providers hence, partnering with big IT and cloud players is the way forward to drive increased bandwidth usage with existing customers, in turn feeding into data analytics related revenues.

Cumulative SatCom Cloud Service Revenues, 2019 - 2029



Source: NSR

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NSR's ***Cloud Computing via Satellite*** report forecasts upwards of **52 Exabytes of comms-related cloud data traffic transported via satellite in 2029**. The 2019 to 2029 period is expected to present an opportunity for nearly $10 billion in satcom cloud service revenues cumulatively. That's a lot of data via satellites to be handled by ground systems but also a large revenue opportunity over the 10-year horizon.

The data analytics/cloud computing via satellite market is communications-centric, in terms of both data traffic and service revenues. This is driven largely by demand in the Maritime, Aero and Energy segments, and further by direct cloud connectivity partnerships between satcom and cloud service providers (CSP). Real-time microservices on maritime fleets, optimized capacity usage applications, predictive analytics for operational savings, crew welfare, video intelligence, etc. are but a few main applications driving customer interest. The development of cloud-based data applications is also expected to bring in bandwidth savings as they move closer to being "high value low volume" with greater margins, leading to increased revenue opportunities as well. Direct connectivity partner programs with Cloud Service Providers (AWS Direct Connect, Azure ExpressRoute, IBM DirectLink etc.) ensure high performance cloud-access to satcom customers in all sectors. Satellite operators and satcom service providers that pursue such partnerships are well-positioned in the long-run as increased network usage by their users will lead to ancillary revenues.

The terrestrial telecom industry is fast shifting towards 5G networks, with SDNs and NFV forming key parts of strategic efforts. With the ever-increasing complexity of satellite networks, especially as non-GEO HTS mega-constellations come online, there are adjacent business opportunities expected not just in the application layer as discussed above, but the network layer as well.

SaaS data applications that improve the network management strategies of satcom providers will form the bulk of this segment. Customer demand for value added services continues to rise, and if satellite players are to compete with their terrestrial counterparts, the ability to provide customized solutions with a quick turnaround time will be key. Satcom providers at risk of lower margins driven by increasing capacity supply can circumvent this by bundling high value data analytics services as a portion of their service portfolio. In addition to understanding end-user requirements and the security/privacy concerns of customers, adopting cloud-first approaches, NFV and automated spectrum allocation to provide highly reliable QoS will ensure satcom players are competitive with economical and affordable services.

Data analytics and cloud computing bring multiple benefits to an organization. Newer cloud-based solutions further blur the demarcations in the traditional satellite value chain, opening up the satellite/space market to competition and innovation from the wider big data and cloud computing industries. With digitization cutting out the need for ownership of hardware/software, satellite players are now able to cooperate with IT/big data players to serve their customers much more efficiently.

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Edge Computing

Edge computing has always been a key feature of satellite solutions given that equipment in remote areas have the core mission of providing a communications pipe to create new and improved ways for enterprise sites to maximize operational efficiency, improve performance and safety, automate core business processes, and ensure "always on" availability. In the satellite backhaul world for instance, local switching can be considered as an edge computing solution. In terms of improvement of performance and safety, SCADA and M2M/IoT have been performing edge computing services for decades, in oil & gas pipelines for instance. There are many examples of edge computing services that satellites have served over time, but there is one important feature of today's edge computing definition or requirement that needs an updating or upgrading of capabilities and that is the "cloud."

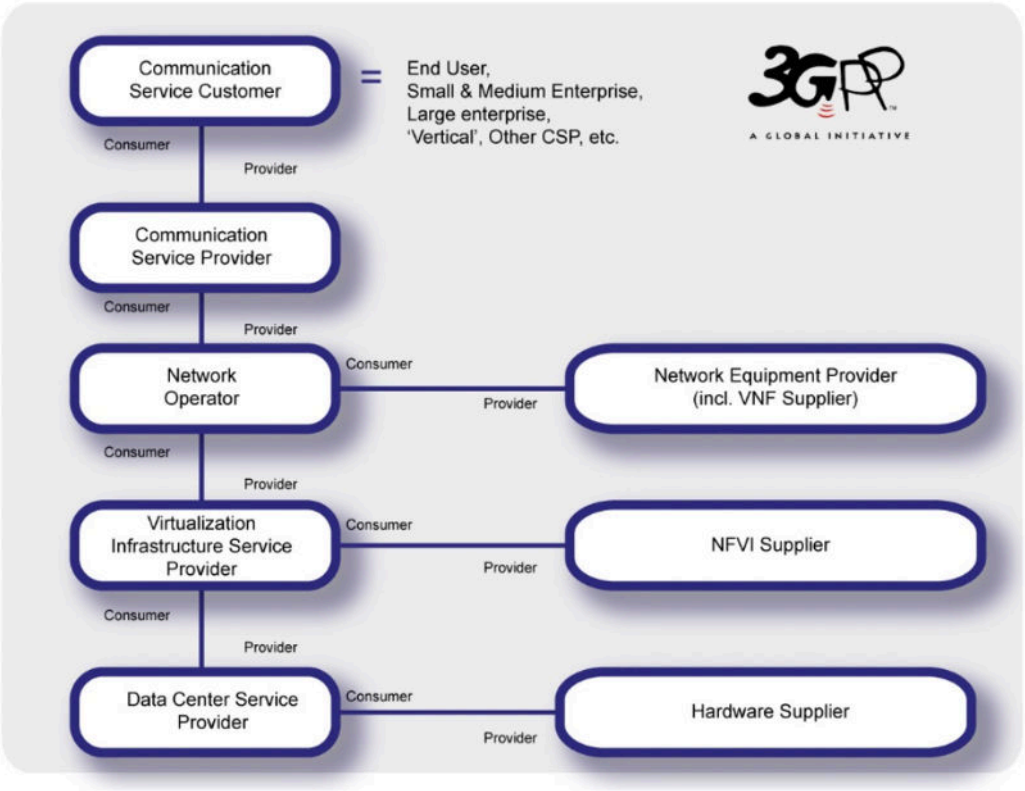
As mentioned above, edge computing is an optimization measure in terms of handling Internet devices, but a growing ingredient are web applications where the value proposition of edge computing lies in bringing computing closer to the source of the data. Edge computing by definition minimizes the need for long distance communications between client and server, thereby reducing latency and saving on bandwidth being used such as the local switching example on wireless backhaul mentioned above. Such a solution that brings computation and data storage closer to the "edge" such as remote locations where satellite solutions are used extensively increases reliability since reliance on the cloud, which may be at a distance or involves several data centers to accomplish given tasks is now closer to the remote site or is replicated in a manner of speaking to terrestrially unconnected areas. It is often said that edge computing does not mean the cloud will disappear but that the cloud is coming to you.

For current and future ground equipment, edge computing that brings the cloud to the remote site is and will be a growing and basic requirement. As such, equipment vendors need to integrate cloud-based solutions that likewise account for edge computing, data analytics and the core solutions that address SD-WAN challenges in terms of high latency, packet loss, bandwidth limitations, and congestion.

When examining spectrum resource allocation, network operations or integration with terrestrial networks and technologies, VSAT networks are largely private networks that operate in siloed environments where procedures are rigid and isolated, at least in today's current environment. Requiring custom processes, service providers find difficulty and challenges in setting up satellite networks in 3G/4G environments as the set up requires complex integration, escalation and replication. In a hybrid world, satellites continue to maintain its peculiarities in supporting bandwidth efficiency requirements and other physical constraints, which will become even more pronounced as networks integrate more capabilities and complexity.

However, there is good news coming to the satellite industry in light of the future network landscape for telcos as well as for enterprises. **By adopting standardized service orchestration, which is part of the 5G transformation, satellite networks will become much more user-friendly and easier to integrate.**

Roles Related to 5G Networks and Network Slicing Management



Source. 3GPP

Satellite operators and other players within the ecosystem are cognizant of 5G opportunities and are moving down the value chain via managed services platforms with future 5G integration as part of their future strategic thrust. Many players have taken the initial steps in the direction of creating greater flexibility and solving current challenges, most notably in global roaming for mobility platforms. The industry is positioning itself for future relevance and in reaping the market's full potential in terms of being part of the telco and enterprise network architecture and are thus beginning to integrate standardized service orchestration solutions in order to offer end customers:

- Reduction of configuration and support costs
- Enabling innovative services with shorter time-to-market
- Optimization of OPEX by adopting automation, self-service, and on-demand provisioning of network functions
- Facilitation and integration of satellite solutions in hybrid networks

5G provides unique opportunities and positions satellite as an integral component for supporting new and mission-critical use cases such as IoT, thus impacting how networks are architected and how future business models are developed. **Virtualization, cloudification together with 5G will redefine how network capabilities are procured** where Infrastructure-as-a-Service will become highly compelling. As multi-orbit domains, expansion of beams, scaling of users and resource flexibility lead to network complexity, **network orchestration provides a technology differentiator mechanism that will position industry players to be 5G-enabled** and thus reap the benefits and rewards 5G was designed to deliver.

Thus, 5G basically increases speed and improves latency for users. In the world of satellites, these features are increasingly being supported on the space segment via faster pipes and lower orbit solutions. **Once again, what about the ground satellite systems?** Can current systems support 5G? For supporting the wireless backbone as a 5G requirement, satellite ground terminals already support this, but performance thresholds will have to increase to keep pace with 5G performance.

As part of emerging solutions, ground terminals have to incorporate or once again take into account edge computing, data analytics and the value proposition of SD-WAN in a 5G and/or Wi-Fi6 environment. The "modern" satellite ground terminal is not only robust but is able to account for the growing intelligence of networks. More importantly, the ground equipment must not act as the bottleneck within the network but be a highly capable computing device that can multi-task and adapt to each enterprise or industry's need in a fairly plug-and-play environment.

Private LTE

Private LTE, a standards-based network designed to serve enterprises, government entities as well as educational institutions, is designed to be customized for more optimized network performance. In implementing a Private LTE network, micro towers and small cells can become access points for coverage and connectivity, functioning as scaled-down versions of public LTE networks but without the problems associated with congestion that is often experienced during peak hours in public networks. As independent networks that are non-reliant on cellular service providers, enterprises can craft and support mission-critical applications with high SLAs as they are not interfered with by spectrum used by public networks.

Apart from forming the core of corporate networks in traditional settings, other use cases can be applied in sites that include stadiums for special events, ports and airports for secure and high SLA applications, agricultural settings, mines, and oil & gas sites among others. These use cases have been served by satellites whether in an SNG/occasional use/special event scenario or in more permanent settings such as offshore oil platforms. Private LTE thus provides a new and emerging opportunity for satellite to quickly and seamlessly tap into these requirements whether as a backhaul solution or an integrated and new "Private LTE via satellite platform." Going forward, public safety missions, smart cities/highways and even digital divide programs for rural connectivity implemented by small private MNOs can utilize Private LTE via satellite to quickly provision services.

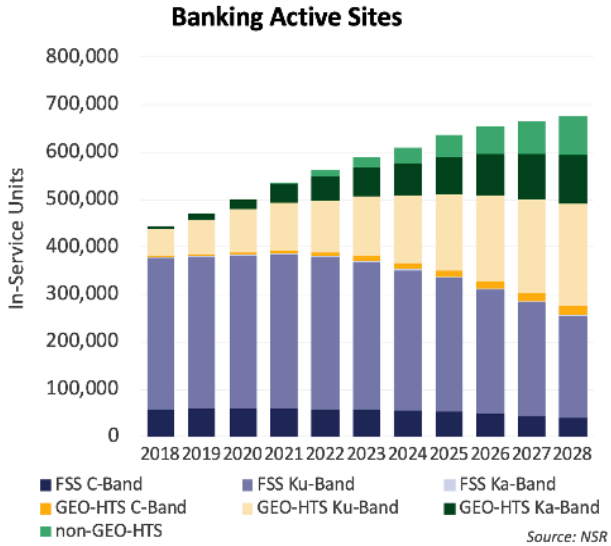
Private LTE networks is all about better performance where satellite ground systems, which are key pieces of the network that is truly private have to be robust enough to account for the high SLAs required by end customers. Private LTE is meant to support a high number of devices in a wide area setting with high-data transfer thresholds. Given these requirements, satellites can provide ideal solutions for a host of application suites including IoT, POS, SCADA and many others bundled within the network.

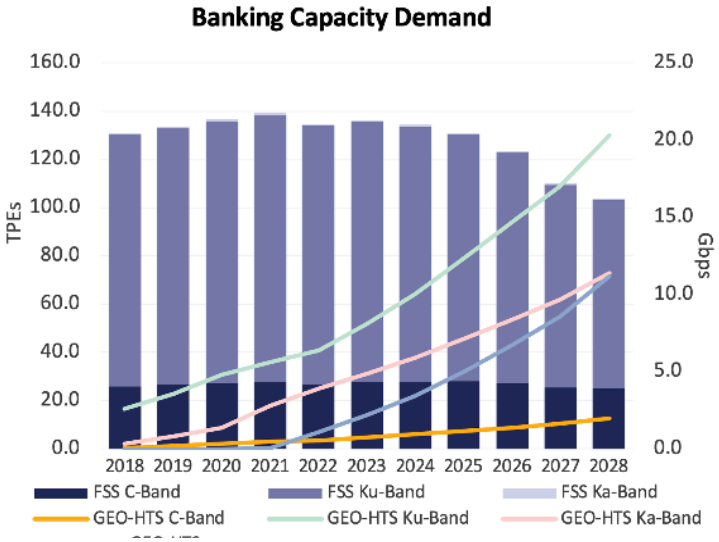
Moreover, device handover, security and throughput will be key drivers for Private LTE adoption via satellite. The recent CBRS spectrum auction in the US exemplifies the high interest in Private LTE (and eventually private 5G) networks. New requirements for these future-generation private networks will be demanded on the ground segment as well.

Overview of the Enterprise Market

The Banking Sector

The requirements of VSAT systems in remote branches and new ATMs are likely to be sustained, especially in developing regions. According to NSR's ***VSAT and Broadband Satcom Martket, 18th Edition*** report, the total number of in-service units is estimated to grow to 675,000+ units by 2028 at high CAGR levels for HTS platforms. The segment is already witnessing significant migration from traditional to advanced system/network solutions, and this will continue over time.





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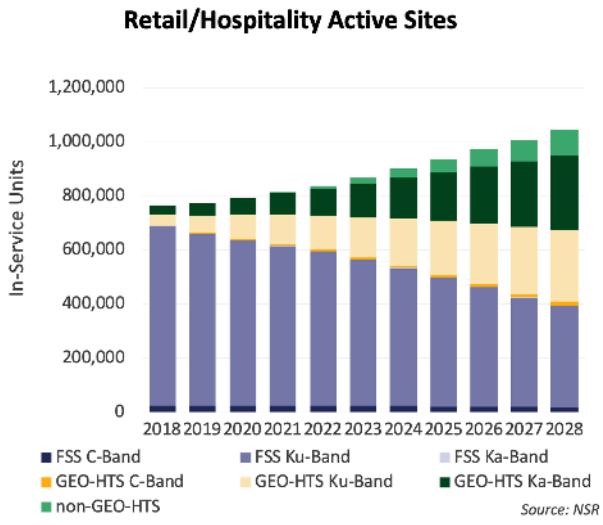
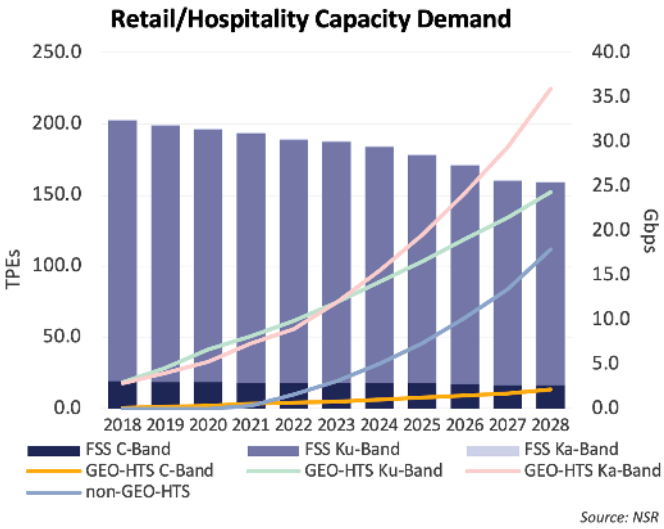
The Banking sector, particularly the retail banking area, is focussing on offering an omnichannel experience to its customers across its services and applications, as customers increasingly demand to use/execute financial services anytime and anywhere. As a result, the sector is investing on forward-looking technologies such as data analytics, edge computing, IoT & SD-WAN and new business models seamlessly integrating software applications and cloud-based services. The traditional WAN infrastructure is complex and expensive for operation in terms of integrating advanced technologies and applications. Moreover, it does not meet omnichannel customer experience expectations. As such, SD-WAN is one of the fastest transformations that the banking sector is executing as SD-WAN leverages the connectivity across LTE, MPLS and Internet Broadband in real time and allows seamless integration of advanced technologies and new business models.

Some key examples of incorporating these technologies are Barclays Video Banking as well as ING in the Netherland. As migration to HTS and SD-WAN are likely to be accelerated and sustained, VSAT equipment manufacturers/suppliers and service providers must focus on these advanced offerings (SD-WAN) and system compatibility for greater growth and higher ARPU.

The Retail/Hospitality Industry

Retailers such as gas stations have supported point-of-sale transactions using satellites for decades as a primary mode of connectivity. Similarly, across different retail and hospitality outlets/infrastructure Satcom plays a key role either as a primary or redundant or hybrid connectivity network. NSR estimates the number of in-service units to grow from 0.76 million in 2018 to 1.05 million units in 2028 at a CAGR level of 3.2%. Although seemingly a low growth level, the true market opportunity lies in the shift from traditional solutions to next-generation platforms. Like other enterprise segments, the retail/hospitality segment will witness greater migration from traditional FSS systems to HTS solutions. The cumulative HTS capacity demand is expected to grow by greater than 13 fold during the period 2018-2028 and the ground equipment in terms of upgrades will grow at high levels as well. The demand ramp-up is attributed to the increasing data need from end-users and transition to data-driven operations. The demand for seamless connectivity and bandwidth in the retail and hospitality sector have become more important than ever to address the needs of data-hungry customers, process optimization, run analytics to address customers specific needs, incorporate cloud-based services and many others.





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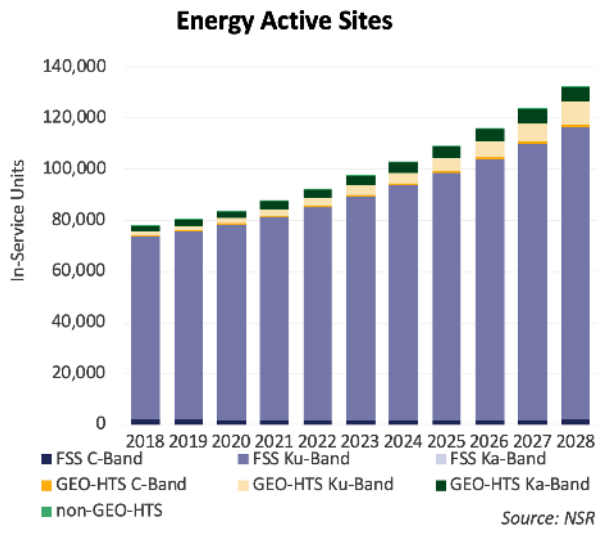
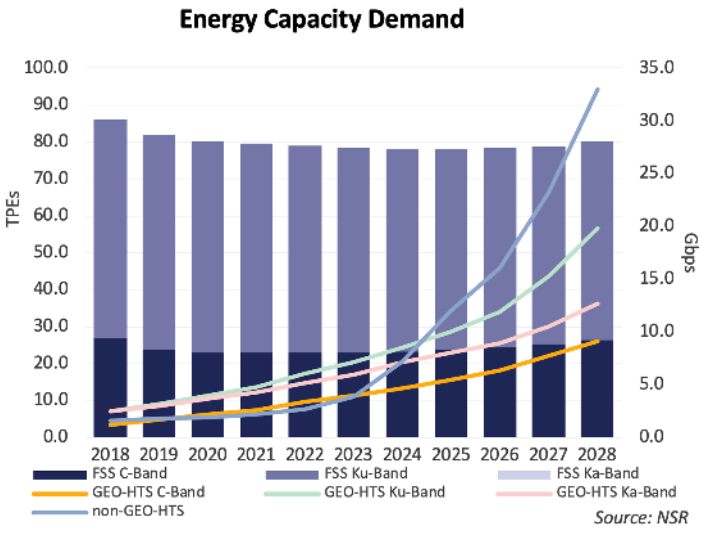
The segment is witnessing greater innovation from both the equipment and services side. Cradlepoint, in partnership with AT&T, is deploying WAN-Edge routers to retail and hospitality customers. The hardware integrates gigabit-class LTE modems, WiFi 6, gigabit Ethernet for LAN and WAN, and supports a second LTE modem for redundancy. On the network side, Extreme networks is deploying a turn-key dedicated retail cloud environment with pre-selected hardware and service elements, enabling merchants to deploy and support all its retail stores from anywhere quickly and remotely. On the Satcom side, service providers are investing in WiFi-hotspot business models in regions including Latin America and Sub-Saharan Africa to counter the price-sensitive nature of the market.

The key to long term success in the segment for Satcom service providers and equipment suppliers will be in the integration of connectivity and value added services that enables operational efficiency of merchants/users and offers competitive edge across technologies like data analytics, cloud applications, seamless network interoperability and other capabilities that will be enabled robust networks such as Private LTE, %g//5G and WiFi6.

Energy

Of all the enterprise verticals, the Energy segment has been the most reliant on satellite systems. In many instances, the fortunes of service providers have been closely tied to the investment activity of the oil & gas industry as well as other verticals that include utilities, green energy and mining. Investments in technology continue despite the ups and downs of the industry given the physical location of facilities and assets of the energy sector that are often beyond the reach of public carriers. Ubiquity, a key value proposition of satellite solutions, is a natural fit but it also has to feature high security where data can be kept either on-site or users on remote sites have unhampered access to the cloud.





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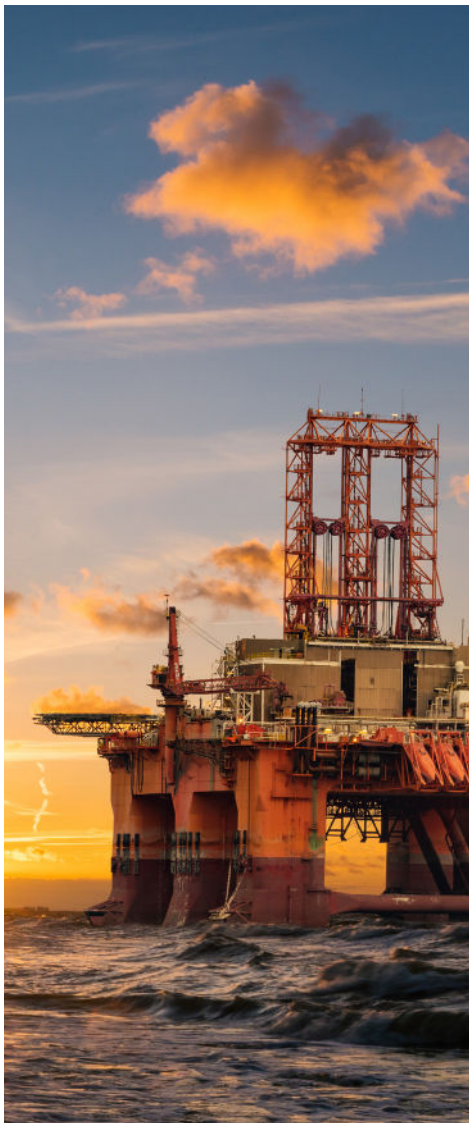
According to NSR's latest research, the upstream Oil & Gas market remains the core opportunity, nearly $900M in retail revenues projected by 2028. Utilities will add another $250M+, and Mining will remain largely flat over the next ten years at just over $100M in retail revenues. On a capacity metric, Non-GEO HTS and GEO-HTS Ku-band are the 'growth enablers' as satellite operators continue to build-out coverage maps. FSS Ku-band will not be left out of the mix as a key building block for utility-centric networks. Overall, the Energy sector in-service VSAT unit count is estimated to grow from 77,866 in 2018 to 132,677 in 2028 at a CAGR of 5.5%. With a growing need for 'more connectivity' at all segments/slices of the Energy markets, growth is coming in two-fold: more sites, and bigger/faster pipes. The shift and transition to HTS platforms will also mean high unit shipments for equipment upgrades.

Onshore energy (land-based Oil & Gas, mining and utilities) is in transition as an industry, with most majors eyeing digitalized integrated operations. Real-time data intensive video surveillance, crew welfare applications and smart grid solutions are expected to drive usage and thus cumulative revenues in this segment. In the post-pandemic world, the current shift to remote and automated mining is only expected to accelerate.

In the digital oilfield, one example of private LTE is where the network optimizes and handles traffic with specific requirements such as IoT/SCADA applications featured with guaranteed real-time, low latency reporting for immediate response. The reliance of the energy industry on satellite technology will become even more pronounced as new technologies, applications and offerings make their way to the marketplace.



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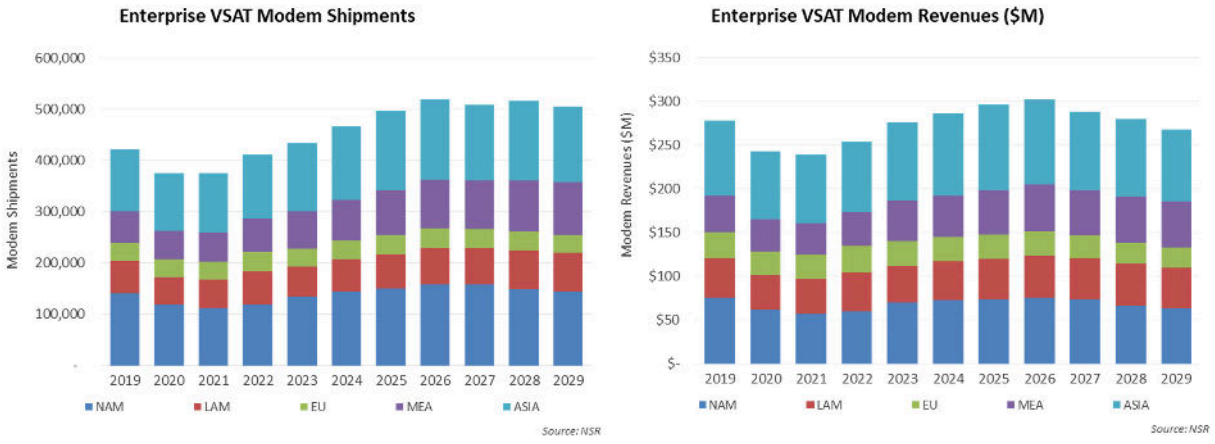
Bottom Line - Market Trends & Requirements

Given market trends and requirements for a diverse set of industries, feature sets and technology trends will need to be part of the building blocks for current and future-generation ground satellite systems. Taking current and emerging capabilities and technologies as part of their toolkit, enterprises will mix and match 5G and private LTE to offer maximum connectivity for a variety and/or combination of simple and complex use cases bundled together that feature SD WAN, Data Analytics and Edge Computing. A single implementation or enterprise customer could require high-definition video surveillance, remote monitoring and control, mission-critical communications for cloud-based applications, fixed site and mobile connectivity as well as crew welfare added to the mix. Meeting and serving all these needs on single sites and on an aggregated network covering multiple sites must address performance, optimization, intelligence, scalability, robustness, flexibility and low latency.



Ground terminals serving these needs will be priced at a premium such that future-proofing systems today to limit as well as justify CAPEX over the long term is essential. NSR sees a healthy market in terms of modem shipments and revenues with a cumulative market base of over 5 million modems shipped representing a revenue opportunity of over $3 billion from 2019-2029. Apart from a short term negative impact brought about by COVID-19, upgrades as well as new installations for Greenfield markets will incorporate next-generation technologies to enable capabilities and services that meet the growing needs of today's and tomorrow's enterprises.

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The ST Engineering iDirect Solution

The satellite enterprise market is characterized by its diversity, encompassing everything from banking and education to energy and business continuity. Today's enterprises are fully dependent on reliable connectivity at all corporate locations for faster, more secure transactions and improved productivity that come as a result of efficient information sharing. Digitalization efforts driven by data analytics, 5G and internet of things (IoT) applications are fueling the need for transformation. The key to unlocking the full spectrum of use cases is the right choice of ground infrastructure. Enterprise service providers require a VSAT platform that can support services across an array of markets, support multiple service packages with a wide mix of applications and offer ultra-high throughput as well as low data rates with the highest efficiencies to optimize costs. This platform must be able to handle these current business demands — as well as tomorrow's requirements — for scale and for seamless integration within their terrestrial network and with future technologies.

ST Engineering iDirect is a leader in satellite ground infrastructure and solutions. Our primary offerings for the enterprise market are Dialog, Evolution and Velocity. Leading satellite operators and service providers around the world rely on these multiservice platforms to deliver exceptional efficiencies, performance and service capabilities with the scale and flexibility necessary to expand global connectivity requirements. Our platforms are designed to provide the highest quality of service (QoS) across a full spectrum of network sizes and bandwidth requirements while minimizing capital expenditures.

Dialog features high-efficiency waveforms, such as DVB-S2X and award-winning Mx-DMA technology; SCPC technology for high-efficiency links; and MF-TDMA for very scalable networks. Mx-DMA is a great fit for enterprise traffic because it provides the highest QoS while enabling the highest spectral efficiency possible based on real-time traffic and fading conditions. We are innovating Mx-DMA even further with the introduction of Mx-DMA MRC. MRC is a new technology that combines MF-TDMA's benefits and Mx-DMA's spectrum efficiency into a single return technology suited to a greatly expanded set of applications to minimize operational complexity and maximize statistic multiplexing.

Evolution is a native IP platform that features efficient DVB-S2X and Adaptive TDMA return waveform technologies in a bandwidth-sharing environment to operate large-scale enterprise networks. Evolution delivers a high quality of experience, enabling countless possibilities for QoS levels, bandwidth management and traffic prioritization. Its modular design and flexibility allow customers to offer multiple service types, such as starting with small networks that scale with a business over time. Evolution also features advanced security standards (including AES and IPSec) for applications that demand secure connectivity, such as point-of-sale, ATMs and corporate communications.

Velocity is specifically designed for HTS operators deploying managed services that require massive scale, mobility and advanced bandwidth management capabilities addressing a multitude of market applications. Today, leading satellite operators such as Inmarsat, Intelsat and SES have adopted Velocity to serve more than 400 beams of HTS coverage worldwide.

At ST Engineering iDirect, our platforms are designed to facilitate the integration of satellite networks with telecom core networks. Our platforms' feature sets mirror the quality and reliability of terrestrial services for an enterprise-class user experience. In addition, all can operate seamlessly as part of an integrated global IP network. With Layer 2 over Satellite (L2oS), our platforms can implement a variety of modern, converged network architectures; pass any Layer 3 protocols; and more easily integrate with hybrid network scenarios.

Our versatile modem portfolio can address all market needs, ranging from IoT and broadband access to large enterprise applications with a broad range of requirements. Our latest modem addition, the iQ LTE series, combines our next-generation DVB-S2/DVB-S2X satellite connectivity with a powerful LTE cellular router to deliver reliable, persistent communications across a wide range of use cases.

At ST Engineering iDirect, we have all the enterprise solutions that service providers need to pursue the broadest market opportunity and choose the right technology for their business model and expansion strategy.