Satellite Executive BRIEFING
Vol. 18 No. 7 November-December 2025
SATELLITE Markets & Research
Industry Trends, News Analysis, Market Intelligence and Opportunities

Multi-Orbit Satellite Antenna Market

by Bernardo Schneiderman

The Global satellite market has-been moving toward multi-orbit satellite solutions as consequence have been driving demand for advanced, flexible antennas that can automatically and seamlessly switch between Low Earth Orbit (LEO), Medium Earth Orbit (MEO), and Geostationary Orbit (GEO) satellites.

The trend of multi-orbit satellite antennas began to emerge around 2018, with significant milestones occurring in 2021. While satellite communication has existed since the 1960s, the current trend involves new, electronically-steered terminals that can seamlessly connect to satellites in multiple orbit

During a recent conference executives from satellite companies reinforced the view that multi-orbit systems combining satellites at different constellation altitudes are now a concrete reality for the corporate, government and defense market and are no longer just a trend.

The satellite market after decades of geostationary (GEO) satellite dominance, has undergone a rapid transition toward low-Earth orbit (LEO) systems, mainly driven by the growth of constellations such as Starlink, OneWeb and the implementation of Project Kuiper which have enabled greater flexibility for new applications. These multi-orbit solutions are applicable to services that require a higher SLA (service level agreement), where the risk of downtime is unavoidable, as this could lead to major losses."

The Satellite Executive Briefing invitedsatellite antenna manufacturing companies to provide feedback on how they are addressing the market both in the segments of land, maritime and aeronautical with applications in enterprise, government and defense segments.

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What's Inside

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EDITORIAL

Key Markets

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In case you are not familiar with our occassional MarketBriefs and TechBriefs reports, we have published several of them that would be of value to your planning for 2026. These MarketBriefs and TechBriefs are executive summaries of the most promising market segments or innovative technologies Check them out now at https://satellitemarkets.com/Market_Brief

As we approach our 19th year of publication, we at Satellite Markets and Research remain committed to developing innovative ways to provide our readers with the information they need to do their jobs in an ever-changing market. Watch out for some of these innovations which we will be introducing in 2026. So, watch this space and we'll keep you abreast of the key trends and opportunities in the global satellite industry,

Virgil Labrador

Editor-in-Chief

Satellite Executive BRIEFING
Industry Trends, News Analysis, Market Intelligence and Opportunities

EDITORIAL

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Satellite Executive Briefing is published monthly by Synthesis Publications LLC and is available for free at www.satellitemarkets.com

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Multi-Orbite Antenna Market...
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We received responses from the following executives: **Kenny Kirchoff**, VP-Product Management, Antennas Terminal Products, **Gilat Satellite Networks**; **Bob Potter**, Chief Technology Officer, **Global Invacom**; **Blad Stavropoulos**, Senior Director Sales and Solutions Engineering, **Global Invacom**; **Rick Bergman**, CEO of **Kymeta**; **Amelia Liu**, COO of **Starwin**; and **Jeff Sare**, Chief Commercial Officer, **ThinKom**. Follows are excerpts from the virutal roundtable:

Please provide a brief profile of your company and a current status of your multi-orbit antenna solutions for the market?

Gilat: Gilat Satellite Networks is a leading global provider of satellite-based broadband communications. With over 35 years of experience, we develop and deliver deep technology solutions for satellite, ground, and new space connectivity, offering next-generation solutions and services for critical connectivity across commercial and defense applications.

Our portfolio includes a diverse offering to deliver high-value solutions for multiple orbit constellations with very high throughput satellites (VHTS) and software-defined satellites (SDS). Our offering is comprised of a cloud-based platform and high-performance satellite terminals; high-performance Satellite On-the-Move (SOTM) antennas; highly efficient, high-power Solid State Power Amplifiers (SSPA) and Block Upconverters (BUC) and includes integrated ground systems for commercial and defense, field services, network management software, and cybersecurity services.

Gilat Stellar Blu, a subsidiary of Gilat Satellite Networks and center of excellence for Gilat's antenna solutions and terminals for air, sea, and land applications has approximately 275 multi-orbit electronically steered antenna (ESA) terminals installed and flying on commercial, VIP and MoD aircraft today. They have logged >175,000 flights and >250,000 hours of flight time with an availability rate in the high-90's percentile.

Gilat also offers the ESR 2030Ku product, a LEO OneWeb business aviation ESA supporting full duplex in-flight connectivity. The ESR 2030Ku is a fully integrated Line Replaceable Unit (LRU)suitable for business aviation and government markets., consolidating multiple key functions into a single, compact unit.

The design incorporates: Active transmit and receive apertures; Frequency conversion unit; Antenna control unit and OneWeb GPS receiver.

In addition, the ESR 2030Ku boasts a highly efficient aperture design, resulting in smaller aperture size and lower power consumption.

Global Invacom - For over thirty years, we have served the satellite ground equipment market, delivering an extensive portfolio of innovative and award-winning technologies, products, and solutions. With millions of products deployed across a wide range of markets, our technology underpins the largest satellite broadband and broadcast networks in the world. And uniquely, we continue to design and build all our products in-house, giving us total quality control and assuring our customers of optimal supply chain resilience.

The surge in demand for multi-orbit antenna solutions is set to continue because of the massive projected growth in the deployment of multi-orbit satellite constellations and we are fully prepared for it. We have consistently tracked the market and ensured that our antenna technology can support the requirements of our customers across GEO, MEO and LEO. We are constantly working with our customers and listening to their feedback and requirements to inform our R&D process. As we design our

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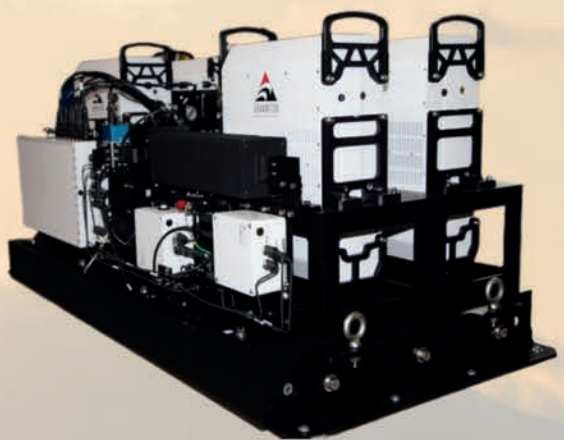

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products in-house, we can optimize our products to meet particular multi-orbit market requirements, so we have great flexibility and we are always innovating. For example, Our Obliquiti is an end-to-end platform designed to serve NGSO and GEO networks and scales to provide cost-effective gigabit services in multiple bands. We have also developed our Titan antenna system which answers the growing need for NGSO gateway antenna platforms that is highly portable yet robust and suitable for fixed and nomadic scenarios. Another example of our R&D in this area can be found in SatSenz, a virtual modem hosting technology that will enable future network roaming.

Intellian – Intellian is the established global leader in resilient satellite communication solutions, specializing in advanced antenna systems and ground gateways that define the future of global connectivity. Our core mission is delivering high-performance, future-proof communications across all major market segments.

We maintain a clear competitive advantage by working with more satellite operators than any other manufacturer in the industry. As experts in all satellite orbits - including GEO, MEO, LEO, and HEO - the status of our multi-orbit strategy is highly advanced and market-proven. We pioneered this field, moving far beyond concept to deliver a diverse portfolio of over 18 multi-orbit solutions. This range began with our world-first flagship v240M terminal (released in 2013), and extends to our WGS-certified ARC-Series of military antennas. While our industry-standard NX Series offers multi-orbit flexibility via conversion kits, the majority of our next-generation portfolio features automated electronic switching between the specific orbits and for some this also includes multi-band, required for maximum hybrid connectivity resilience.

Kymeta: Founded in 2012 and headquartered in Redmond, Washington, Kymeta utilizes cutting-edge metamaterial technology to manufacture multi-orbit, multi-network intelligent communications platforms. Its platforms offer software-defined solutions, enabling continuous connectivity even in the most contested environments.

Kymeta's current product range includes:

- Osprey u8™: GEO-LEO-LTE terminal providing a customized connectivity platform for military communications. Designed for easy installation on military vehicles and vessels to provide reliable connectivity in contested conditions.
- Goshawk u8™: Delivers multi-orbit, multi-network satellite communications on a single terminal (GEO-LEO-LTE). Provides jamming mitigation, seamless integration with existing networks, and a low-profile design.
- Peregrine u8™: Designed specifically for maritime use cases, delivers reliable connectivity by seamlessly integrating with vessels' IT infrastructure (LEO-.
- Hawk u8™: Utilizes Kymeta's electronically steered antenna (ESA) to provide GEO or LEO connectivity for fixed and mobile applications.

Intellian NX Series- V100NX 1 m ku-Ka dual band GEO/MEO/LEO VSAT

StarWin: StarWin is a world-leading one-stop solution provider for satellite communication terminals, antennas, and signal processing technologies. We supply cutting-edge Ku and Ka band Electronically Steered Phased Array Terminals for land, maritime, and airborne applications across GEO, LEO, and MEO orbits. Our broadband ESA terminals can be seamlessly integrated with self-developed UHF, L, and S band terminals, ensuring compatibility not only with the TianQi IoT LEO constellation but also with multi-orbit satellite systems.

With terminal products qualified by dozens of satellite operators worldwide, and holding internationally recognized certifications such as FCC, CE, RCM, and Anatel—along with more than 200 independent intellectual properties—StarWin's new generation of high-performance ultra-small ESA terminals has entered large-scale mass production. Our technology for government and enterprise applica-

tions has evolved from "high-quality usability" to "empowerment and popularization."

Pioneering the development of an AI-driven integrated system that combines Communication (5G + NTN-Satcom), Navigation, Remote Sensing, and Measurement, StarWin has achieved a strategic leap from adapting to scenarios—including government emergency response, disaster relief, defense, firefighting, oil and gas, power grids, logistics, construction, and adventure tourism—to actively creating new scenarios. We safeguard the low-altitude economy, support unmanned and smart shipping vehicles, enable pan-robotic applications, empower consumer-grade vehicles, contribute to rural revitalization, and participate in global digital infrastructure construction.

StarWin Ku, Ka ESA terminal has unique features of scalability for configuring from Ultra -Small ESA terminal to medium and big size for not only working under GEO, but also under LEO and MEO. And especially StarWin Ku ESA terminal now can be working under Chinese LEO such as Spacesail and Ka ESA terminal working with China Satnet and MEO -Chinese Qing Song and expect to be qualified by SES mPower MEO constellation. All these muliti-orbit Terminals are also versatile for land, marine and air mobility.

Thinkom: Based in Hawthorne, California, ThinKom Solutions, Inc. designs and manufactures high-performance antennas and phased-array antenna systems for commercial, government, and defense applications, including Inflight Connectivity (IFC), Counter-Unmanned Aircraft Systems (C-UAS), and Intelligence, Surveillance and Reconnaissance (ISR).

Kymeta Goshawk Front and side image Antenna

By leveraging proprietary, patented designs, ThinKom delivers broadband solutions that are fast, resilient, and cost-efficient, serving millions of users worldwide.

Our phased-array terminals are uniquely capable of operating across all satellite orbits—GEO, MEO, HEO and LEO—either selectively or simultaneously, ensuring maximum flexibility and user experience. Today, our ThinAir® products are committed or flying on more than 2,500 aircraft, and we continue to expand capabilities for the next generation of multi-orbit connectivity.

What applications for the multi orbit antenna are you are offering to the commercial and defense/government market?

Gilat: The Gilat Stellar Blu Sidewinder terminal is a complete multi-orbit, Ku-band SATCOM in-flight connectivity solution in the commercial, business, VIP and MoD aviation sector. The Sidewinder terminal consists of the ESA antennas that mount on top of the aircraft fuselage as well as the interior line replaceable units (LRUs) consisting of the antenna control & modem management unit (ACMU) and power supply unit (PSU). The ACMU contains the OneWeb aero modem required for enabling LEO service. The Sidewinder terminal is integrated with our GEO satellite service provider partners using their modem manager (MODMAN) LRU to enable GEO services. Our satellite service partners also serve as OneWeb distribution partners to manage the entire multi-orbit service for the airline operator or end customer.

Global Invacom: Space is becoming easier than ever to access as technology evolves for multi orbit antenna systems that can be integrated with multi waveform modem technology. This offers governments the option of high quality of service and the multi-orbit nature of the services available means that they have access to diverse, resilient, secure mission-critical connectivity.

We design and produce a wide range of multi-orbit products that are optimised for government and defense use from flyaway, highly portable systems to vehicle-integrated mobile terminals and indoor or underground non-line of sight solutions. Our solutions are both robust and secure and can be deployed for remote operations in the harshest environments. Our systems can also be deployed in disaster situations for emergency response vehicles to temporary crisis centers, utilizing both permanent and fast-de-

ploy terminals and gateway ODUs optimized for these use cases. Our antenna systems can host hardware based or virtualized multi waveform modems and provide auto connect to networks when required.

Intellian: Our antennas empower connectivity so the applications for our multi-orbit antennas span the entire spectrum of high-demand maritime connectivity, requiring mission-critical resilience. In the commercial market this means achieving the elusive 'home-like' experience at sea, supporting bandwidth-intensive applications like guest streaming, real-time cloud migration, and IoT vessel management for greater operational efficiency and enhanced crew and passenger welfare. For Defense and Government, the application is typically for high-volume intelligence sharing and maintaining essential communications.

Kymeta: Kymeta's terminals have a broad range of applications across the defense and government market, including land and maritime defense, security and intelligence, and emergency response. Across all of these areas, its multi-orbit, multi-network terminals provide resilient, always-on connectivity and situational awareness to support the success of mission-critical operations.

Kymeta's terminals are also deployed in a number of key areas in the commercial sector, including maritime, providing rugged connectivity solutions on cargo ships, cruise ships, and mega yachts, and land connectivity, where the terminals are deployed on commercial fleets, bus and rail networks, energy infrastructure, and for humanitarian aid.

Starwin: StarWin Multi-Orbit Terminal can be widely used both for Government such as Emergence recover, Disaster Relief, Fire extinguishing , Defense , Enterprise such as Oil &Gas, Power Grid , Logistic ,Transportation , and Adventure etc. and now extend to empower Low Altitude Economy -UAV etc, unmanned vehicle , unmanned shipping vehicle and enable Pan Robotic such as equipped narrow band antenna module & broadband ESA terminal, 5G module with anti-jamming antenna +timing devices with Satcom Robotic Dog, empower Vehicle industry for medium and high grade consumer markets etc.

Starwin Ku ESA Terminal

Thinkom:Commercial IFC: ThinKom's ThinAir Ka2517 and Ka1717 solutions operate across GEO, MEO, HEO and LEO networks, ensuring passengers and crew can reliably access bandwidth-intensive services such as streaming, social media, and productivity tools—even during peak demand. Without this multi-orbit flexibility, operators are susceptible to network outages, limited geographic coverage areas (dead spots), and congestion in highly contended airspace. Our latest ThinAir Ka2517Plus introduces simultaneous multi-orbit operation, providing redundancy and intelligent traffic routing to optimize Quality of Experience (QoE).

Defense/government: For mission-critical operations, our ThinAir GT2517 and KQ1717 deliver secure, low-latency, and high-capacity connectivity across multiple orbits. These systems support applications such as live video feeds, target tracking, ISR data transfer, and Command & Control (C2) communications. The ability to maintain reliable links in contested, remote, or high-risk environments ensures operational continuity and resilience.

What vertical market is the focus of you portfolio of Multi Orbit antennas (ie. Land, Maritime, Aviation, etc.)?

Gilat: We are currently offering our multi-orbit Ku-band solution in the commercial, business, VIP and MoD aviation sector. We are also exploring sectors like industrial/government/MoD maritime and land mobility platforms for the multi-orbit solution.

Global Invacom: In terms of markets, we provide antenna systems for a range of verticals including broadcast; residential and enterprise broadband; government and defense (as we have already covered); land transport networks and 5G mobile backhaul.

Intellian: While our strategy has broadened to include Enterprise and Aviation, the Maritime and Government Markets is the primary driver, for now, of our multi-orbit portfolio. The unique demands of vessels constantly moving through varying coverages and facing blockage challenges are uniquely resolved with hybrid connectivity and multi-orbit solutions. Within maritime, our multi-orbit portfolio is particularly well suited for Cruise, Yachting, and Energy (vessels and platforms) verticals. These sectors share the crucial need for the highest levels of bandwidth, massive data consumption, low latency, global redundancy, and mission-critical reliability, validating our significant investment in products like the tri-band, multi-orbit v240MT 2 and our XEO Series.
In the Defense/Government Market, in addition to our expansive range of commercial solutions available to them, our Mil-Spec-qualified WGS terminals provide secure, redundant communications for naval forces, ensuring operational continuity in the harshest environments by automatically accessing the best available service at any given time. Not only that, but our ARC-M4 Block 1 is the first tri-band antenna that provides simultaneous X-band and MIL Ka-band service which ensures connectivity on WGS and has tracking capabilities across LEO, MEO, GEO and HEO.

Kymeta: The Kymeta Osprey u8 and Goshawk u8, were specifically built for government and military operations, these solutions ensure reliable, on-the-move connectivity for command and control. The multi-orbit architecture enables seamless switching between GEO and LEO, maintaining secure communications even in contested environments.

Starwin: StarWin is focusing on Land mobility and Aviation more currently by utilizing Multi Orbit Terminal.

Thinkom: ThinKom's primary focus is aviation, where our low-profile phased-array designs deliver both aerodynamic advantages—reducing drag and fuel consumption—and compliance with strict Size, Weight, and Power (SWaP) requirements. The result is higher efficiency, longer endurance, and improved overall mission or operational performance.

What differentiates your company and your offerings from your competitors?

Gilat: Gilat Stellar Blu is the only solution provider with a certified multi-orbit SATCOM terminal in the

aviation sector today. Our Sidewinder terminal has been approved by OneWeb for aviation service and certified by multiple aviation and regulatory authorities for operation. We offer a robust, high performing platform that can provide global coverage with redundant capabilities in situations where a single orbit service may not always suffice.

Along with the Sidewinder, the ESR 2030Ku offers a low-profile design that minimizes drag and combined with its low weight, reduces operational overhead without compromising on performance. This advanced antenna supports diverse connectivity applications in commercial, business, and defense aviation.

These features make both the ESR 2030Ku and Sidewinder ESAs suitable for a wide range of aircraft.

Global Invacom: We have been serving the market for over thirty years and in that time, we have seen many changes yet have always adapted and evolved with the industry through our innovative design and customer-focused approach. We utilize cutting-edge technology to produce our high-performance products and low-cost manufacturing techniques.

Our technology underpins the largest satellite broadband and broadcast networks in the world, and our portfolio comprises solutions for the transport of RF signals via multiple media. including unique waveguide technology, RF in Fibre and Satellite Communications antennas systems. Our advanced antenna solutions can incorporate the other technologies as well as our in-house design advanced satellite RF electronics, antenna controllers and mounts and mechanisms for precision tracking of satellites and superior pointing while tracking. With our products designed and built in-house, and a robust supply chain, we can take complete control of quality.

We consistently listen to our customers' requirements and experiences, incorporating their feedback in our designs. Our focus on R&D maintains our place at the leading edge of terminal development. Our teams are working with several new technologies including Software Defined Radio (SDR), 5/6G SpaceRAN, AI satellite tracking and switching orchestration and scalable phased array antennas.

Global Invacom multiorbit XY Antenna

The XY antenna allows multi-orbit capability across Geostationary Earth Orbit Satellite (GEO), Low Earth Orbit (LEO), Medium Earth Orbit (MEO) and High Earth Orbit (HEO).

Intellian: Our primary differentiator lies in the unmatched breadth of our network operator partnerships and our unique insight into their connectivity architecture. We are a strategic partner for nearly every major satellite operator globally, developing highly customized, often closed network terminals and integrated solutions for their specific constellations. These partnerships give us unparalleled understanding of each operator's network architecture, so when it comes to designing our open, multi-band, multi-orbit terminals we can leverage these insights to develop solutions optimized with the collective intelligence across the satellite ecosystem.

Global Invacom multiorbit XY Antenna

A customer's investment in our technology, maximizes uptime, and allows them the commercial flexibility to always choose the best available service, providing an unmatched level of operational confidence.

Kymeta: What sets Kymeta apart is its unique metamaterials technology and software-defined solutions. This combination enables the company to produce antennas that not only consume less power and are low-profile but also work seamlessly across constellations and networks with no restrictions.

Compared to phased-array antennas, Kymeta's metamaterials-based technology enables polarization agility, allowing seamless connectivity to both GEO and LEO constellations on a single, flat-panel antenna. Metamaterials also enable the terminals

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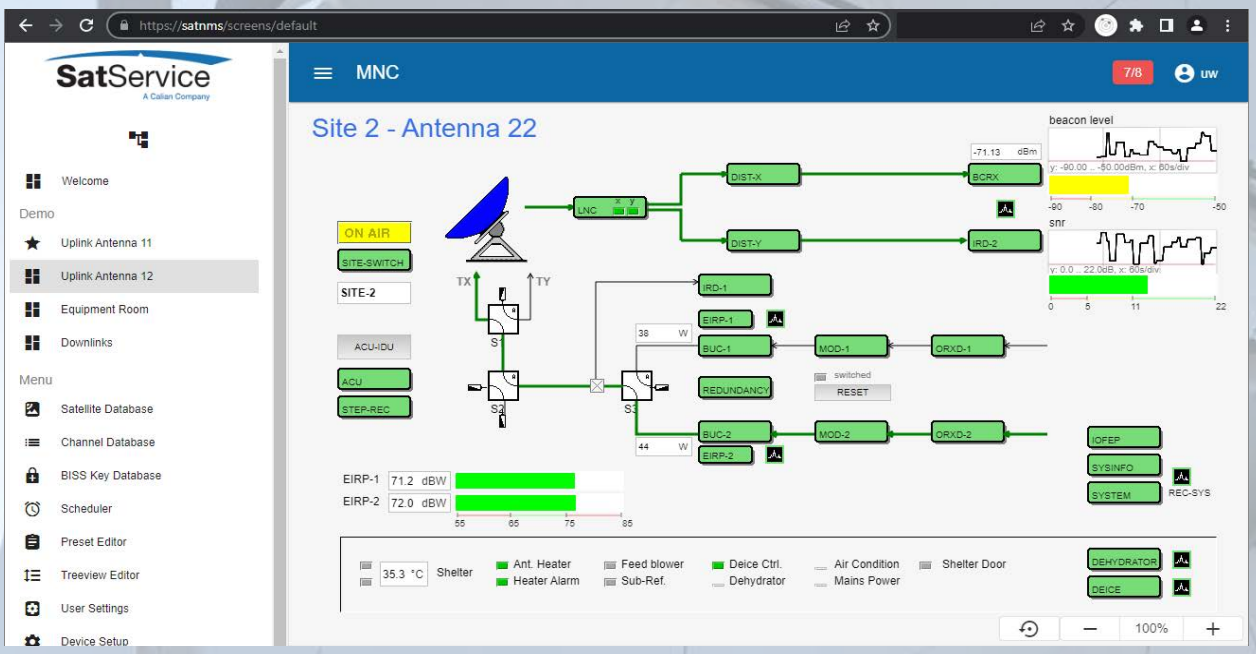

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to be more energy efficient, as beam steering is achieved without motors or power-hungry RF hardware.

Starwin: Our ESA terminal products differences:

1) High performance- StarWin Ku, Ka ESA terminal is specially designed with ground breaking Sub array technology with AI driven Algorithm for beam forming and beam control.

2) Scalability -StarWin ESA terminal can be designed and produced from small size -medium size to big size to meeting different markets' demands.

3) Versatility- StarWin Ku, Ka ESA terminal can work under GEO, LEO and MEO.

4) Multi-function: StarWin Ku, Ka ESA terminal can be in various type of COTM, COTP, and Fixed in one terminal.

5) Multi-application -StarWin Ku, Ka ESA terminal can widely apply for land, marine and air scenario.

StarWin R&D is not only dedicated to contribute to Satcom ecosystem with FDD ESA terminal now we also have TDD model ESA terminal for Chinese LEO with smaller size and better performance for Chinese LEO satellite operators at cost effectiveness. Besides, we are working on the technology advancement on digital ESA terminal for multi-beam.

AI drive Compound Solution system with highly integrated Communication (5G+NTN-GEO, LEO, MEO) +Navigation +Remote Sensing+ Measurement to create application scenarios.

Solution Oriented Service: Superiority in quality from products and tech support, Speedy in response (7X24 in 365 days), Solution Oriented Service to make Customer Simple & Easy with more convenience and happiness.

Thinkom: ThinKom's competitive edge lies in the efficiency and versatility of our phased-array technology. Compared to similarly sized systems, our antennas provide superior aperture gain efficiency, enabling more compact designs that operate seamlessly across GEO, HEO, MEO, and LEO. Additional differentiators include:

- Lower power consumption, eliminating the need for bulky, expensive thermal management systems
- Wide instantaneous bandwidth, ensuring compatibility across networks, modems, and modulation schemes
- Operational cost efficiency, with lower OpEx or greater throughput using the same spectrum.

These advantages translate into higher performance, reduced lifecycle costs, and greater adaptability across commercial and defense use cases.

Anything else you would like to add?

Gilat: We are continually evaluating multiple markets and platforms for applying our ESA solutions across different frequency bands of operation. With the announcement earlier this year of the formation of Gilat's new Defense Division, we see opportunities for developing product offerings to satisfy the increasing demand for government and defense SATCOM solutions. The need for autonomous or unmanned vehicle SATCOM solutions is especially interesting with recent Geo-political events.

Intellian: Intellian has solutions per sector per market across all commercial bands of the satellite services of the world.

Kymeta: This year, in a groundbreaking world-first, Kymeta achieved a major technical leap in satellite technology, simultaneously operating across both Ku and Ka frequency bands in a single, compact antenna. This breakthrough paves the way for a new era of seamless satellite connectivity across different networks and frequency bands, bringing satellite communications closer to the type of ubiquitous connection seen in cellular.

Starwin: StarWin will and is always dedicated to address all challenge

in Satcom and 5G =6G field and become more flexible, resilient to work out more cutting-edge products to contribute to move forward the ecosystem's more transformation and delivery all ubiquitous connectivity to worldwide users to enjoy all domain intelligent interconnection.

Thinkom: Just to add some additional detail on our latest multi-orbit and multi spectrum solution, the ThinAir Ka2517Plus.

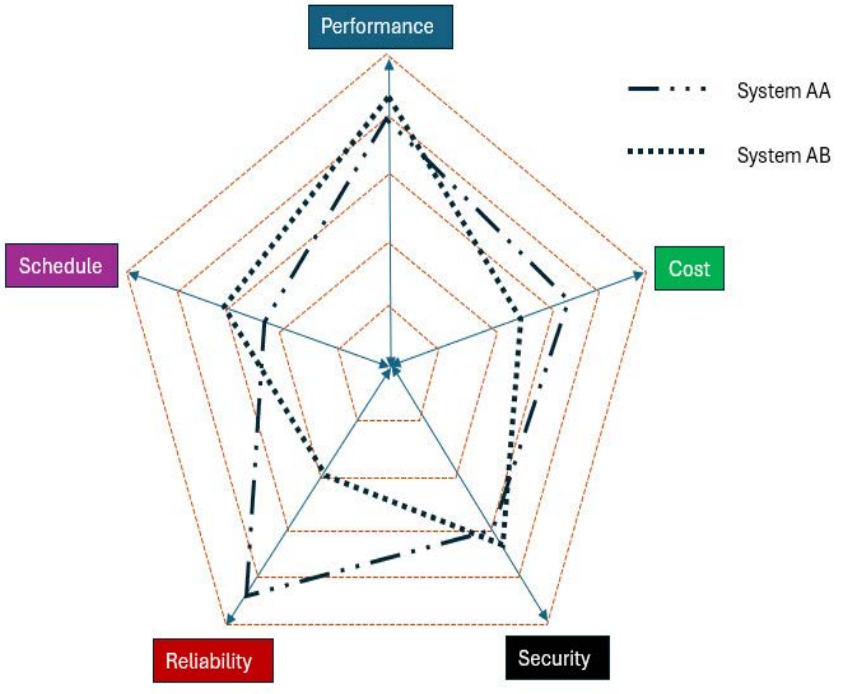
Delta Air Lines through its partnership with Hughes has selected the "Plus" on select Airbus A321neo, A350, and Boeing 717 aircraft. Uniquely combining multi-orbit and multi-band satellite technologies the Plus blends capacity from both Ku low Earth orbit (LEO) and Ka geo-stationary orbit (GEO) satellites to deliver a highly reliable high speed, low latency internet service that maximizes coverage, performance, and Quality of Experience.

Bernardo Schneiderman is the Principal of Telematics Business Consultants. He can be reached at: info@tbc-telematics.com

Reliability: You Don't Know What You've Got Till It's Gone

by Bruce Elbert

Anyone who either purchases or provides telecommunications services understands the importance of reliability – the confidence that the service will always be there when it's needed. The popular song from 1970, The Big Yellow Taxi, sung by Joni Mitchell, tells us how we're surprised when what we thought we had isn't there. I've experienced a fiber outage due to the construction of a hotel (not pink like in the song but it did have a parking lot); it was across the street from our satellite control center. My organization planned for 100% backup fiber from AT&T, composed of two underground cables to separate switching centers. A cable cut wasn't supposed to happen because the local telco had their inspector on the construction site with the underground drawing. Unfortunately, that plan was inaccurate and a backhoe cut a cable. Unbeknownst to the seller of this service, the alternate route actually went over the same cable! A senior technical executive with MCI (now part of Verizon) once defined this as a backhoe fade: "It's deep, and it's long". Loss of communication between the control center and the Tracking, Telemetry and Control (TT&C sites left eight GEO satellites on their own for a day, until we restored service using a temporary backhaul satellite link.



Often the best time to arrange for backup and alternate paths is at project initiation. Cost will increase somewhat due to added time and material, but it will be much more to add it after the fact. Another bit of experience is that when installing new facilities, it could be attractive to keep an older facility in place as a backup. I've done this several times – in fact, this kind of backup might come for free.

Satellite communications is the result of a systems engineering exercise in which backup and alternate routes would be part of the requirements. We can compute the reliability of service ahead of installation, based on component failure rates and how everything is connected. Redundancy is often desirable and it comes from extra internal components or externally as given above. The accuracy of classical reliability calculations can be questioned, so how do you use them? Simply stated, you can make comparisons between different arrangements based on computed reliability. Still, you have to apply your own knowledge and experience to qualify assumptions and the results. It's like using Artificial Intelligence (AI) – ultimately, the decision on how to proceed is yours.

Systems engineering trade studies usually address three areas: performance (e.g., technical specifications), cost (on a life cycle basis), and schedule (time to project completion as well as time to money). To this we must add reliability

and probably security. Rather than a three-legged stool, the systems engineer has to deal with five dimensions giving a polyhedron with five vertices and four sides – a square pyramid. That's hard enough to visualize and even harder to get your arms around the trades.

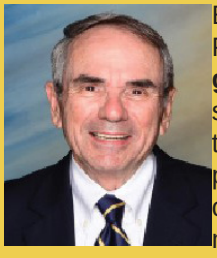
Consider the two-dimensional graph in the previous page that simultaneously can show five dimensions – the spider diagram. You are comparing multiple ways of making the solution or system, and you need quantitative measures for each of the five areas cited above. Here is a simple example being used to compare say a three GEO satellite fleet with multiple MEO satellites for the same data requirements. All numbers are fictitious in this illustration and each of the concentric pentagons indicate higher measures (e.g., some are inverse values that need to be inverted before comparing to the others).

This spider graph helps us visualize the strengths and weaknesses of the different approaches. Assuming you have done the trades and picked a superior system that meets requirements, you still have lots of work in a normal development schedule. After this configuration is operational, we still need to be sure that the backup or alternate paths are there when needed. In my experience, the most effective way to do this is to actually use these backup means routinely during normal operation. You can split the traffic or send traffic over different paths so that all of the means are used at least daily. The fallback in case of failure is to take the unusable means off the table, or out of the network plan, as appropriate.

To make this real, let's replay the title of this article – "You Don't Know What You've Got Till It's Gone." I've been in circumstances that don't subscribe to this concept. In one, an Asian customer employed a redundant uplink system to assure 100% reliability of the command of a satellite. The problem was that the staff never bothered to check the backup. One day, the primary failed and the uplink path to the satellite wasn't there! Another example of the same issue is where the primary fails and but the backup works. This time, the staff left the uplink on the backup and did not bother to fix the primary. A future incident was catastrophic – again, no backup.

An old timer who came to us from AT&T Bell Labs had our systems engineers play what he called "what-if games". This is where we describe how the system can work under different conditions, and what happens when elements fail or there isn't a backup. A computer program can do a good job of examining performance under the myriad of possible component failures, but people are needed to apply common sense. The same process is followed when the system is represented by a digital twin to allow engineers to create failures scenarios and the software displays the impact. Isn't it better to predict what failure will do rather than leave it up to chance? Don't let the big yellow taxi roll over you.

"...Satellite communications is the result of a systems engineering exercise in which back-up and alternate routes would be part of the requirements..."



Bruce Elbert is the Founder and President of **Application Technology Strategy LLC**.(www.applicationstrategy.com) He is a satellite industry expert, communications engineer, project leader and consultant with over 50 years experience in communications and space-based systems in the public and private sectors. Areas of expertise include space segment design and operation in all orbit domains, systems architecture and engineering, ground segment systems engineering, development and operation, overall system performance improvement, and organizational development. He can be reached at: bruce@applicationstrategy.com

SMS Teleport: Ready for Your Services

Satellite Mediaport Services (SMS) is a full-service, state-of-the-art teleport located in Rugby, England. With exclusive, fully redundant network connectivity to multiple Points of Presence (PoP) in London and across the globe; SMS offers the optimal infrastructure for providing essential and reliable satellite communications services.

SMS's strategic position in England's industrial heartland, only a one-hour train ride from London, has made it a very attractive gateway option for Tier-one global network operators and for broadcast service operators alike. From its central location in the UK, the teleport has clear line-of-sight to over 120 communication satellites between 60^0E to 60^0W. Currently the teleport has over 80 antennas in a range of sizes in C-, Ku- and Ka-band with plenty of room to add more – including space for a cluster of antennas typically required for effective Non-Geostationary Orbit (NGSO) tracking.

"Our company has invested heavily in technology and our facilties in recent years. In fact the teleport has almost doubled in size in just the few years and is now 10 acres, with room for further expansion, " said Valentin Kislyakov, Gemernal Manager of SMS.

The teleport is ISO:27001:2002 certified and its core network comprises more than 10 Gbps of dedicated and fully redundant terrestrial fiber connectivity connects within 2 m/s with multiple major PoPs in the City of London and in Munich, Jerusalem, Singapore, .Washington, D.C., among others. The teleport's location, combined with extensive and growing infrastructure, has made it ideal for any services, specifically back up services to add aanotehr layer of redundancy to your current services. Aside from reliable connectivity, the SMS teleport delivers relentless Quality of Service (QoS) combined with a highly responsive customer focus and accumulated know-how in service provisioning – all essential elements for an optimal base for satellite communication services over the European continent, throughout the Atlantic, African and over Asian regions. The SMS service offerings includes:

- Transmission and reception;
- RF uplink and downlink;
- IP connectivity and backhaul;
- Conception, installation and operation of VSAT networks

From its central location in the UK, SMS teleport has clear line-of-sight to over 120 communication satellites between 60^0E to 60^0W and within 2 m/s connection with multiple-peering points in London.

- One-way or two-way Internet backbone connectivity via satellite;
- Network/Hub Hosting;
- Hosting/Maintenance of Customer Furnished Equipment (CFE);
- Satellite capacity;
- Worldwide lease line connections;
- DVBS2 + SCPC services;
- Data Storage and backup; and
- Colocation.

In addition to the above services, SMS teleport is well-poised to provide gateway services to Low Earth Orbit (LEO) constellations and for accommodating cloud edge connectivity needs.

"There are really no limits to what applications we can support," said Kislyakov. The teleport currently supports applications including broadcast, content distribution, enterprise, VSAT services, gateway services and mobility such as maritime, among others. "We are ready to serve potential customers and meet their requirements," added Kislyakov.

For more information on SMS' services go to:
www.sms-teleport.com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The Emergence of Sovereign Constellations

by Vivek Prasad

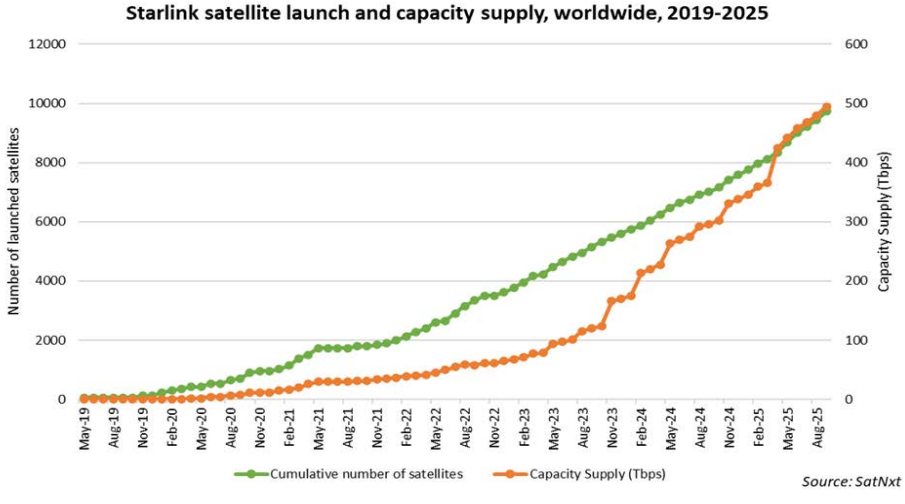
Non-GEO constellation players have transformed the satellite communication (satcom) industry in the past five years. Leading this transformation is Starlink, which has set new benchmarks in satellite deployment speed, capacity influx, and customer acquisition. Other players like Amazon's Kuiper, Eutelsat's OneWeb, Telesat's Lightspeed and SES's mPower continue to reinforce the viability and advantages of Non-GEO solutions. As nations increasingly recognize the benefits, such as scalable bandwidth and reduced cost per Mbps, there is a growing shift toward developing sovereign constellations. These national initiatives are driven by the urgent need for secure communications, digital autonomy, and strategic resilience in response to shifting geopolitical landscapes and rapid technological progress.

The Starlink Impact

The unprecedented growth of Starlink has fundamentally reshaped the satellite communications landscape. In just five years, the company has launched over 10,000 satellites, adding approximately 500 Tbps of satellite capacity in orbit. Alongside its rapid deployment pace, Starlink has progressively upgraded its satellites from versions V0.9 to V1, V1.5, and V2 Mini, with each iteration enhancing per-satellite throughput. In its upcoming version, the company aims to achieve a throughput of 1 Tbps per satellite.

Chinese government-backed Guowang constellation aims to expand China's digital footprint and influence, particularly in the Belt and Road Initiative partner countries. Considering these advancements, nations face growing concerns over foreign player service suspension, data interception, and traffic prioritization, especially during geopolitical tensions. Another concern is the orbital slot race, where spectrum congestion and orbital crowding may restrict access for late entrants. These advancements and associated concerns have led nations to increasingly prioritize the development of sovereign satellite constellations.

Indicators Signalling the Global Rise of Sovereign Constellations



A major indicator of the global momentum toward sovereign satellite constellations is the European Union's IRIS2 program. This initiative reflects Europe's strategic intent to reduce reliance on non-European satellite connectivity networks, by deploying a multi-orbit constellation of 290 satellites by 2030. The program is led by the SpaceRISE consortium with incumbent satellite operators, SES, Eutelsat, and Hispasat. The consortium has extensive network of partners including Airbus Defence and Space, Deutsche Telekom, OHB, Orange, OHB, Hisdesat, Telespazio, Thales Alenia Space, and Thales SIX. The focus will be to provide secure communication to EU member states, covering government, enterprise, mobility

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India is actively evaluating the development of a sovereign LEO satellite constellation to address the country's broadband connectivity needs. Various government departments are assessing both civil and strategic requirements to determine the viability of this initiative. The current consideration involves deploying ~140 satellites to meet immediate bandwidth demands, with a strong focus on supporting government services and enabling digital inclusion across underserved regions. Notably, India has already granted permission to foreign operators such as Starlink and OneWeb to offer satellite broadband services within its borders. This move underscores the urgency of establishing a sovereign alternative to ensure long-term digital autonomy, secure communications infrastructure, and strategic resilience in an increasingly contested orbital environment.

Australia has announced a consortium led by Optus to develop LEO satellites within the country. The initial developmental satellite will carry both earth observation and connectivity payloads. The broader vision is to build national LEO capabilities and potentially scale the technology into a sovereign satellite constellation.

Other countries likely to pursue sovereign satellite constellations in the coming years include the UAE with Space42, and Saudi Arabia. Both nations are aiming to secure national digital sovereignty and accelerate the development of their domestic space ecosystems. Their strategies are expected to range from building indigenous satellite constellations to forming strategic collaborations with global players.

The Future of Sovereign Constellations

The race for control over sovereign satellite constellation infrastructure is intensifying, driving increased investments from governments and national agencies that will significantly benefit the broader space industry ecosystem. While the strategic rationale for sovereign constellations is compelling, decision-makers must carefully evaluate the economic sustainability of such initiatives.

Non-GEO satellite constellations are inherently capital-intensive, with shorter satellite lifecycles and rapid technology turnover. Designed for global coverage, these systems face fundamental inefficiencies when restricted to serving a single nation, leading to underutilised capacity and potentially unsustainable operations. To mitigate this, nations must develop robust strategies to commercialise capacity on a global scale and account for existing and emerging competition. Ultimately, true and sustainable sovereignty in the Non-GEO connectivity domain will depend on achieving a balanced approach, one that harmonises autonomy with strategic partnerships, secure networks with commercial openness, and national investment with cooperative efficiency.

"...The race for control over sovereign satellite constellation infrastructure is intensifying, driving increased investments from governments and national agencies that will significantly benefit the broader space industry ecosystem. ..."

Vivek Prasad is the Founder and Director of **SatNxt** (www.satnxt.com). He began his career as scientist at the Indian Space Research Organization (ISRO) in 2010, contributing to the design and integration of seven earth observation and scientific satellites, including SARAL, ASTROSAT, and INS-1A & 1B. After seven years at ISRO, he joined Frost & Sullivan in 2017, where he expanded Space Industry Practice and earned the President's Club Executive Award. He later served as Head of Satellite Capacity Programs at Analysys Mason (formerly NSR), leading global research and advisory projects across satellite constellations, satcom wholesale, enterprise connectivity, consumer broadband, maritime, and cloud markets. With 15 years of experience spanning satellite missions, market intelligence, and strategic consulting, Mr. Prasad has authored over 60 industry reports and client engagements. At SatNxt, he leads market intelligence and consulting initiatives across the entire space industry value chain, transforming complex satellite market data into actionable insights that drive confident, high-impact decisions. He can be reached at: vivek@satnxt.com

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Cyberthreats in your own Backyard

by Jason Bates

In the age of intense competition from emergent low Earth orbit operators and declining broadcast business, teleport operators are facing unprecedented business challenges, which they are addressing in part by embracing technologies that enable greater efficiency, easy scalability and closer integration with the mainstream telecommunications grid.

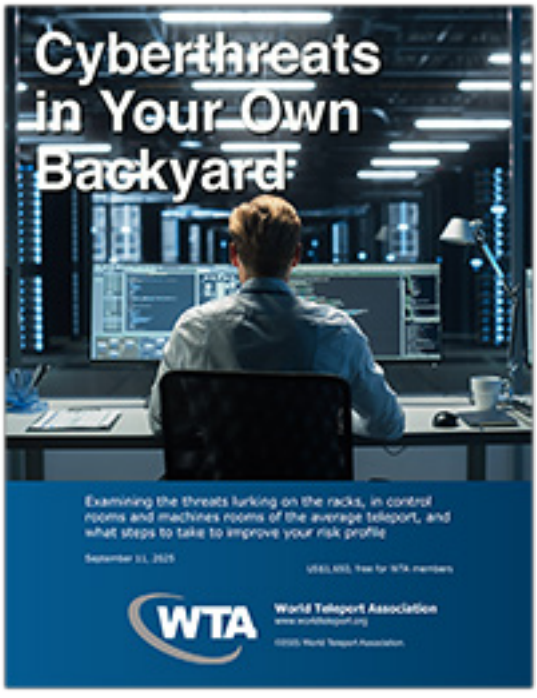
In doing so, however, these operators are increasing their exposure to threats of a different type: hackers seeking to penetrate networks for reasons including theft, government and corporate espionage, and extortion.

Traditional geostationary satellite and teleport operators have long touted security as a feature of their relatively closed-loop networks, but the emerging reality is they are becoming just as vulnerable as ground-based networks. Gone are the days when satellite telecom was a siloed universe, relatively insulated from now pervasive cyberthreats. And with a client list that includes government agencies and large corporations with sensitive information that must be protected, teleport operators recognize cybersecurity as an imperative.

Building a Cybersecurity Fortress

Cybersecurity is foremost in the minds of today's teleport operators, who are taking a multi-layered, standards-driven approach to safeguard their networks and infrastructure from a growing array of digital threats.

Best practices begin early. Security is built into the design of ground systems, following internationally recognized frameworks and standards from organizations like the U.S. National Institute of Standards and Technology, the International Organization for Standardization and others.



On the ground, companies are deploying familiar tools: firewalls, signal encryption, access controls, intrusion detection and prevention systems and real-time threat monitoring systems. Access to critical systems is tightly managed through multi-factor authentication and role-based privileges. Routine vulnerability scans and round-the-clock traffic monitoring provide ongoing threat awareness.

The cloud, which today is increasingly integrated with teleport operations, is heavily guarded. Operators using platforms like Microsoft 365 and Azure are layering in identity verification and data loss prevention tools, backed up by regular security audits.

Monitoring centers work 24/7 to detect anomalies, respond to incidents and flag vulnerabilities before they're exploited. Some operators run dedicated Vulnerability Operations Centers in parallel with their Security Operations Centers to stay ahead of emerging threats.

As is the case in other sectors, one of the biggest vulnerabilities for teleport operators comes from within; not from deliberate insider attacks but employees who inadvertently compromise networks by using unvetted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devices or falling for social engineering ploys. That's why satellite and ground network service providers are pouring resources into mandatory training for all

employes on a regular basis, with specialized training for security personnel.

Cybersecurity is a Shared Responsibility

Protecting data and operations necessitates close collaboration between operators and customers. Because their operations are intertwined, an attack on one has implications for the other; some teleport operators, in fact, view customers as their first line of defense. The more sophisticated clients, such as internet service providers, tend to have robust protections, whereas those with fewer resources, or government and enterprise clients with unforgiving security requirements, generally ask more of the operators. In these cases, operators often rely on highly secure cloud networks like Amazon Web Services (AWS) or Microsoft Azure.

Automation technology, notably including artificial intelligence (AI) and machine learning, is fueling an arms race between teleport operators and cybercriminals. On one hand, these emerging technologies are enabling a new class of threats, including AI-generated phishing campaigns, adaptive malware and automated vulnerability scans—tools that evolve faster than conventional defenses can react. On the other hand, companies are increasingly turning

to AI-powered platforms to detect behavioral anomalies, correlate threat intelligence and automate responses in real time. These systems help identify patterns that humans might overlook, allowing for more precise and proactive threat mitigation.

Future Trends

Satellite teleport operators are facing a threat landscape that is growing more sophisticated by the day. As cyberattacks increase in volume and complexity, companies are moving beyond traditional firewalls and antivirus software toward more adaptive, intelligent and layered defenses.

The rise of AI-driven threats—ranging from social engineering to autonomous malware—underscores the need for adaptive defenses. Zero-trust principles are gaining traction, and quantum-safe encryption is starting to appear on the radar. Companies understand they need not just continuous protection but an evolving strategy to stay ahead of the threat.

Zero-trust architecture is now the baseline—no device or user is trusted by default, even if they sit inside the network perimeter. This model is particularly critical as operators adopt hybrid and cloud infrastructure, which is harder to secure and manage without automation. AI and machine learning have become indispensable on both sides of the cybersecurity divide. Operators are deploying AI to detect anomalies, automate responses and strengthen

SOCs. At the same time, attackers are leveraging AI to scale and customize their campaigns, making defense a moving target.

Across the board, teleport operators recognize that cybersecurity it a continuous, evolving mission, with no silver bullet solution. Participation in national cybersecurity frameworks, real-time threat intelligence sharing and collaboration with government agencies remain vital. So does the adoption of the latest technologies to, at minimum, keep up with nefarious actors—national, extranational or just plain criminal—whose attacks are becoming increasingly bold and sophisticated.

In summary, teleport operators aren't just securing infrastructure—they're reshaping their cybersecurity posture across all network layers to match the scale, complexity and persistence of the threats they face.

Jason Bates is editor for the World Teleport Association (www.worldteleport.org), which conducts research into the teleport and satellite industry, provides a unified voice for teleport operators and offers Teleport Certification programs to service providers. "From Teleport to Network Service Provider: The Search for Tomorrow's Business Model" is available for free to members and for sale to non-members from WTA's online store.

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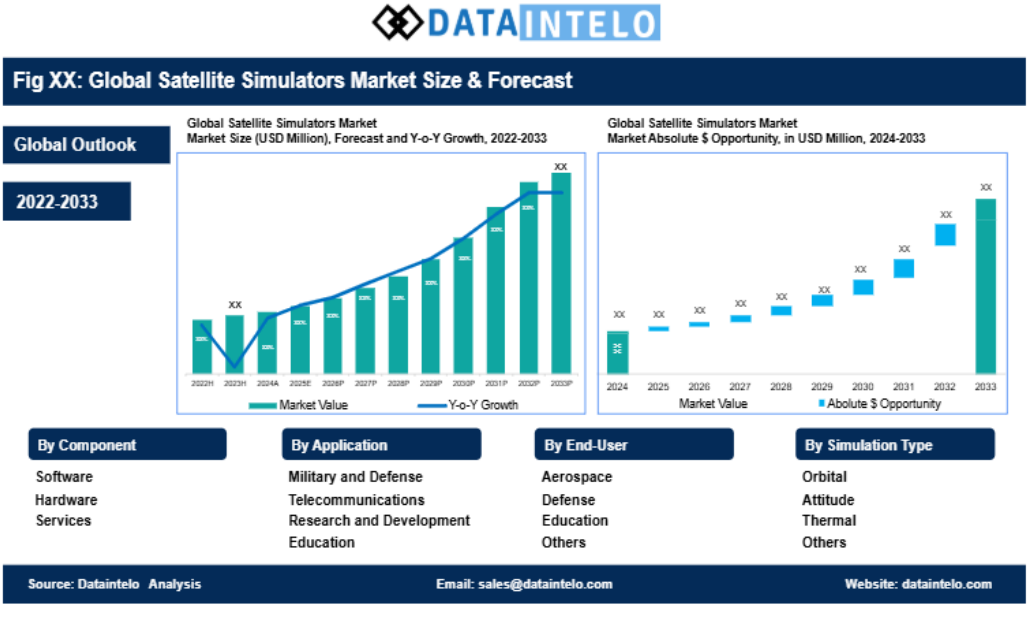

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