Satellite IoT Communications—How Globalstar is Innovating to Cost-Effectively Enhance and Expand the IoT Opportunity

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Contents

INTRODUCTION

The satellite market is entering an exciting era of Internet of Things (IoT) opportunity. New standards are extending the satellite industry's influence across familiar IoT connectivity technologies, while incumbent satellite operators introduce new services targeting IoT applications. Satellite operators recognize that IoT customers increasingly have demanding connectivity requirements. By providing new services or supporting new protocols, satellite operators hope to usher in a new age of ubiquitous IoT coverage.

Since entering the IoT world, satellite operators have had to contend with customer expectations. IoT users are accustomed to the low pricing and high reliability of popular, terrestrial IoT connectivity technologies, like Low-Power Wide Area (LPWA) cellular networks. Whether or not a satellite operator can work alongside terrestrial technologies and meet consumer demands depends on various technical factors like the size and type of its satellite constellation, its frequency bands, and expected latencies.

Some satellite operators have navigated this technical landscape adeptly. Globalstar, for example, has been an early pioneer and one of the leaders in the satellite IoT market, constantly innovating and expanding its satellite offerings and technical specifications to fit the dynamic needs of IoT customers. Its expertise in one-way messaging has given satellite IoT customers a unique, Low Cost, Size, Weight, and Power Consumption (C-SWaP) option. Its new two-way messaging service will reveal more opportunities in the satellite IoT market, reaching mission-critical IoT customers, while continuing the company's legacy of affordable connectivity. The new two-way messaging service puts Globalstar in the same league as other high-performing incumbent players at a time when satellite operators across the board are recognizing the value—and the challenge—of IoT connectivity.

TECHNICAL CONSIDERATIONS FOR THE IoT

The success of Globalstar and other satellite operators in the IoT world is primarily dictated by their technical characteristics. One of the most influential factors for an operator—the type of satellite constellation it manages—helps determine the rest of its technical variables, including latency, power, and coverage. Other considerations, like frequency bands and cost, also affect whether and how a satellite operator can efficiently and affordably deliver services to most IoT users.

GEO Versus LEO Satellite Constellations

Satellite operators typically manage Geostationary Earth Orbit (GEO) or Low Earth Orbit (LEO) satellites. GEO satellites orbit above the Earth's equator at around 36,000 Kilometers (km), while LEO satellites reach an altitude of between 250 km and 2,000 km.

If the constellation is large enough, LEO satellites are arguably more relevant for most IoT users. It takes less time and power for a device to send a message to a LEO satellite, due to its low orbit, resulting in lower latencies and improved device battery conservation. In addition, being a low-power option means LEO hardware is often smaller and, therefore, cheaper. Each of these advantages is significant in the IoT market, given that most IoT use cases are either cost-sensitive, power-constrained, or both.

Elevation Angles and Device Coverage

LEO satellites can also provide more adaptable coverage. A GEO satellite's orbit time matches the speed of Earth's rotation, meaning its coverage remains fixed above one area of the Earth and its elevation angle never changes unless the ground user equipment moves. The signal quality of a ground terminal is, therefore, highly dependent on whether it is correctly angled and directed toward the GEO satellite's fixed location. If the device falls outside the GEO satellite's Field of Vision (FOV), perhaps because it is covered by a blockage or significant foliage, it risks not being connected.

LEO satellites are much more flexible. LEO satellites move quickly, typically completing an orbit around the Earth in about 90 minutes. At this fast pace, a LEO satellite scans different parts of the Earth and constantly shifts the angle of its line of sight, meaning a terminal can be more flexibly angled and directed, and still have a chance at receiving a strong signal from a LEO satellite, especially if a LEO satellite constellation is large.

LEO satellites can also provide more reliable support for mobile applications. GEO satellites often use larger fixed antennas and, if mobile, must use specialized antennae that maintain a clear line of site with the satellite to be continuously connected. In contrast, LEO satellite constellations like Globalstar's have many moving satellites with multiple paths to ground stations, creating more diverse coverage routes for both mobile and fixed applications.

Constellation Size and Ground Infrastructure Investment

Most of the advantages offered by LEO satellites hinge on the size of the constellation and the extent of an operator's ground infrastructure. A single LEO satellite has a small coverage footprint, meaning that LEO operators must invest in a large satellite fleet to ensure consistent global coverage. LEO operators must also invest in ground infrastructure around the world to increase the likelihood that a ground station can be caught in a LEO satellite's limited line of sight. An operator risks long latency times if there are only a few ground stations globally that can sync with a LEO satellite and transfer data.

In contrast, a single GEO satellite has a large beam that expands over a huge portion of the Earth's surface. While a single GEO satellite can be very expensive, its large coverage area allows GEO satellite operators to invest in smaller constellations and less ground infrastructure to offer global coverage. GEO satellites can also last longer in space (around 15 years), sometimes resulting in even lower Capital Expenditure (CAPEX) costs for GEO operators (though many LEO satellites are living past their designed life span, with some built purposefully to reach the 15-year mark, like Globalstar's HIBLEO-X fleet).

To decrease the upfront costs of a LEO constellation, some operators launch enough LEO satellites to service only one area of the world, like the Americas or the Middle East & Africa. Though this targeted approach can ultimately result in faster and more tailored satellite services for regional IoT users, some might view it as a disadvantage for intercontinental IoT use cases.

The expensive and complicated nature of LEO satellites is why many LEO-based operators have struggled to create viable services for IoT customers, even though their orbital regime is theoretically better suited to IoT needs. LEO satellite operators can successfully compete with GEO operators in latency, pricing, and coverage only if they have invested in the appropriate supporting infrastructure. Some LEO operators have successfully done this. Globalstar, for example, has a constellation of 24 LEO satellites (with plans to launch another 8 in 2025), as well as 28 ground stations spanning 18 countries.

Frequency Bands

The most relevant frequency bands for a satellite operator primarily depend on the demands of its target users. The IoT industry typically requires low-power connectivity technologies that can send small payloads of data across wide areas. Even mission-critical use cases in the IoT industry have lower data rates and latency demands compared to the non-IoT use cases found in consumer markets.

Given these requirements, satellite operators that target IoT use cases predominantly support communications on the L-Band (1 – 2 GHz), S-Band (2 – 4 GHz), and sometimes the C-Band (4 – 8 GHz). These lower frequency bands provide stable, low-power communications for most low-data use cases. Customers can also achieve service on these bands with cheaper antennas and radios. The L-band is particularly stable in volatile weather like harsh rain or storms and is, therefore, frequently applied to maritime and aviation use cases, IoT applications, and satellite phones. As a higher frequency band, the S-Band can be used for more data-intensive IoT satellite communications, as can the C-Band. Higher frequency bands, like the Ka-Band, are more often used for broadband use cases and are not typically relevant to a satellite operator that is primarily targeting IoT markets.

A satellite operator can sometimes use its approved spectrum licenses to its advantage. For example, Globalstar owns both L and S bands, with exclusive rights to this Mobile Satellite Services (MSS) band per Big LEO Band allocation. Globalstar recently received re-authorization for this allocation for another 15 years. Access to both bands grants the company a meaningful competitive advantage in the satellite IoT market, as it unlocks a greater array of applications compared to most satellite IoT operators that are limited to operating on either the L or S band alone.

Spectrum Allocation

Satellite operators, like many terrestrial communication operators, must attain frequency licenses and sometimes landing rights from local government entities to operate in different countries. These approval processes in many countries can take years, significantly impacting a new satellite operator's ability to quickly roll out global services. Incumbents, like Globalstar, in this regard, have a major advantage—given their history, many legacy satellite players have already established the local authorizations and landing rights needed to operate worldwide.

These existing relationships have become especially essential as countries grow more concerned with data sovereignty and increasingly ask global satellite operators to build gateway stations within their borders. Most incumbents already have ground infrastructure worldwide and established relationships in many countries to help facilitate new infrastructure if needed.

Latency

Satellite IoT users often understand that satellite connectivity has longer latencies than terrestrial IoT communication technologies, with most accepting the LEO satellite communication latency of 10s of milliseconds.

The latency offered by a satellite operator primarily depends on its orbital regime and its ground infrastructure. As explored in Section 2.1.2, a sufficient number of ground stations is vital for supporting acceptable latency levels, particularly for LEO-based satellite constellations. Like a GEO satellite, a LEO satellite must be located over a ground station to send data back to Earth. Passing over a ground station in a timely manner can be difficult, given that LEO satellites have a smaller cone of view that restricts their ability to cover many devices and ground stations at any given angle. LEO operators, therefore, must have enough ground stations, or satellites supported with a mesh architecture, to ensure that a LEO satellite can pass over a ground station and send data back down to Earth in a sufficient amount of time.

Incumbent LEO-based operators like Globalstar have been in the satellite IoT market for decades and had time to establish a sufficient ratio of satellites to ground infrastructure to guarantee low latency in its areas of service. In contrast, startup LEO operators using The 3rd Generation Partnership Project (3GPP) Non-Terrestrial Network (NTN) protocol have struggled to establish sufficient constellations and ground infrastructure, contributing to the standard's slow growth.

Cost

Many IoT markets are cost-constrained. Popular target IoT use cases for satellite operators, like asset tracking and condition-based monitoring, can feature hundreds of devices that are often outside the reach of terrestrial networks. To be competitive in these markets, satellite operators must maintain low per-device connectivity costs, while also providing reliable coverage to these remote devices.

Providing low-cost connectivity has traditionally been difficult for satellite providers. Satellite is an inherently more expensive and difficult connectivity technology than most terrestrial networks. To offset their large CAPEX and networking costs, some incumbent satellite players entered the IoT world targeting the more profitable, higher-bandwidth use cases, while either neglecting low-data markets or offering them pricey connectivity packages that did not align with the IoT's less intense requirements. Given the sheer volume and diversity of IoT use cases, some operators now realize this was a limiting strategy.

As more operators attempt to pivot to lower data use cases, LEO-based satellite operators with lower frequency bands will likely prevail. These operators benefit from lowered connectivity costs and can allow users to invest in cheaper device equipment. Overall, when supported by large constellations and sufficient ground infrastructure, LEO-based satellite operators can better manage the usual IoT trade-offs, striking a balance between latency, coverage, power conservation, and cost.

GLOBALSTAR'S MESSAGING SERVICES

A Satellite Partner Well-Suited for the IoT

LEO-based satellite operator Globalstar has been serving the satellite market for decades, carving out unique expertise for reliable, low-cost services in the Industrial IoT (IIoT), ground and maritime transportation, and animal tracking markets.

Globalstar's technical architecture aligns well with IoT demands. As a LEO-based satellite operator, Globalstar can offer flexible, low-latency coverage worldwide at a low cost. Globalstar is supported by extensive ground infrastructure across the Americas, Europe, Australia, and Africa, and its licensed spectrum in the L-Band, S-Band, and C-Band allows the company to cater to a diverse range of IoT customers. The company offers 16.5 Megahertz (MHz) downlink and 8.725 MHz uplink, a valuable advantage over some competing operators. Additionally, its bent pipe architecture allows Globalstar to be agnostic to satellite communication technologies and affords the company flexibility for ground updates, energy-efficient terminals, and reliable low-latency transmissions.

The company has deployed various technologies over the years, including satellite phones and location-based tracking and messaging devices used for personnel safety management. Globalstar also provides Direct-to-Device (D2D) services, enabled by its influential partnership with Apple. Additionally, given its experience in providing secure satellite communications, the company is a reliable partner for governments, just recently announcing a partnership with defense contractor Parsons to bring secure messaging services to military personnel.

Globalstar also offers a unique terrestrial wireless solution for use in private networks. Its terrestrial spectrum, Band n53, is a slice of mid-band spectrum that can be adopted for private network deployments, including in markets like ports, warehouses, mines, governments, and agriculture. Band n53 is also, importantly, available for dual use with the ability to support both terrestrial and satellite communications. This multi-mode offering allows customers to use the same band products and modems for private terrestrial networks and satellite connectivity, a unique hybrid offering that will find purchase as private network deployments continue to grow among IoT users.

Most importantly, Globalstar has differentiated itself in the IoT field by offering high-performing satellite connectivity services at an affordable cost. This, perhaps more than its technical architecture, has influenced the company's reputation as a reliable IoT partner.

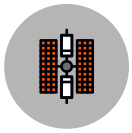
Globalstar's One-Way Messaging Services

A primary reason for Globalstar's affordability is its expertise in one-way communications. Two decades ago, Globalstar's satellite-forward link capabilities failed, forcing the company to innovate and explore various use cases that do not require a confirmation message. Globalstar soon became the leading expert in the one-way messaging space, prioritizing cost optimization and efficient, low-data communications, while other incumbent satellite operators targeted high-cost, two-way communication plans for IoT customers, often regardless of their bandwidth and messaging requirements.

In satellite communications, a device sends data to a satellite, which communicates with a ground station to send the payload to the designated recipient. In two-way satellite messaging, a confirmation message will be sent back to the device to confirm the data have been received. As well, systems and applications can communicate with the device. In one-way communication, there is no confirmation message—the communication is strictly unidirectional. The one-way application is analogous to cellular applications using User Datagram Protocol (UDP)/Internet Protocol (IP) to send data versus two-way communication that is similar to Transmission Control Protocol (TCP)/IP.

Whether an IoT customer can tolerate one-way messaging depends on the criticality of their use case. Two-way messaging is often used in command and control use cases, given that these customers typically require confirmation to ensure that a message has been successfully sent, often because of the data's sensitivity and mission-critical nature. One-way messaging is largely reserved for asset tracking. Customers in this market feel comfortable forgoing the confirmation and would prefer the lowered price of one-way communications.

Globalstar has successfully targeted these non-mission-critical, cost-weary IoT customers with its one-way communication service. The company's targeted one-way messaging applications include low-data use cases in industrial segments like transportation and agriculture and certain condition-based monitoring applications in oil & gas and mining. Globalstar has developed a best-in-class Total Cost of Ownership (TCO) for these application segments, offering unique flexible pricing packages compared to the competition. As a result, the company has created a reputation for reliable, low-cost IoT support.



GLOBALSTAR'S NEW MESSAGING SERVICE EXPANDS AND EXTENDS THE IoT OPPORTUNITY

With the recent announcement of a new two-way messaging service, Globalstar will grow its total addressable markets, while maintaining the cost advantage it has developed over 2 decades.

Two-Way Messaging Service

While providing one-way messaging services, Globalstar recognized a gap in the IoT market. The company discovered that many IoT users needed two-way communications, but could not afford the expensive messaging plans of other incumbents. These customers typically have low-data requirements, mostly serving asset tracking use cases that include the tracking of expensive and important equipment in industrial markets like oil & gas. Though these asset-tracking payloads are frequently small, tracking this valuable equipment is crucial and, therefore, requires the confirmation and certainty of a two-way messaging service. The two-way messaging service enables command and control capabilities by an operator sitting in a remote office or possibly automating certain activities with the use of AI, further streamlining critical communications.

Low-data customers were often forced to adopt two-way messaging pricing from other incumbents that did not fit their needs, often paying a premium for high-bandwidth plans, even though their use cases required very little data. Using its experience catering to low-data-rate IoT segments, Globalstar introduced a new two-way messaging service, offering price plans more tailored to the true requirements of these low-data, mission-critical customers.

Globalstar's new two-way messaging service will also allow the company to compete for use cases that other proprietary satellite companies have traditionally targeted. These use cases typically require two-way messaging services for hyper-remote customers in specialized markets like maritime and mining. These sophisticated customers often need lower latencies and ultra-reliable connectivity. Globalstar can now enter these more demanding markets with the same messaging capabilities as other operators, but with a more tailored, and affordable, TCO approach.

Globalstar's expansion into new markets will be further supported by its distinctive multi-mode capabilities. Using its Band n53 resources, Globalstar can apply satellite and cellular IoT communication to the same chipset, offering converged communications for new use cases that require it, like fleet management and supply chain tracking. By offering both two-way messaging services and multi-mode capabilities at a reasonable price point, Globalstar will lower the barrier of entry for reliable, "always-on" connectivity.

The LEO-based, two-way satellite communications market has largely been monopolized by a few incumbent players. Globalstar's two-way communication service will revitalize competition in the satellite IoT market, offering a new option for two-way communication customers. The new service, sitting alongside the company's unique multi-mode capabilities, will continue the company's tradition of affordable IoT innovation.

SUMMARY

The IoT market is filled with diverse mobile and global use cases that increasingly require equal coverage in urban and remote areas around the world. Satellite operators like Globalstar will play an important role in fulfilling these difficult coverage demands.

Satellite operators offer a highly unique and useful connectivity technology that can reach beyond the borders of familiar cellular and LoRaWAN networks. In competing with these terrestrial technologies, satellite IoT providers have struggled to provide a price point suitable for cost-sensitive IoT markets. An operator's ability to provide for these customers often depends on the technical choices they have made over decade-long periods, including the type of satellite constellation they manage, the ground infrastructure they support, and the frequency bands they have licensed.

Companies like Globalstar have made technical choices that match the true needs of most IoT users. Its LEO-based satellite architecture and support for low-frequency bands allow the operator to offer services at a price point that is at least recognizable to IoT users accustomed to cellular and LoRa costs. Most importantly, Globalstar has developed a unique reputation for prioritizing low-data IoT users, a customer segment often neglected by other satellite operators.

Globalstar's new two-way messaging service solidifies its place as a reliable partner in the IoT world. The new communication service allows the company to continue to capture low-data customers, while catering to the high-bandwidth use cases traditionally reserved for other operators. Globalstar is offering customers choice in a traditionally monopolized market, backed by a disruptive pricing model and highly relevant IoT experience.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