Next Generation Space Defense

MilsatMagazine

April 2022

COVER IMAGE IS
COURTESY OF SPACEBRIDGE

Publishing Operations

Silvano Payne, Publisher + Executive Writer
Simon Payne, Chief Technical Officer
Hartley G. Lesser, Editorial Director
Pattie Lesser, Executive Editor
Donald McGee, Production Manager
Teresa Sanderson, Operations Director
Sean Payne, Business Development Manager
Dan Makinster, Technical Advisor

Columnists + Contributors

Chris Forrester, Broadgate Publications
Karl Fuchs, iDirect Government
Bob Gough, Goonhilly Earth Station
Rebecca M. Cowen-Hirsch, Inmarsat
Giles Peters, Track24 Defense
Koen Willems, ST Engineering
Mike Young, Envistacom

Authors

Jeroen Cappaert
Martin Hart
Michal Mazurek
Charlie McGillis
Charles Pope
Alexandre Silva

Dispatches

Features

Advertisers

MilsatMagazine is published 11 times per year by SatNews Publishers, 800 Siesta Way, Sonoma, California - 94576 - USA
Phone: (707) 939-9306 / Fax: (707) 939-9235

SPACEBRIDGE

CONNECTING OUR MILITARY TO ITS MISSIONS

ASAT II™
Tactical , BLoS
HTS System

For over 30 years, SpaceBridge has striven to provide C4I over SATCOM connectivity by being an innovator, leader, and trusted provider of bold tactical solutions in the military ground segment Satellite technologies.

We live on the cutting edge of what's possible, challenging ourselves to provide products and services that rise to the occasion. In a world of mounting unconventional threats, there is no room for failure or compromise.

We are dedicated to the exploration and implementation of new communication technologies that provide our armed forces with ultra high-performance satellite connectivity products that boast the best security, and highest availability.

Recognized by major players such DISA, SpaceBridge will continue to offer high-throughput solutions at exceptional value.

Contact us today to learn how we can connect you to your beyond line of sight missions.

SpaceBridge.com | info@SpaceBridge.com | +1.514.420.0045
USA | CANADA | LATAM | BRAZIL | EMEA | APAC

SATCOM BORDER MONITORING IN THE NEW AGE

SURVEILLANCE ACTIVITIES TO ENABLE ECONOMIC GROWTH

Author: Alexandre Silva, Government and Defense Business Development, Defense Product Owner, SpaceBridge

The Integrated Border Monitoring System (SISFRON) acquired a new satellite communications solution that provides greater flexibility, efficiency and effectiveness of the Land Force Command and Control System in the range of Brazilian land borders.

Selecting the correct solution was key, as the objective of the system is to enable defense and security agencies to curb illicit acts, such as arms trafficking, drug and contraband smuggling, cargo and vehicle theft, environmental crimes, and prevention of border conflicts in coordination with the neighboring countries.

By contributing to improve security and stability, SISFRON is able to help the long-term development of Brazilian border areas, including the Amazon region. ***SpaceBridge ASAT™ WaveSwitch***™ technology was selected due to its efficiency in supplying communications with enough scalability, flexibility and reliability in mission-critical real-time conditions, significantly optimizing the Space Segment and providing reliability to the communication links in remote areas, including where interference is present.

"WHERE YOU NEED THEM AND WHEN YOU NEED THEM"

in a bandwidth on-demand scheme. With the acquisition from SpaceBridge of a bandwidth on-demand scheme — the ASAT™ WaveSwitch™ VSAT hub system with georedundancy and 15 Lightweight Flyaway Terminals (TL) was perfect for the Pilot Project. The project encompassed the country region under the responsibility of the ***Western Military Command*** (**CMO**). The Brazilian Army was then better able to make a use of available satellite resources and increase reliability, flexibility and efficiency with quickly deployable terminals that easily connected remote military units or subunits to headquarters.

The ASAT™ WaveSwitch™ system is capable of dynamically managing the available bandwidth and switching the waveform according to each application's demands and to the propagation conditions, even with interference present. In a scenario where military HF and VHF radio aggregation and termination are needed, the most favorable real-time, MF-TDMA waveform will take place and be automatically activated in the system for secured and immune transmissions.

However, when an important event needs video or high-resolution picture needs to be sent in real time, the SCPC waveform will enter into action, transmitting secured high-data rate and high-quality live video from HD cameras. With the adoption of this new paradigm, newfound agility and flexibility to deploy the terminals became clear.

Better efficiency was then fully achieved with the system's ability to provide ***Bandwidth on Demand*** (**BoD**) from the unused capacity on the fly for those remote vehicles or deployed command posts and maneuvering special units, according to their needs and applications. This includes: ***C^2 systems***, ***sensor data transmission***, ***trunking radio communications backhauling***, ***VoIP calls***, ***video streaming*** and ***videoconferencing*** — all without the need for previous scheduling. This allows the remote units to communicate with headquarters more fluidly and, as a consequence, a better outcome is produced from defense and law enforcement activities along the Brazilian border.

Worth noting is that the ASAT™ WaveSwitch™ system was provided with the capacity to absorb all the armed forces' X-band terminals of the ***Military Satellite Communications Integrated System*** (**SISCOMIS**) currently in use, as well as advanced gateway georedundancy capabilities, to provide continuity and resilience in case of turbulent weather conditions, interference or natural disasters.

The SpaceBridge disaster-ready architecture is designed to deal with such high-risk scenarios. Therefore, all of the Brazilian Armed Forces and MoD are able to benefit from the flexibility, efficiency, resilience and reliability of the satellite communications infrastructure in joint and interagency operations.

During the expansion of the Amazonian and West region of Brazil, SISFRON increased the number of deployed terminals by procuring and adding other flyaway remote terminals to allow for flexibility, resilience and independence when it comes to the SATCOM aspects of the deployed commands.

As a well-established vendor and operator of advanced managed services, SpaceBridge provided in-country project management. This included the ***Factory Acceptance Test*** in Canada, as well as Advanced SATCOM trainings and knowledge transfer to Brazilian Army operators and other partners.

Army officials' were extremely satisfied with the demonstration that the ASAT™ WaveSwitch™ system provided the Brazilian Army had the capability to better monitor the almost 17,000 km. of the nation's terrestrial borders. As a result, the Brazilian population living closer to the borders can now feel more secure, as they are being better supported and defended by the Brazilian Army. This security allows for better economic growth in that area as well as better utilization of the land and of the wealth of natural resources.

Ultimately, the Ministry of Defense benefits immensely, as they can save as much as 30% of the precious satellite important resources of the Brazilian Defense and the ***Strategic Communications Satellite*** (**SGDC**), a valuable piece of the ***Brazilian Communications and Defense System***.

Furthermore, due to the success of the implementation of the ASAT™ WaveSwitch™ system within SISFRON, and its scalability along with its already existing integration with the Brazilian MoD's Defense Operational Network (ROD) and the Military Satellite Communications System (SISCOMIS), SpaceBridge envisions potential future opportunities with the Brazilian Armed Forces and MoD, to improve the provision of C^2 information to key-decision makers in joint and interagency operations for matters of National Defense.

www.spacebridge.com

Author Alexandre Silva retired from the Brazilian Army in mid-2021 as a Colonel and military telecommunications engineer, after more than 29 years of service. He is now part of SpaceBridge's team, leading the Government and Defense Business Development initiatives and defining the next Generation Product Lifecycle as Defense Product Owner. Throughout his career, he commanded and led several ground and satellite communications systems and projects, among them worth mentioning his role as technical engineering commander of the Brazilian MoD's Defense Operational Network (ROD) and the Military Satellite Communications System (SISCOMIS).

SPACE SUSTAINABILITY

IN THE WAKE OF RUSSIA'S ASAT TESTS

Authors: Charlie McGillis, Vice President, Partnerships, Slingshot Aerospace

Looking back to mid-November of 2021, when Russia destroyed a defunct Soviet satellite orbiting at an altitude of 480 km., gives the world a wider look at Russia's strategy in light of their invasion into the sovereign country of Ukraine.

Putin wasn't just after affecting the future regulation of space weapons and desire to be a part of any negotiations, but he was sending a clear signal to the world. Knowing that Russia planned to invade Ukraine prior to the ASAT test, Russia wanted the world to know the nation had the capability to destroy satellites and was willing to use that destructive power. Russia knew the environmental damage an ASAT test at high altitude would cause, including threatening the safety of those onboard the International Space Station (ISS).

The remains of the two-ton ***Cosmos-1408*** satellite are expected to disrupt commercial operations for years to come. Looking further ahead, Russia's actions have cast uncertainty over the long-term sustainability of space and led to renewed calls for international regulations and norms to govern activity in orbit.

Since the turn of the millennium, the United States, India, China, and now Russia, have all conducted ASAT tests. The targets, techniques and resulting debris have varied in scope. But all of these tests — in addition to the development of other counter-space capabilities — suggest an arms race is well underway.

Left unchecked, this gradual weaponization could escalate in a way that undermines access to space for all and gives pause to NATO on that organization's response options to Russia's invasion of the Ukraine. The picture is complicated.

Space is the ultimate high ground and infrastructure in orbit is increasingly vital to national security. Developing capabilities that deter attacks on those assets and actively using them against adversaries are two very different elements.

Russia's November ASAT test is a reminder of how precarious the orbital environment is and that aggressive behavior on behalf of one bad actor can have collateral impacts on the entire industry and space operating environment. The actions of one state could spark a chain of events that would complicate the domain for all.

With so much at risk, it is imperative that the international community sets norms of behavior and strict non-adherence protocols for how to safely and sustainably operate in the space environment. International condemnation followed as more than 1,500 trackable debris fragments were created in ***Low Earth Orbit*** (**LEO**).

AN INTERNATIONAL TREATY IS ON THE HORIZON

It's useful to start with recent developments at the ***United Nations*** **(UN)**. Just two weeks before the test was carried out by Russia, the ***UN General Assembly First Committee*** — which discusses disarmament, global challenges and threats to peace — approved a resolution to form an open-ended working group. This group will explore potential threats to space sustainability, "*make recommendations on possible norms, rules and principles of responsible behaviors*," and "*contribute to the negotiation of legally binding instruments*."

Reading between the lines, the end goal is a treaty that will reduce the likelihood of military confrontation in orbit. This will be the most significant international space legislation since the ***Outer Space Treaty*** in 1967. A binding agreement will be years in the making but the legislative wheels are now in motion. It's fair to assume a ban on counter-space activities — or at least on kinetic physical ASAT weapons — will be high on the UN's agenda.

During that November 1 committee meeting, the Russian Federation pushed for a legally binding instrument to prevent the placing of weapons in outer space. However, that *No First Placement* resolution did not encompass ground-based ASAT weapons and Russia's continued development of this capability doesn't sit comfortably alongside the peaceful rhetoric. Welcome to the ***complicated world of space diplomacy*** and interesting bedfellows.

PUTTING RUSSIA'S ASAT TEST INTO CONTEXT

Russia has a long history of successful space endeavors: the first satellite, the first man and woman in orbit, the first space station, and photographing the dark side of the moon. Russia wants to maintain their superpower status in space.

To assess the significance of Russia's ASAT test and its bearing on the future of ***space sustainability***, it's important to understand what may have motivated this action.

Russia knows the United States and its allies rely on space technologies to project power globally and Russia wants to negate these advantages. Russia and China both agree on this course of action and both nations have built ***counterspace capabilities*** to potentially deter and challenge the U.S. position in space. Russia and China have a long standing, yet complicated partnership around space programs and they continue to ***partner*** on ambitious space projects. Furthermore, Russia wanted to demonstrate its capabilities before their use (*and development by other nations*) is outlawed.

Over the last couple of years, Russia has seen the U.S. create a new and separate service, the ***U.S. Space Force***, as well as a new combatant command, the ***U.S. Space Command***. These armed services are solely focused on space warfighting.

In response over the last year, Russia has tested numerous counterspace capabilities, ***performed complex RPOs*** and expanded its space-based military infrastructure[1]. Russia may not have the budget to create its own Space Force, but developing ASAT capabilities and firing missiles into orbit is an alternative way to counter the United States. Especially as U.S. sanctions are having an effect on Russia's ability to obtain ***microchips***, according to Rogozin, the head of Russia's civil ***Roscosmos*** program.

Rogozin has threatened to withdraw from the ***International Space Station*** in 2025 unless sanctions against Russian space contractors are dropped, and soon[2]. Additionally, Roscosmos lost revenue, now that the U.S. is not dependent on Russia to launch astronauts and supplies to the ISS since ***SpaceX*** has this capability.

The important question now is whether Russia will want to push ahead with further tests. Were Russia's actions in November a show of force, possibly in response to U.S. actions, a forward step in capability development that provides a bargaining position before UN legislation, or a combination thereof? At the moment, there is more uncertainty than answers.

COUNTERSPACE WEAPONS + SPACE SUSTAINABILITY

A catalyst for change

There's hope that Russia's ASAT test will be a catalyst ahead of the UN's ***Open-Ended Working Group***, which will explore space threats and define what constitutes responsible behavior.

During its meetings in 2022 and 2023, the global community could agree that irreversible, kinetic ASAT tests fall into the '*irresponsible*' category. In time, a binding agreement would serve to reduce tension in what is an increasingly adversarial environment.

Russia's recent actions raised the profile of these tests and highlighted the ***issue of space debris*** more broadly. That much is clear from the December 1 ***United States Space Priorities Framework***, which perhaps includes stronger wording on sustainability than it might have done. In particular is the commitment that the U.S. "*will work with other nations to minimize the impact of space activities on the outer space environment…increase efforts to mitigate, track, and remediate space debris*" and "*advance development and implementation of domestic and international best practices to mitigate the creation of space debris.*"

A gloomier perspective is that other nations could follow Russia's lead and race to conduct their own kinetic tests before any UN measures are agreed upon.

The reality of conflict in space

It's important to note that kinetic physical ASAT capabilities represent just one weapon in the counterspace arsenal. Direct-ascent missiles are irreversible, clearly attributable and of most concern from the perspective of space sustainability.

There is also a proliferation of more subtle capabilities, including jammers, high-powered lasers and cyberattack techniques. These can block communications, temporarily dazzle or permanently blind satellite sensors and interfere with the transmission of RF signals, respectively.

A 2020 ***Secure World Foundation report*** suggests that Russia and China develops and tests a range of counter-space weapons — the U.S., India, France, Iran, and Japan are also building capabilities. This exploration is to be expected at such an early stage in a new space race, but it's also a reflection of the fact that kinetic conflict and the ***Kessler Syndrome*** risk that follows is not in any nation's best interest.

For all of those nations, counterspace weapons are primarily tools to deter aggression by adversaries. The U.S. Space Force, for example, aims to prevent conflict from starting or extending into space by assuming a position of strength and relying on the traditional deterrence calculus: by denying the advantages or imposing costs related to a specific action from an adversary, that action can be prevented.

The *U.S. Under Secretary of Defense for Policy*, ***Colin Kahl***, recently spoke about the concept of ***integrated deterrence***, which is particularly important in space where infrastructure and intelligence can be shared between allies to improve resilience. "*We have to work alongside our allies and partners so that our adversaries know that they're not just taking on the United States,*" he said. "*They're taking on a coalition of countries who are committed to upholding a rules-based international order.*"

U.S. Space Force Lieutenant General ***Saltzman put it another way*** when describing the importance of resilience and having more disaggregated capability on orbit: "*If they don't know what to shoot at, then what's the benefit of shooting?*"

All of which reduces the potential advantage of a space-based attack. In terms of imposing costs, we can look closer to home for a good example.

The threat of mutually assured destruction has, so far, been enough to prevent nuclear war on Earth. The same equation holds in space, where a chain reaction of conflict would quickly render the domain unusable for humankind. That would mean no satellite television, no internet on a flight, no devices that require GPS signals, such as your cell phone, gas station, or ATM machine.

Space is complex enough

From a sustainability perspective, these deterrence measures are promising. But of course, there's already plenty going on in orbit after decades of launches, ***accidental collisions***, previous ASAT tests, and the recent rise of ***mega constellations***.

As the orbital environment grows more complex, commercial operators also have to embrace the notion of integrated resilience to collaborate, mitigate risk and make data-backed decisions. Situational awareness platforms such as ***Slingshot Beacon*** are set to be a critical part of that equation. A safe and sustainable orbit can only be achieved when communications and information are a shared endeavor. Space is a most challenging domain there is and is increasingly home to vital infrastructure — for national security and everyday lives. Beyond that, it's the next frontier for exploration and key to the destiny of humanity.

My wish this year and every year is we work together and keep space open for all with the correct tools, safeguards and international standards in place.

References

[1] CSIS_Harrison_SpaceThreatAssessment2021.pdf

[2] Russian Space Chief Says US Sanctions Keep Satellites Grounded

Co-author Charlie McGillis is the Vice President of Partnerships at Slingshot Aerospace.

Charlie McGillis

COMMS ON THE MOVE

Designed, tested and proven for today's soldier communicator.

Field Configurable X-, Ku- & Ka-band

Multi-orbit LEO/MEO/GEO

Platforms for Land, Sea, Air

Open & Closed Loop Tracking

Flexibility that ensures resilient communications over satellite in battlefield environments

AvL TECHNOLOGIES

See our new COTM terminal at SOFIC ✦ Booth 229

RF SPECTRUM MONITORING

INTEL: SPIRE GLOBAL

Author: Jeroen Cappaert, Chief Technical Officer, Spire Global

Spire Global Inc. is a satellite-powered data company that uses a large, distributed constellation of satellites to persistently collect radio frequency (RF) data at a global scale in near-real time. Founded in 2012, the company leverages proprietary Software Defined Radio (SDR) technology to collect radio frequency signals and extract information and intelligence from the RF spectrum.

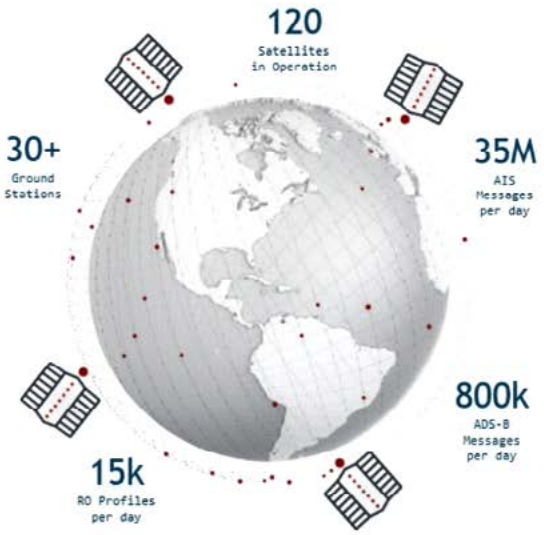
The company specifically uses the smallsat form factor for data collection to take advantage of this spacecraft's potential for exponential technology trajectory. Advances in miniaturization reaching the market from the consumer electronics and robotics industries on Earth enable smallsats to perform more sophisticated missions at ever smaller ***Size, Weight, and Power*** (**SWaP**) requirements.

Data is downloaded from each spacecraft through Spire's own global ground station network. Spire uses this 'raw data' to produce high-value information products on the movement of world resources as well as on global weather and climate conditions.

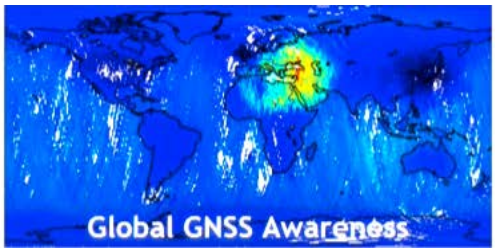
This article outlines the background, current status and existing customers of Spire's capabilities to monitor, detect and geolocate RF signals. This service will be available across a number of frequency bands as both stand-alone and augmentative products.

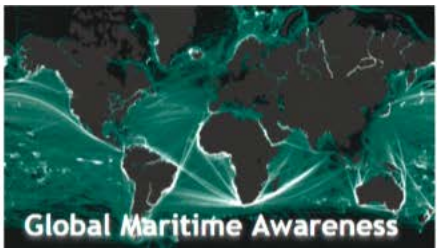
This service is expected to have an immediate effect on entities that use the ***Automatic Identification System*** (**AIS**), ***Automatic Dependent Surveillance-Broadcast*** (**ADS-B**) and ***Global Navigation Satellite System*** (**GNSS**)-based products, all the while greatly expanding into custom RF monitoring capabilities in the VHF, UHF, L-, S-, X-, Ku- and Ka-bands (*among others*).

- **Launch:** We have completed over 30 campaigns with seven different launch providers.
- **Licensing:** We have access to satellite licensing coordination through 3 jurisdictions – United States, Singapore, and Luxembourg. All of our satellites have received the appropriate licensing.
- **Data Management:** We maintain a database and customer interface for all data collected from our satellites in addition to all engineering/TT&C related data.
- **Operations:** We have been operating satellites on a 24/7 basis since 2013
- **Ground Stations:** We have designed and installed 30 ground stations around the world that have a greater than 99% uptime.



- **Satellite Design:** Spire is on the 21st design iteration of our spacecraft.
- **Space Heritage:** Spire's satellites have accumulated over 390 years on orbit (cumulative)
- **Supply Chain:** Proprietary software for full traceability and tracking of all parts coming in, inspection and log delivery, and tagging to individual satellites. We work with more than 100 different component vendors.
- **Manufacturing:** We have built and tested more than 150 satellites in total. Our average build cycle time across all satellites is about five days
- **Software Stack:** Our software stack was built in-house and uses a combination of C++, Python, and Linux with over 2M lines of code written by Spire.





Spire controls all stages of the RF spectrum monitoring enterprise, from satellite design and manufacturing to ground station management and payload tasking. This means that Spire is uniquely positioned to provide a uniform and seamless RF spectrum monitoring service.

With more than 150 satellites launched, Spire is able to provide persistent, near-global coverage of a wide range of RF observables and payload telemetry. Additionally, Spire operates a global network of 30+ ground stations, that allows for timely data product downlinks for processing and distribution to clients. From the firm's place as a world leader in satellite, commercial, data services and analysis, Spire is expanding into the RF spectrum monitoring domain.

For nearly a decade, Spire has harvested RF signals for a variety of applications. Spire's push for robust and resilient RF spectrum monitoring capabilities will provide even more insights for customers, such as:

- ***AIS position validation***
- ***Near real-time GNSS jamming detection and geolocation***
- ***Custom RF spectrum monitoring***

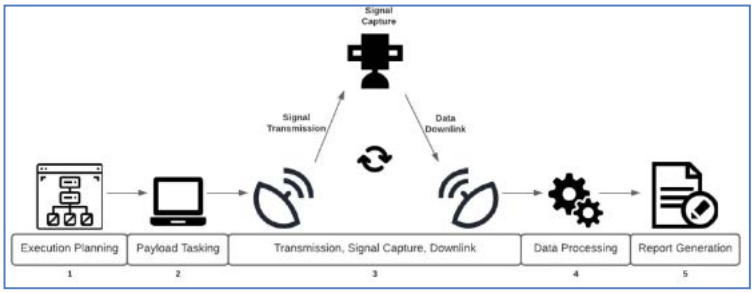
All of these capabilities are under contract today, in addition to Spire's intent to continually expand into other frequency bands of interest. Pairing these upcoming capabilities with existing ones positions Spire as a unique and powerful commercial data partner that is able to provide persistent, immediate and actionable insights on global situations from a variety of varying measurements.

TECHNICAL BACKGROUND

Mission Profile

The basic RF monitoring mission consists of the following five steps:

1. ***Execution Planning** can be done on the ground or automated onboard the satellites. It is driven by customer requirements of collection time, geographic area, signal type, and desired analytics*
2. ***Payload Tasking** schedules and tasks relevant payloads with the mission executables.*
3. ***Transmission** of the signal of interest is generally not Spire-controlled, and comes from cooperative or non-cooperative 3rd party emitters. Occasionally, Spire may transmit a calibration signal in the area for enhanced RF monitoring capabilities. Signal capture implies Spire has successfully collected the signals of interest (SOI). Downlink of the captured information is scheduled using as many of the Spire ground stations as needed to fulfill the client's latency requirements.*
4. ***Data Processing** takes the captured, downlinked information and parses it for relevant signal attributes such as geolocation, modulation scheme, and power. This processing can be done onboard the satellite or on the ground.*
5. ***Report Generation** produces and formats the information obtained from the missions to the client.*



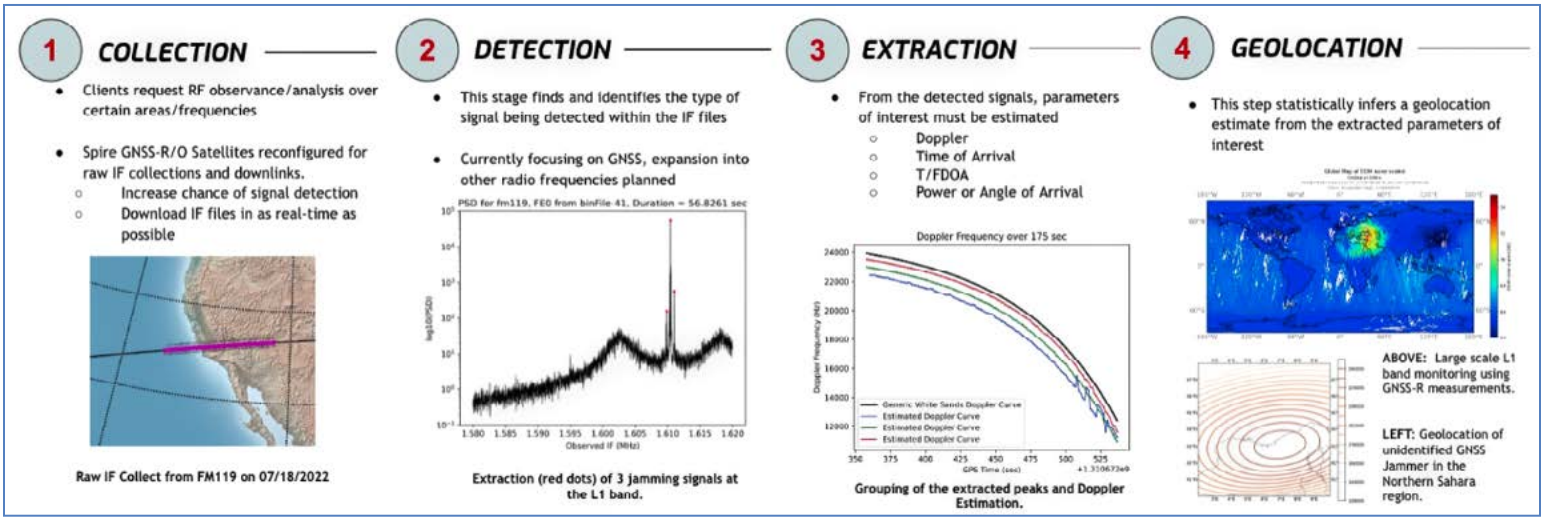
INFRASTRUCTURE

Infrastructure RF spectrum monitoring requires an extensive network of satellites, ground stations, and operational infrastructure to successfully execute missions with useful real-world product performance. Time-sensitive, temporally persistent, and geographically-specific client mission requests require a proliferated set of global satellite assets, a high number of ground stations, and intersatellite links to enable near-real time, actionable dissemination of spectrum insights.

- ***Spire Ground Stations***
  Spire operates a global network of 30 ground stations and is continually expanding this network to improve data downlink capacity and data latency. The ground stations support UHF and S-band transmit and receive functions. Spire is rolling out X-band downlink capability to support large-file missions (e.g., IF collections), targeting completion in 2022. Currently Spire has more than 70+ antenna systems, >70,000 contacts and >300,000 contact minutes per month. Spire also has partnerships with third party ground station providers to provide surge capacity on-demand.

- ***Spire Satellites***
  Spire's 120+ satellite network cumulatively carries hundreds of payloads. Collection payloads must be capable of capturing or extracting phase information from a particular signal of interest. This phase captures many types of phenomena that Spire uses to infer attributes about the transmitted signal, including the modulation type, the induced Doppler, the environmental mediums affecting the signal, and even minutia on the RF transmitter itself. From these inflections in phase, Spire looks to detect, characterize, and geolocate the transmitted signals. Once the appropriate data has been captured, RF monitoring requires precise position, navigation, and timing (PNT) knowledge across multiple RF-collecting platforms. Therefore, a satellite capable of RF monitoring must have these attributes and can be differentiated based on the spectrum it is able to monitor.

- ***Signal Processing***
  There exist many forms and methods for detecting, extracting, and geolocating signals of interest. RF monitoring requires precise PNT knowledge across multiple platforms, circumstantial transceiver geometry, and a solution choice from a suite of algorithms that vary in effectiveness depending on the collection scenario. By collecting the



phase for the signal(s) of interest, which captures many type of signal phenomena, Spire can infer attributes on the transmitted signal including the modulation type, the induced Doppler, the environmental mediums affecting the signal, and even minutia on the RF transmitter itself. The figure above demonstrates the general process:

Consider a stationary ship transmitting an AIS signal. The signal impinges upon a Spire satellite. The fast speeds of the LEO satellite induce a ***Doppler*** *effect that is captured as a time-varying, phase shift in the received signal. This phase shift can, in some circumstances, be modeled and unambiguously mapped to an emitter location, even if the Spire satellite has no prior knowledge of the ship's location (i.e. if the ship is reporting an erroneous GPS coordinate). If multiple satellites capture the signal simultaneously, or perhaps in succession, unique proprietary algorithms are available to detect and geolocate the signal.*

This same process is used for ADS-B, GNSS, and any other signal of interest which Spire satellite payloads are able to capture, though the algorithms used to detect the signal vary widely with the signal type. Signal geolocation can also use nonlinear filtering, time frequency ***difference of arrival*** *(***TFDOA***), and parameterized covariance matrix algorithms when multiple satellites are present to simultaneously collect.*

EXAMPLE APPLICATIONS

Spire is engaged in several sponsored activities to extend the capability of our standard LEMUR VHF, UHF, and L-band capable platforms to collect and geolocate signals in a wider range of the RF spectrum. In order to enable these emitter detection and geolocation capabilities, Spire has developed custom RF front ends, RF intersatellite links (S-band), and a precision GNSS receiver to deliver coherent timing and frequency reference to every collection payload. These building blocks coupled with purpose-built RF front ends and apertures will enable Spire to collect, process, and geolocate signals of interest across various signal types. A few examples are detailed below.

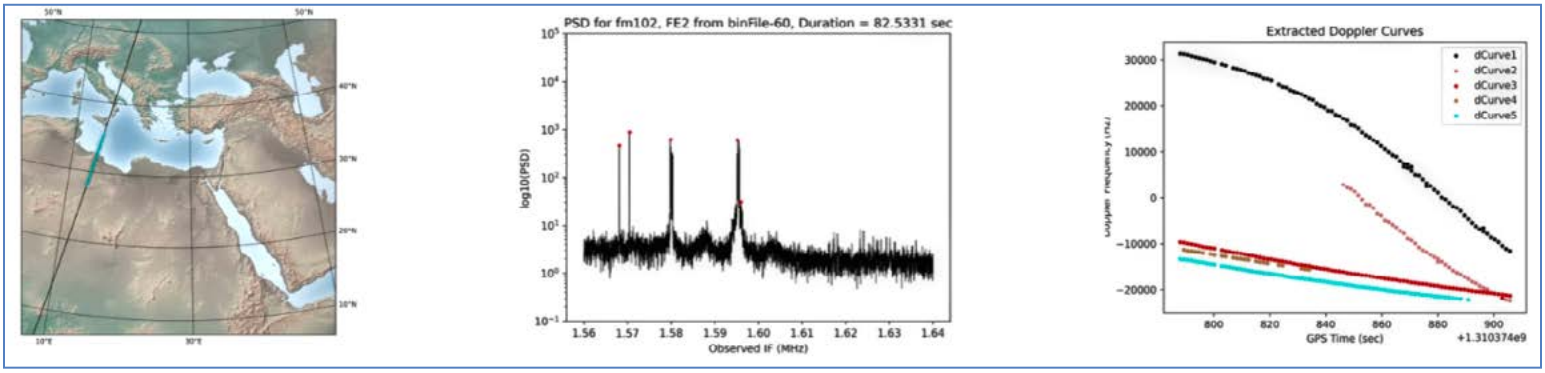
- ***GNSS Jamming Detection and Geolocation***

In recent years, effective jamming of GNSS users, purposely and not, have increased across the world. These jammers, generically referred to as GNSS radio frequency interference (RFI) sources, degrade the quality, reliability, and usability of GNSS/GPS position, navigation, and time (PNT) services. Knowledge of the power, location, and directionality of these jamming events can significantly help local entities maintain safe and consistent activities.

The figure* ***below left *is a GNSS jamming collection Spire completed over the Saharan Desert. The Spire satellite collected raw, intermediate frequency (IF) data in the highlighted area on the image to the far left. A snapshot of a power spectral density (****PSD****) plot is shown centrally, where 5 peaks can be seen. These 5 peaks, when tracked and extracted over time, produce the Doppler curves shown on the right. Two of the curves were able to be geolocated to potential jamming locations with approximate error ellipsoids of just under 10 kilometers in the ECEF coordinate system.***

- ***Custom RF Collections***

Spurious RF emissions, intentional or not, can affect local infrastructure in a harmful manner. Procuring a set of sensors to detect, quantify, and geolocate the RF emissions from space can quickly bring about the right plan of action by first disseminating the nature of the interference or unknown signal. The customizable SDRs onboard Spire satellites allows for custom collection campaigns to be executed expediently. For instance, the proliferation of commercial SATCOM services have enabled Terrorists,



phase for the signal(s) of interest, which captures many type of signal phenomena, Spire can infer attributes on the transmitted signal including the modulation type, the induced Doppler, the environmental mediums affecting the signal, and even minutia on the RF transmitter itself. The figure above demonstrates the general process:

Consider a stationary ship transmitting an AIS signal. The signal impinges upon a Spire satellite. The fast speeds of the LEO satellite induce a ***Doppler*** *effect that is captured as a time-varying, phase shift in the received signal. This phase shift can, in some circumstances, be modeled and unambiguously mapped to an emitter location, even if the Spire satellite has no prior knowledge of the ship's location (i.e. if the ship is reporting an erroneous GPS coordinate). If multiple satellites capture the signal simultaneously, or perhaps in succession, unique proprietary algorithms are available to detect and geolocate the signal.*

This same process is used for ADS-B, GNSS, and any other signal of interest which Spire satellite payloads are able to capture, though the algorithms used to detect the signal vary widely with the signal type. Signal geolocation can also use nonlinear filtering, time frequency ***difference of arrival*** *(***TFDOA***), and parameterized covariance matrix algorithms when multiple satellites are present to simultaneously collect.*

EXAMPLE APPLICATIONS

Spire is engaged in several sponsored activities to extend the capability of our standard LEMUR VHF, UHF, and L-band capable platforms to collect and geolocate signals in a wider range of the RF spectrum. In order to enable these emitter detection and geolocation capabilities, Spire has developed custom RF front ends, RF intersatellite links (S-band), and a precision GNSS receiver to deliver coherent timing and frequency reference to every collection payload. These building blocks coupled with purpose-built RF front ends and apertures will enable Spire to collect, process, and geolocate signals of interest across various signal types. A few examples are detailed below.

- ***GNSS Jamming Detection and Geolocation***

  In recent years, effective jamming of GNSS users, purposely and not, have increased across the world. These jammers, generically referred to as GNSS radio frequency interference (RFI) sources, degrade the quality, reliability, and usability of GNSS/GPS position, navigation, and time (PNT) services. Knowledge of the power, location, and directionality of these jamming events can significantly help local entities maintain safe and consistent activities.

  The figure ***below left*** *is a GNSS jamming collection Spire completed over the Saharan Desert. The Spire satellite collected raw, intermediate frequency (IF) data in the highlighted area on the image to the far left. A snapshot of a power spectral density (****PSD****) plot is shown centrally, where 5 peaks can be seen. These 5 peaks, when tracked and extracted over time, produce the Doppler curves shown on the right. Two of the curves were able to be geolocated to potential jamming locations with approximate error ellipsoids of just under 10 kilometers in the ECEF coordinate system.*

- ***Custom RF Collections***

  Spurious RF emissions, intentional or not, can affect local infrastructure in a harmful manner. Procuring a set of sensors to detect, quantify, and geolocate the RF emissions from space can quickly bring about the right plan of action by first disseminating the nature of the interference or unknown signal. The customizable SDRs onboard Spire| satellites allows for custom collection campaigns to be executed expediently. For instance, the proliferation of commercial SATCOM services have enabled Terrorists, Narcotics traffickers and smugglers to employ L-Band

SATCOM phones to conduct their operations. Additionally, local governments or commercial entities could query Spire satellites to persistently monitor the interested spectral bands over certain geographical areas, geolocating the emissions if any are detected with applications to spectrum usage validation or using traffic pattern monitoring for satcom. An example of a custom collection mission is shown. Following reports of jamming activity in the Southwest United States, within a few days Spire tasked 7 satellites whose collecting positions are highlighted. From our collections, two to five GPS jamming signals were detected with geolocation fixes produced.

PATH FORWARD

1. *Select Current Programs*

Space Systems Command (SSC) DEEP Program
In the DEEP Program, Spire will provide GPS telemetry data to Slingshot Aerospace. The focus of the program is to build a prototype RF Spectrum Awareness capability to detect and localize GNSS RFI using strictly commercial LEO constellation observables.

SNC L-Band Emitter Detection & Geolocation Technology Program
Spire's cluster of four 6U satellites built for Sierra Nevada Corporation (SNC) will enhance SNC technology that detects and geolocates certain objects based on targeted RF emissions. The program will provide valuable insight into how military and government organizations can safeguard against RF and GPS interference.

Australian Office of National Intelligence (ONI) NICSAT Program
Spire designed, built, and launched a 6U satellite platform for ONI with the capability of on-board computing and processing of machine learning and artificial intelligence across multi-modal data.

UK DASA Next-Gen Space Tech Funding for RF Signals Detection and Geolocation
This program will support the demonstration of radio frequency (RF) signals detection and geolocation from 3U satellites built and operated by Spire. Spire will demonstrate its ability to geolocate RF signals emitted near the Earth's surface, focusing on L-Band SATCOM signals, and investigate further geolocation techniques using Spire satellites.

ESA NAVISP Project
Spire is demonstrating a prototype service for space-based surveillance, detection, and geolocation of GNSS interference.

EXPECTATIONS

This article outlines the motivation, background, and current status of Spire's capabilities to monitor, detect, and geolocate radio frequency (RF) signals. Spire is looking to leverage our existing constellation and planned additions to provide persistent, global, near real-time delivery of RF insights in the future. This enterprise into the RF spectrum monitoring realm looks to further position Spire as the world leader in smallsat-based commercial data and data analysis.

ir.spire.com

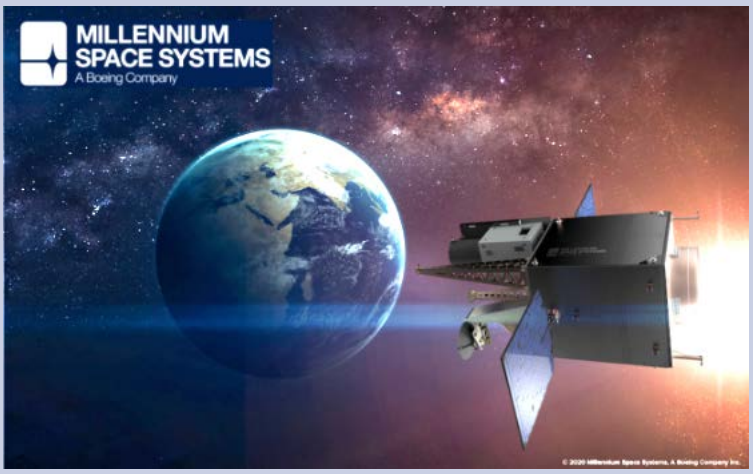
spire

Jeroen Cappaert is one of Spire Global's co-founders and serves as the Chief Technology Officer at Spire, focusing on ensuring future technology developments deliver what the business needs. With a background in electronics engineering and aerospace engineering, Jeroen's previous work and research includes high-enthalpy flow simulation, computational mechanics and fluid dynamics, spacecraft avionics and payload design, geo-engineering, and low-thrust astrodynamics at NASA Ames, Von Karman Institute for Fluid Dynamics, International Space University. Jeroen's education includes a MSc in Space Studies from the International Space University.

DISPATCHES

Slingshot Aerospace Receives Million$$ Contract From USSF's Space Systems Command
Additional information at this direct SatNews link.

Trans-Atlantic Teams To Develop Technical Concept For NATO's Future Surveillance + Control Capabilities
Additional information at this direct SatNews link.



Boeing's Millennium Space Systems Ships The USSF's GEO Wide Field Of View Satellite For Launch
Additional information at this direct SatNews link.

Advantech Wireless Technologies

Military & Government Solutions

X-Band SSPAs/BUcs
GaN & GaAs configurations

Engage Class Integrated
SATCOM Terminals

X-Band / Ka-Band
Frequency Converters

Troposcatter Products

LNAs / LNBs

Solid State
Pulsed Amplifiers

Faster & More Secure Communications for Military and Government Agencies

At Advantech Wireless Technologies, we have over 25 years of experience delivering cutting-edge innovations in communications that solve mission critical communications challenges.
We understand the challenges that government & military leaders face and our technologies empower them with the freedom to communicate quickly, reliably and securely.

ADVANTECH
Wireless Technologies

advantechwireless.com

DISPATCHES

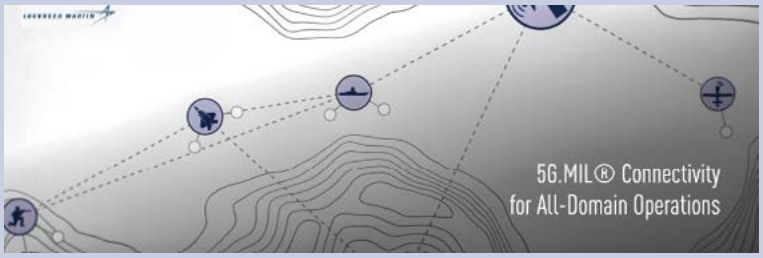
Mission Data Framework For U.S. Space Systems Command To Be Developed By BAE Systems
Additional information at this direct SatNews link.

SSC Awards L3Harris Technologies For Year #2 Of The Object-Tracking Modernization Contract
Additional information at this direct SatNews link.

SES acquires DRS Global Enterprise Solutions + also continues to enable European Maritime Safety Agency RPAS operations via satellite with a new contract.
Additional information at this direct SatNews link.

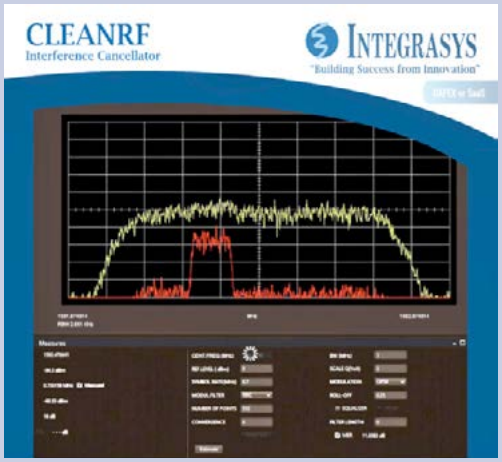
Viasat Donates Satellite High-Speed Internet To Ukrainian Refugees Via Partnership With The Košice Region of Slovakia
Additional information at this direct SatNews link.

U.S. Space Force Releases Decades Of Bolide Data To NASA For Planetary Defense Studies
Additional information at this direct SatNews link.



MoU Signed Between Lockheed Martin + Intel For 5G Comms For U.S. Allied Defense Systems
Additional information at this direct SatNews link.

DISPATCHES



INTEGRASYS Awarded The Government Mobile Innovation Award By The MSUA

Additional information at this direct SatNews link.

Telesat Government Solutions Receives Security Clearance From The DCSA For U.S. Services + Appoints Highly Experienced Board Directors

Additional information at this direct SatNews link.

Australian Federal Government Awards Gilmour Space A Million$$$ Grant

Additional information at this direct SatNews link.

Viasat + Inmarsat Reach Agreement With The UK Government On Their UK Space Sector Plan

Additional information at this direct SatNews link.

INTEL: GISS

A MILSATCOM Solution For Polish Armed Forces

Author: Michal Mazurek, Senior Sales + Business Manager

Military satellite communication (MILSATCOM) technology is the most important communication system available on the modern battlefield. Among all of the advantages that this technology brings to end users, the following are particularly important: reliability, the ability of expansion over long distances and the difficulty of hostile jamming of communications.

These advantages led to the first communication satellites being placed in Earth's orbit as early as the 1960s. Since then, a long and dynamic journey has led to today where SATCOM has become a widely available communications medium in use by militaries and governments and the civilian community.

The dynamics of progress in the field of satellite communications cause many current solutions to become obsolete rather quickly, particularly with MILSATCOM technologies. This means that users of satellite networks are forced to constantly keep an eye on industry capabilities in order to implement modern technologies that will ensure the highest operational efficiency. With a wide global market, companies from all over the world continuously compete to deliver increasingly, improved technologies.

Currently, the expansion program of a MILSATCOM network at the disposal of Polish Armed Forces is being realized. Intensive modernization of the communication system began in early 2000s when the Polish Army procured portable 4.6 meter stations and dozens of 1.8 to 2.4 meter satellite terminals.

In 2018, the ***Armament Inspectorate*** (now the nation's ***Armament Agency***) signed a contract for the development of a satellite Earth station located in Poland. The project included the installation of three hub stations with antenna sizes ranging from 6 to 9 meters and providing C-, X-, and Ku-band capabilities. The delivery of this system was the first installation of this sort in the Polish Army.

In 2021, the Armament Inspectorate began to expand the infrastructure with equipment manufactured by ***ND SATCOM GmbH***, using ***SKYWAN SR-X*** 5G devices. ND SATCOM equipment has been widely used by the Polish Armed Forces since the introduction of satellite systems.

In 2022, another proceeding was finalized, a result of which was the selection of GISS as the supplier of 100 Manpack class terminal units for the Polish Armament Agency.

The project contract was issued on February 28, 2022, with implementation to occur between 2022 and 2024. The PLN 38.1 million ($8.8 million) contract will involve the delivery of portable ***SHF*** tactical-level satellite terminals (***pictured, right)*** that will provide reliable, mobile, and territorially unlimited MILSATCOM, according to an Armament Agency announcement.

As part of the months-long bid preparation, a number of customizations to meet end-user requirements were made to the existing GISS Manpack ***COBALT*** equipment that has been in service by the Polish SOF since 2018. The ***Polish Ministry of Defense*** (**MoD**) requires that the terminal be operational with two sizes of antenna reflectors as well as provide SCPC and TDMA operation.

As part of the proposed solution, GISS presented a system that integrates the equipment of ***Teledyne Paradise Datacom*** and other leading manufacturers of satellite technology, whose products are in use by the Polish army. The complex design and testing process was made possible, thanks to the infrastructure of the GISS R&D center located in the Warsaw area. The research center was commissioned in March 2021 with the center's development financed with European Union (EU) funds.

GISS Cobalt terminal.

Finally, a project proposal was submitted...

- ***Supply of complete satellite terminals equipped with 60 cm and 100 cm antennas and two independent modems and ensuring operation in Ku- and X-bands***
- ***Spare parts kits to ensure uninterrupted operation of the delivered system***
- ***Measuring equipment***
- ***Transportation equipment consisting of transit cases and backpacks***
- ***RACK version satellite modems as management infrastructure equipment***
- ***Sets of portable chargers that are adapted for use with BB-2590 batteries, designed by GISS.***

In addition, the scope of the project also covered the organization of comprehensive personnel training, including the GISS instruction of users, the instructors themselves and the technical staff.

Andrzej Puścian, CEO of GISS, said, "*I am proud that the GISS team has achieved this incredibly important milestone in the life of our company, which confirms its ability to respond quickly to market needs in the area of satellite communications. Delivering products that fully meet the expectations of our partners has always been our core value.*"

www.giss.pl/en/

Author Michal Mazurek is the Senior Sales and Business Development Manager at GISS.

THE ACHILLES HEEL IN THE RADHARD FPGA SUPPLY CHAIN

A SHARED VISION IS CRUCIAL

Author: Martin Hart, Chief Executive Officer, TopLine Corporation

Choke points within the MILSATCOM industrial base are semiconductor devices that rely on solder columns to connect to PC boards — and the MILSATCOM industrial base is surprisingly vulnerable, due to solder columns.

A small number of civilians in the supply chain, primarily engineers and department managers, practice a policy that could have a harmful effect on U.S. national security. This policy creates the potential for a single point of failure in the supply chain.

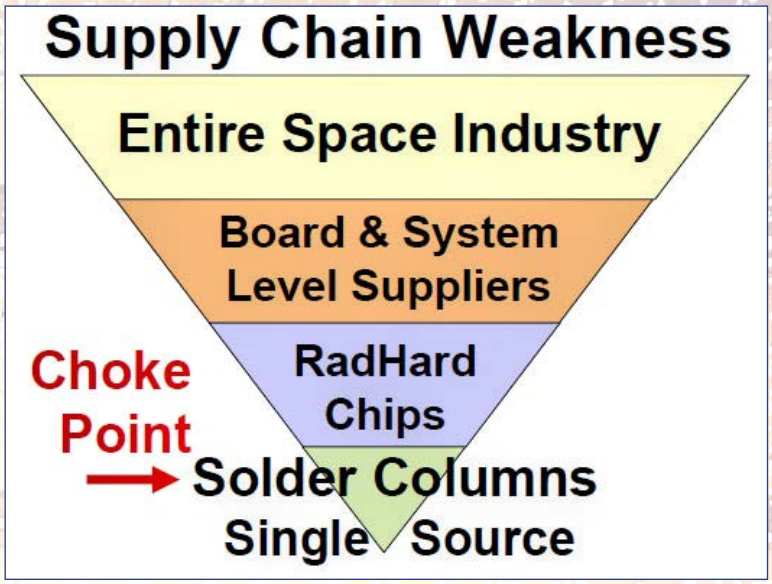
The issue is that 90% of the U.S. MILSATCOM industry rely on a single hardware subcontractor to provide a critical manufacturing service of attaching millions of solder columns, that are smaller than a grain of rice, to ***Radiation Hardened Field Programmable Gate Array*** (**RadHard FPGA**) and to certain ***Application Specific Integrated Circuits*** (**ASIC**).

These high-value semiconductor devices are key to the functioning of critical military and aerospace hardware guidance systems, for they cannot function without solder columns.

Civilian decision makers in the supply chain, with awareness of the ***Department of Defense*** (**DoD**), have established a course of action that discourages qualification of alternative suppliers for solder columns. Concerns have been voiced by the community that the market is too small to financially support more than one supplier of column attachment services. Hence, all business is channeled to just one column vendor.

To assume that the current single source subcontractor of solder columns will be capable of providing this vital service forever is quite risky.

Less than 100,000 FPGA and ASIC devices with solder columns (known as ***Column Grid Array*** - **CGA**) are produced each year. These solder columns are an integral part of the device, serving as an electrical and mechanical conduit to connect the semiconductor device package to the ***printed circuit board*** (***PCB***). Systems that rely on these ruggedized chips can not function without solder columns.

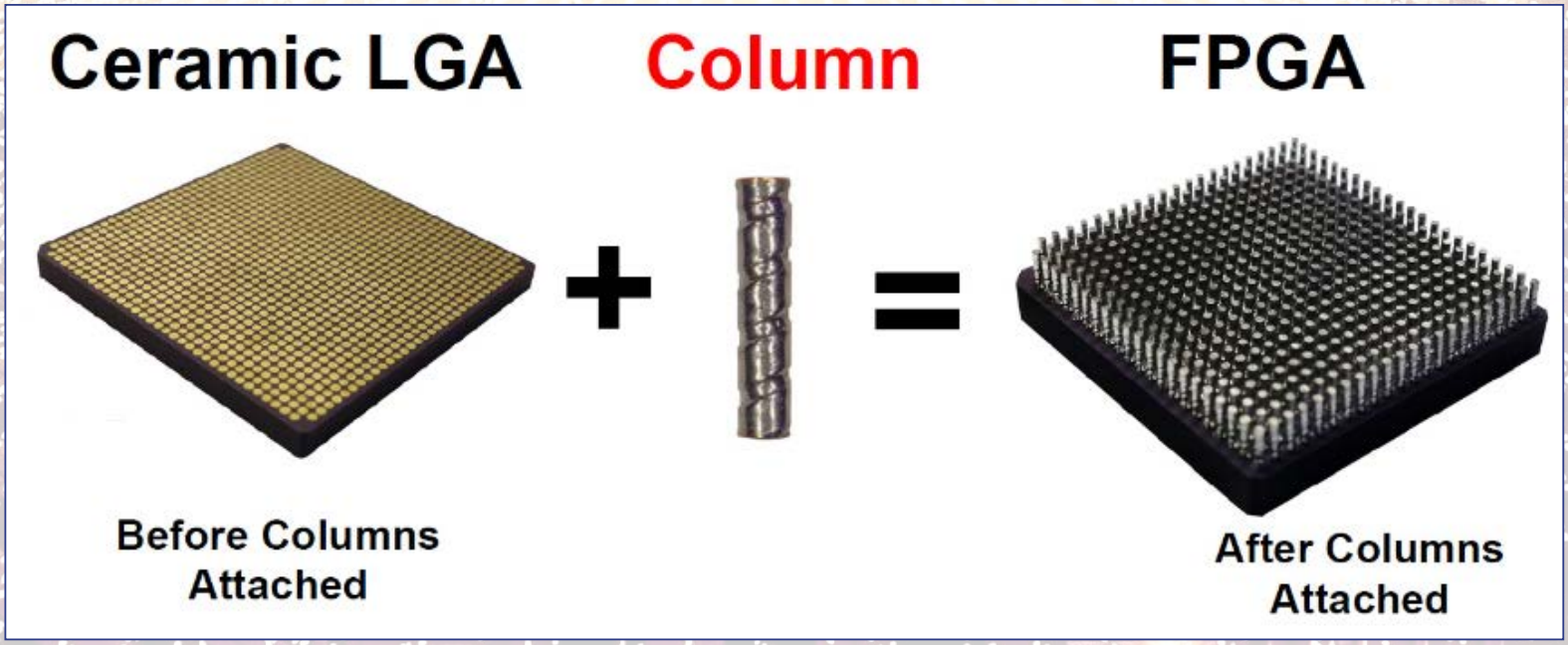


A stoppage of RadHard CGA production would cripple the MILSATCOM industry, should the current single source subcontractor be unable to meet a demand surge. In such scenario, the industry would be compromised, essentially without interference by a foreign actor and without a single shot being fired.

This would cause havoc in the MILSATCOM industry, together with a multitude of companies that support it, resulting in a massive liability to the U.S. military establishment and to our nation's allies. Surprisingly, the DoD is aware of this issue. Yet, no action has been initiated to encourage more solder column suppliers to enter the field. Plus, there is interest by some to discourage qualification for additional solder column vendors.

INACTION IS A RECIPE FOR DISASTER

Nine out of ten of the Nation's top FPGA and ASIC makers support the decision not to qualify a second column attachment vendor. Fortunately, one maker of RadHard FPGA devices has recognized the need to pursue action to qualify a second source solder column vendor.



Company	CAGE CODE
BAE Systems	1RU44
CAES (Aeroflex)	65342
Cypress Semiconductor Infineon Technologies	65786
Data Device Corporation	19645 / 7NV27
Honeywell International	34168
Microchip (Actel/Microsemi)	0J4Z0
Microchip (Atmel)	F7400
Teledyne Technologies	OC7V7
Texas Instruments	01295
Xilinx	68994

This situation, if left unresolved, could trigger a catastrophic chain reaction, not only for National Security, but for the multitude of workers in the MILSATCOM industrial base who would sit idle should such ruggedized FPGA and ASIC devices fail to be delivered.

It is well known by thought leaders within the Defense Industrial Base that solder columns are the "*Achilles Heel*" for sustainability and resiliency of ruggedized FPGA components in the supply chain. Warfighters and satellites cannot operate without solder columns attached to FPGA components.

Our Nation does not have a "*Plan B*" to fill the supply chain void should a demand surge exceed the capacity of the current sole source supply of solder columns.

THE RISK OF SINGLE-SOURCE SUPPLY

Assuming that any particular subcontractor will be in business 5 years, 10 years or even 20 years from now is overly optimistic. The defense industry has ongoing programs that will require delivery of devices with columns even 30 years from now.

Most likely, a minimum of three years for the supply chain to fill the void should the current single source vendor experience an interruption in providing solder column attachment services.

There are many hurdles to becoming certified to attach solder columns on space components. Providing column attachment services is an artisan endeavor in a constrained niche market.

Any subcontractor who is interested in providing column attachment services must be willing to invest millions of dollars in specialized equipment and commit to training employees for years for them to become proficient in the art and science of making and attaching solder columns.

A great deal of havoc can occur while the Industrial Base remains vulnerable during a three year period, even as the Nation's space capability sits idle, due to a lack of FPGA components with solder columns.

SUPPLY CHAIN SUSTAINABILITY AT RISK

Simply stated, if the current column vendor should face a production shutdown, then deliveries of defense and satellite grade FPGA and ASIC devices with columns will come to a halt. The establishment would be incapable of providing black box systems to MILSATCOM customers due to the lack of these critically needed devices. This is analogous to a situation whereby the lack of a low-cost fastener, such as a special screw, for example, brings an entire industry to its knees.

During the past three years, due to COVID-19 travel restrictions, the ***Defense Logistics Agency*** (**DLA**), an arm of the DoD, has not conducted requested field audits to certify an alternative subcontractor for column attachment.

A stoppage of production caused by the demise of a single source vendor could trigger a catastrophic chain reaction in the U.S. defense establishment and, ultimately, adversely affect our allies, who rely on a continuous supply of these products from the USA. Economically, the stoppage of a continuous supply of column interconnects could cascade into a widespread loss of jobs for American workers throughout the supply chain.

MORE INVOLVEMENT + MORE ENCOURAGEMENT

Clearly, defense-grade FPGA and ASIC devices with solder columns are critically important. The defense establishment needs to be more involved and to encourage the industrial base to expand their reliance beyond the single source subcontractor that provides 90% of America's solder column attachment services. A **Plan "B"** safety net is needed to protect the defense industry in the event of the loss of such a critical supplier.

America needs to shore up its self-reliance on defense grade FPGA components, because our country cannot afford to lose her superiority in these critical devices. Stakeholders need to initiate a shared vision to ensure a robust and sustainable supply chain for FPGA devices with solder columns.

Fortunately, alternative manufacturing of copper wrapped solder columns and attachment services is already available domestically, pending certification.

Action should be taken to qualify multiple subcontractors who are ready and willing to provide the critical process of copper wrapped column attachment services for FPGA packages.

A prudent investment today can mitigate the risk of waiting for an unexpected disaster to strike, with its potentially unimaginable cost to the defense and MilSat industry.

An unplanned production stoppage of critical FPGA components could imminently severely diminish market readiness at any time.

The Defense Industrial Base has the means to act swiftly and proactively to build a solid foundation for the long term.

Hopefully, proactive thought leaders in the supply chain are listening.

topline.tv/

Author Martin Hart is the Chief Executive Officer at TopLine Corporation.

Martin Hart

COMMAND CENTER: CAROL M. CRAIG

Chairperson and Chief Executive Officer, Sidus Space

Founder of Sidus Space, Inc., The Danny Craig Foundation and Craig Technical Consulting, Inc., Carol M. Craig holds the position of Chairman & Chief Executive Officer of Sidus Space, Inc. and Chief Executive Officer & Chief Financial Officer at Craig Technical Consulting, Inc. Ms. Craig is also Chairman at Space Coast Disability Council, Inc., Principal at Enterprise Florida, Inc., Member of National Defense Industrial Association, Member of The Society of Women Engineers, Member of Navy League of the United States, Member of AFCEA International, Member of National Association of Women Business Owners, Principal at Orlando Regional Chamber of Commerce, Member of Women In Defense, Member of International Council On Systems Engineering and Member of National Center For Simulation and on the board of 7 other companies.

Carol M. Craig received an undergraduate degree from Knox College, a graduate degree from the University of Massachusetts and an undergraduate degree from the University of Illinois.

Ms. Craig, as a role model achiever, you have a fascinating resume. Could you recap your careers for us?

CAROL CRAIG

You can call it a fascinating resume or you can call it ADHD. The best way to recap or summarize my careers is to use my favorite acronym – *MTSUAYG*. *'Make the Stuff Up As You Go.'* Essentially, being flexible enough to recognize opportunity and pivoting as the world around you changes. I'm one of those individuals who wants to do everything possible and is convinced that I can. I blame my parents because they encouraged me and told me I could do anything if I put my mind to it. What's even more special about that I was adopted — I constantly thank them for choosing me because they are the reason I am who and where I am today.

I've gone from getting a computer science degree with a focus on software engineering to getting an engineering degree with a focus on computer engineering to writing COBAL code directly out of college to becoming a software developer for the Naval Air Warfare Center to working human factors with Marine Corp and Naval pilots to joining the Navy to become one of the first women eligible to fly combat aircraft to going back to writing COBOL code when a knee injury ended my career to starting a consulting business to where I am today as the CEO of a private *and* a public company. How's that for a recap!

The executive class often lacks a certain hands-on experience. As a woman who has both served in combat as a member of the armed forces, and worked to design the systems such service members rely on, you've been a uniquely involved end-user. How does that compliment your skillset as a CEO?

CAROL CRAIG

I need to make a correction first — although I was one of the first women eligible to fly in combat, I didn't serve in combat. I was a Naval Flight Officer in the P-3 Orion community right when women were allowed to join those aviation communities and was one the first female aviator to join my squadron. That timing is a key discriminator in my opinion and, as you mention, combining that with my previous hands-on experience as a human factors/ software engineer for military aircraft gives me a very unique perspective.

What's interesting is that I believe my skillset as a CEO grew out of those experiences. It's complimentary but also a significant contributor to how I lead my companies. It has allowed me to connect to my employees in a somewhat unique way.

Understanding the end-user is important not only from a product perspective but also as a leader. I view my employees as an end-user. I try find opportunities for them to expand their skillset or knowledge base in an area where they did not necessarily see growth potential.

As someone who has literally done it all from HR to payroll to Facility Security Officer, I have walked in their shoes, and I understand the various departments and how they operate. Of course, this can either be perceived as empathetic or it can be frustrating because I keep telling people, "*Come on, it's not rocket science*!" I guarantee it drives them all crazy.

You founded Sidus Space and keep the entity wholly female-owned. How does that power of ownership serve to progress the culture of the military and business worlds the company deals in?

CAROL CRAIG

Well, first of all, I'm no longer wholly owned now that we are public but still majority female-owned. But I hope I am leading by example and that we will continue to see more female owner-founders, CEO's and top executives and women engineers across the board with the next generation.

Although I am seeing some change across the military and aerospace industries with respect to diversity, inclusion and more women-led companies, much more needs to be done. I try to instill that same "*don't ask why, ask why not*?" mentality when I am talking with emerging leaders that I had when I was growing my businesses. I was extremely surprised to find out that I was the first female owner-founder of a space business go public last December and one of only 23 female founded companies in the NASDAQ. I don't expect that I will be the last, and I hope my story helps to inspire others female entrepreneurs to aim high.

Sidus provides manufacturing expertise, using cutting-edge development techniques like waterjet cutting and 3D printing to deliver space-qualified components and satellites. What business cases are you best placed to serve with that ingenuity?

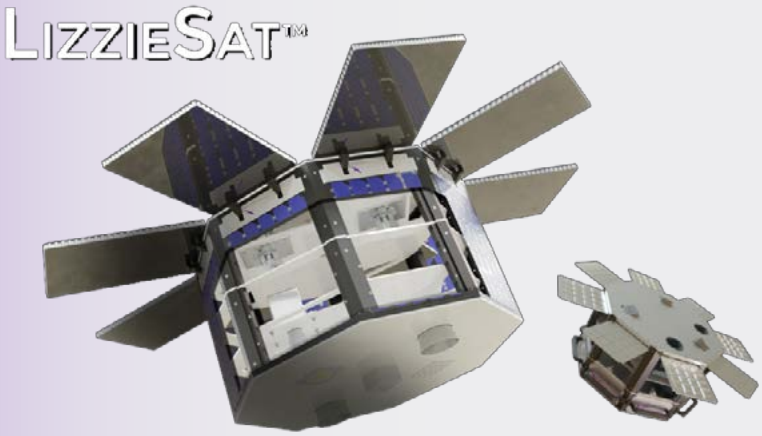
CAROL CRAIG

It may seem lazy to say all '*business cases*', but it's true. Ingenuity combined with state-of-the-art technology is something we take great pride in and there are multiple applications for this type of manufacturing across all industry.

What's most important is that the technologies and services are affordable and accessible to a wide range of customers and partners. You don't have to be a blue chip company investing millions of dollars to get your hardware tested in space. We can provide a solution for any sized business or individual.

We can, or have worked with, tech startups, academia, individual consumers, international and U.S. Government agencies, Channel partners, large government contractors, as well as international countries.

The really important part is that *we 'get it'*. We know how to deliver space-qualified components and satellites at a cost that is palatable to others — and part of the reason is because of our manufacturing expertise and willingness to think out of the box.



Your flagship LizzieSat platform is a modular satellite capable of integrating custom payloads, serving any number of capabilities. I've heard commentators suggest modular and re-programmable satellites are a crucial product of the emerging space economy. Is this an example of that kind of solution?

CAROL CRAIG

Yes! LizzieSat is great example of a creative solution in the emerging space economy where cost-effective and timely access to space is desperately needed. LizzieSat is planned to combine static component testing and LEO spacecraft development and deployment along with providing Space-Based data.

Our smallsats use a hybrid, partially 3-D printed modular design to allow integration of multiple payloads and technologies — including our own technologies. We use the Mark Forged X7 printer which 3D prints Continuous Carbon Fiber reinforced parts that can be as strong as, and capable of replacing, machined aluminum. This translates to reduced weight for the satellite bus and more available weight for payloads.

The time to print the actual bus is significantly reduced and therefore can cut the production time of satellites from years to months. The variable in the production cycle is related to the payloads and complexity of the subsystems.

This helps Sidus and its customers in a variety of ways—generating revenue earlier, getting their technology tested and flight verified ahead of schedule, pulling in critical data and generally helping them achieve their objectives—whatever they may be—in much less time.

A seminal critique of the space industry has always been the misuse of resources which could better be spent on underserved endeavors on Earth. Could you outline how your Bringing Space Down to Earth program addresses that concern?

CAROL CRAIG

It has been said many times that planet Earth is the greatest place to live in our solar system and we ought to do everything we can to preserve it. What that means is that instead of thinking of replacing Earth by colonizing other planets, we should be planning to use our solar system and planets for the activities that have been damaging to our planet for decades.

Sidus' vision is obviously not to colonize Mars but is to use our space-based platforms and services to provide solutions and data that can help return our planet to a less disrupted and technologically saturated environment.

We can replace sensors on Earth with sensors in space and provide more data with less infrastructure. Using space as a replacement resource whenever possible is how we bring Space Down to Earth for our customers and partners. We are actually freeing up resources and assets which creates an opportunity for others to redirect those resources to those endeavors with underserved needs.

What does Sidus aspire to achieve going forward? Do you have a set of expectations for the company over the next decade?

CAROL CRAIG

Our goal is to launch 100 satellites over the next few years and provide others an opportunity to be a part of the space ecosystem without the barriers that exist today — significant investment of cost, complexity, and time. I want to see the last couple decades of our experience in Space translate to empowering and enabling the acceleration of this new generation of technology and commercialization of space.

Just like the crossroads in the 1990s for the Internet, it is critical that those of us who understand the importance of space to our future ensure that new ideas and new perspectives are encouraged and cultivated. My expectation for Sidus Space is that we will be a leader in this space revolution and explosive growth of the global space ecosystem in the decades to come.

sidusspace.com

SIDUS SPACE

INTEL: AIR FORCE RESEARCH LABORATORY (AFRL)

Navigation Technology Satellite-3 (NTS-3)

Author: AFRL editorial team

Artistic rendition of NTS-3 in GEO.
Image credit: 1st Lt. Jacob Lutz

The U.S. Space Force's Global Positioning System (GPS) constellation provides unprecedented position and timing accuracy to the warfighter. Since the inception of GPS, it has become a global utility with commercial use far outweighing military use. Air traffic control, banking, farming, and cellular networks all depend on uninterrupted GPS coverage.

Set to launch in 2023, ***NTS-3***, America's next experimental navigation satellite, will push the boundary of today's ***position, navigation, and timing*** (**PNT**) technology to pave the way for a more flexible, robust, and resilient architecture for satellite navigation technology.

AFRL'S PNT FRONTIER

Together with industry, the ***Air Force Research Laboratory*** (**AFRL**) is developing advanced techniques and technologies to detect and mitigate interference to PNT capabilities and increase system resiliency for military, civil, and commercial users. To test these new capabilities in hardware, software and concepts of operations, NTS-3 will operate for one year in ***Geosynchronous Earth Orbit*** **(GEO)**. Ultimately, NTS-3 will identify key aspects for new GPS receivers that incorporate multiple signals and readily adapt to warfighter needs.

tIn 2019, the U.S. Air Force designated NTS-3 as one of three Vanguard programs, priority initiatives that integrate several technology components to deliver new game-changing capabilities, covering multiple domains and encompassing multidisciplinary solutions. Marked by enterprise commitment, Vanguard programs aim to deliver game-changing capabilities rapidly that transform future operations with cutting-edge technologies.

L3Harris will integrate NTS-3 using Northrop Grumman's ESPAStar bus, building on EAGLE's flight heritage.

The prototype demonstration of NTS-3 will involve a space-based test vehicle, ground based command and control, and agile software defined radios for the user. In particular, NTS-3 will experiment with multiple integrated advanced technologies including electronically steered phased array antennas, flexible and secure signals, software-defined GPS receivers, increased ground control segment (GCS) automation, and use of commercial ground antennas.

NTS-1, NTS-2, and NTS-3. Graphic Credit: 1st Lt. Jacob Lutz

GIVING PNT SIGNALS A SUIT OF ARMOR

NTS-3 will test a new digital signal generator that can be reprogrammed on-orbit, enabling it to broadcast new signals, improve performance by avoiding and defeating interference, and adding signatures to counter spoofing.

AFRL will explore antenna configurations to provide Earth coverage and steerable regional beams in multiple frequencies and signal codes. Ultimately, NTS-3 will provide users with enhanced signal stability, availability, integrity and accuracy.

"BOUNCE-BACK" CAPABILITIES

The space environment poses a persistent challenge to our on-orbit capabilities. Orbits degrade, the Van Allen belts bathe spacecraft with radiation, and solar flares affect the ionosphere. The space and frequency domains are increasingly congested and competitive with the addition of foreign navigation constellations and commercial broadband mega-constellations. Therefore, ensuring that PNT signals are viable, even with interruption or interference, is crucial to system operability and availability.

Specific improvements to the ground segment will enable experimentation with automated "lights-out" operations, control station failover, and near-real time environment sensing and generation of error correction and tailored waveforms. On-board systems will monitor clock accuracy and orbit parameters to mitigate errors and notify the user.

Planned resilience experiments emphasize maintaining accurate timing and position knowledge following loss of contact with ground control, maintaining user position accuracy following satellite maneuvers, and detection and correction of a timing or signal anomaly. Resilience will be enabled in part by the improvement of on-board signal integrity detection and user notification. Data collected throughout on-orbit operations will inform the design of next-generation PNT satellites.

A NEW ERA IN GROUND CONTROL

The NTS-3 GCS is compatible with the Enterprise Ground Services (EGS), an architecture that the Space Systems Command (SSC) is developing to provide a common system for satellite command and control. The goal is to move from a portfolio of stove piped ground systems to a single system that will connect with all Air Force and Space Force satellites, saving millions of dollars by streamlining user training and operations.

EGS will leverage big data and facilitate easier data sharing, situational awareness, and collaboration. The NTS-3 GCS will be backwards compatible with legacy ground systems, incorporate signal monitoring data from diverse sources, and leverage commercial antenna networks to maintain short-notice on-demand satellite control capability.

A USER-FRIENDLY EXPERIENCE

To ensure that user receiver equipment integrates seamlessly, the program team is developing software-defined PNT receivers that can rapidly respond to changing conditions. Like the on-orbit signal generator, the receivers are reprogrammable, thus increasing security and flexibility. They will readily adapt to warfighter needs and incorporate signals from the Galileo, QZSS, and other allied constellations since the experiment results and technology in NTS-3 will ultimately transition to the national space community.

The Long Line of Navigation Technology

- *1974: NTS-1 launched with new standards that advance timing and navigation precision*
- *1977: NTS-2 launched as the first NAVSTAR GPS Phase 1 satellite*
- *2023: Anticipated launch of NTS-3, the first experimental PNT spacecraft in more than 40 years*

www.afrl.af.mil

AFRL

NEXT-GENERATION POLAR IS INDISPENSABLE

IN HIGHLY CONTESTED SPACE

Authors: Northrop Grumman editorial team

Artistic rendition of a Next-Generation Polar (NGP) satellite, courtesy of Northrop Grumman.

On the battlefield, snipers rarely work alone.

Snipers act as part of a system with a spotter who surveys a wide area to identify potential targets. That's one way to think about the ***Next-Generation Overhead Persistent Infrared*** (**OPIR**) system, according to ***Mike Ciffone***, director of programs, OPIR, ***Northrop Grumman***.

The ***Next-Generation Polar*** (**NGP**) satellites act as the spotter, surveying an enormous swath of the Northern Hemisphere from an orbit more than 20,000 miles from Earth. Once spotted by NGP, the ***Hypersonic and Ballistic Tracking Space Sensor*** (**HBTSS**) satellites, which will operate in ***Low Earth Orbit*** (**LEO**), can act as the sniper's high-resolution scope, precisely tracking hypersonic missiles in flight and relaying timely data to shooters on the ground or at sea.

"*A soldier looking through a sniper rifle scope has a narrow field of view,*" Ciffone said. "*That's great for homing in on a specific target, but without that wide view from the spotter, the soldier could miss a developing threat and would be altogether less effective. The teamed system ensures a better, safer outcome. When it comes to detecting ballistic missiles, it's a mission that can't fail.*"

In May of 2020, the ***U.S. Space Force's Space Systems Command*** (**SSC**), formerly called ***Space and Missile Systems Center,*** awarded Northrop Grumman a $2.37 billion contract for the first phase of the NGP program. NGP will serve as the spotter for the HBTSS' scope.

NGP is a technological leap forward compared to the current polar monitoring system — the ***Space-Based Infrared System in Highly Elliptical Orbit*** (**SBIRS HEO**) — as it will detect both hypersonic and traditional ballistic missile launches.

SBIRS HEO service life is planned until 2028, when NGP is slated for launch. According to ***Jeff Sneller***, Northrop Grumman's chief engineer for NGP, these combined factors increase the urgency of launching NGP on schedule.

NGP is an indispensable part of the next-gen OPIR construct for a number of crucial reasons:

It covers the poles. NGP will cover the northern polar region — the shortest route for a ballistic missile to travel toward the United States. It is the most difficult region to monitor from space, said ***Randy Weidenheimer,*** director of programs, OPIR, Northrop Grumman.

"*Covering the North Pole region requires highly elliptical orbiting satellites,*" he said. "*It just can't be done as effectively from geosynchronous (GEO), geostationary or low-Earth orbit (LEO). If the North Pole is uncovered, an adversary could exploit it.*"

Failure isn't an option. Infrared missile detection strengthens nuclear deterrence and NGP is key to the OPIR construct.

"*Without NGP, not only will we risk missing a ballistic missile launch from the polar region, we will lose the resilience inherent in having a robust capability in HEO,*" ***Weidenheimer*** said. "One reason that's important is that, for example, low-Earth orbit *satellites need to orbit over countries that could seek to target or disable them several times a day, making HEO an inherently safer option.*"

Near total coverage. According to ***Sneller***, NGP provides round-the-clock coverage of the Northern Hemisphere, including adversarial countries in Eurasia, the Middle East and the Indo-Pacific.

"NGP monitors virtually every country from which a ballistic or hypersonic missile threat directed at the United States or its allies is likely to originate," ***Sneller said.***

Resilient. On top of the wide coverage NGP provides from its unique orbit, HEO is more resilient than other orbits.

"*Satellites in HEO are difficult to target and NGP has features that will help ensure it can continue to operate in contested environments,*" ***Ciffone*** said. "*NGP is always in communication with ground terminals in the continental United States. If forward-deployed ground stations for satellites in GEO or LEO are attacked or jammed, NGP can still get information back to commanders in the U.S.*"

NGP is on track and on schedule to begin its vital mission in 2028. According to ***Ciffone***, "*NGP is a vital part of the United States' missile defense space architecture that we can't afford to do without.*"

www.northropgrumman.com

NORTHROP GRUMMAN

DISPATCHES

SCOUT + USSPACECOM Sign An SSA Agreement
Additional information at this direct SatNews link.

Isotropic Systems' Commercial Launch Plans For Multi-Link, All-Orbit Antenna To Enable Government + Commercial Connectivity
Additional information at this direct SatNews link.

CopaSAT's STORM SOTM / COTM Terminal Is SOF Tested + Operational
Additional information at this direct SatNews link.

RF + GPS Telemetry Data From Spire Global To Support Slingshot Aerospace + The USSF / SSC DEEP Contract
Additional information at this direct SatNews link.

In Australia, Raymond highlights importance of space, need for allies
Additional information at this direct SatNews link.

USSF + Boeing Complete Protected Tactical SATCOM Prototype Critical Design Review
Additional information at this direct SatNews link.

GOVERNMENT SATELLITE REPORT

Leveraging Commercial Industry Would Deliver Space Superiority

"Accelerate change, or lose." That was the unofficial mantra of the most recent AFA Warfare Symposium, hearkening back to a 2020 strategic memorandum written by U.S. Air Force's Chief of Staff Gen. Charles Q. Brown. The themes of embracing innovation, modernization, and digital transformation were hard to miss, as top officials from the U.S. Air Force and U.S. Space Force delivered their visions on how to protect and defend American warfighting capabilities in the air and space domains.

Throughout the symposium, the space domain took center stage in panel discussions about the U.S. Space Force's plan to move forward in modernizing and digitally transforming its network architecture and systems, in order to establish freedom of action in the space domain, while simultaneously being able to deny the same freedom to our adversaries.

In one specific session, "***Airmen and Guardians in the Fight,***" Gen. ***John "Jay" Raymond,*** Chief of Space Operations at the U.S. Space Force, outlined the requirements and measures that would need to be taken to accelerate the change that will lead to U.S. superiority in the space domain.

According to Gen. Raymond, the keys to moving with and innovating at the speed of the ever-changing space race include leveraging the "*explosion*" of innovation that is coming out of the commercial industry and deploying a new, resilient space architecture that would put the U.S. in an advantageous position over its adversaries.

Commercial industry would strengthen defense industrial base

According to Gen. Raymond, to deliver advanced, military relevant capabilities at speed, the ***U.S. Department of Defense*** (**DoD**) must begin strengthening its ties with the commercial industry and relying more on the technological advancements and innovations that are coming out of the private sector.

"*I think there's great advantage with commercial industry*," said Gen. Raymond. "*There's been an explosion of business going on…We want to be able to leverage them.*"

Quoting last November's ***State of the Space Industrial Base 2021*** report, Gen. Raymond stated that the industrial base is "*tactically strong but strategically fragile.*"

To combat the "*fragile*" state of the space domain's industrial base, he believes that the DoD should embrace the opportunities the private sector presents to the military and expand the industrial base to more innovative players. Doing so would provide the modern and effective systems, capabilities, and approaches that are required in delivering space superiority for the U.S.

Gen. Raymond recognizes that the role of the space domain has drastically changed since he began his career. Previously viewed as a benign arena, he explained that space is now "*the most dynamic and complex security environment in three generations.*"

Near-peer competitors like China have spent more than three decades building a space warfighting architecture that has the same advantageous capabilities that the U.S. employs today. "*They built it for a purpose*," Gen. Raymond emphasized. "*That, coupled with the spectrum of threats that we're seeing from low-end, reversible jamming to high-end kinetic destruction, it's a different domain. And it requires a different approach.*"

The private sector has already created the solutions and capabilities the military needs to protect and secure American assets in space. With near-peer competitors being close to outpacing U.S. capabilities in the domain, relying on the commercial industry would better prepare and position the military with solutions and systems that would defend against the innovations and advancements of our adversaries.

The path to a resilient space architecture

In the past few months, Gen. Raymond has expressed that 2022 is going to be the year of the ***resilient space architecture*** for the Space Force — a sentiment he also echoed at the AFA panel. "*The big focus area for us this year, and for the next decade, is shifting our space architecture to a new, more resilient architecture by the design of the force,*" said Gen. Raymond.

"*The capabilities that we have in space are exquisite. They're small in numbers, and they're not easily defendable. Our joint coalition forces require the space capabilities that we provide. They can't be treated as a given anymore. We're going to continue to provide those capabilities and do so in a way that's more resilient.*"

According to Gen. Raymond, warfighting is on the precipice of a major evolution. He emphasized that the U.S. is pitted against adversaries that have — if deterrence were to fail — incredible space capabilities for their own use. "*As countries are developing capabilities to deny us our access to space, we can't take it for granted,*" said Gen. Raymond. "*And you got to be able to protect and defend it.*"

When the DoD invests time and money on the in-house design, testing, and deployment of limited, stovepipe solutions, adversaries who leverage their own nation's commercial sector have the chance to surpass and deny the U.S. access to its systems and capabilities. Calling back to the need for commercial industry innovation and input, the federal government does not need to reinvent the wheel. The path to a resilient space architecture begins with turning to the existing capabilities and systems that private industry has already created.

Industry is waiting in the wings

The conversation around commercial space and satellite industries' roles in supporting military innovation in the space domain is not just limited to Space Force leadership. In fact, Congress ***added a call in FY22's National Defense Authorization Act*** (**NDAA**) that requires the DoD to report on its utilization of COMSATCOM services from non-geostationary orbits (NGSO) for delivering connectivity to the warfighter.

Though the NDAA directive doesn't necessarily signal a heavier reliance on space industry leaders, it does acknowledge the unmistakably growing role that industry is playing in the defense and security of space as a warfighting domain.

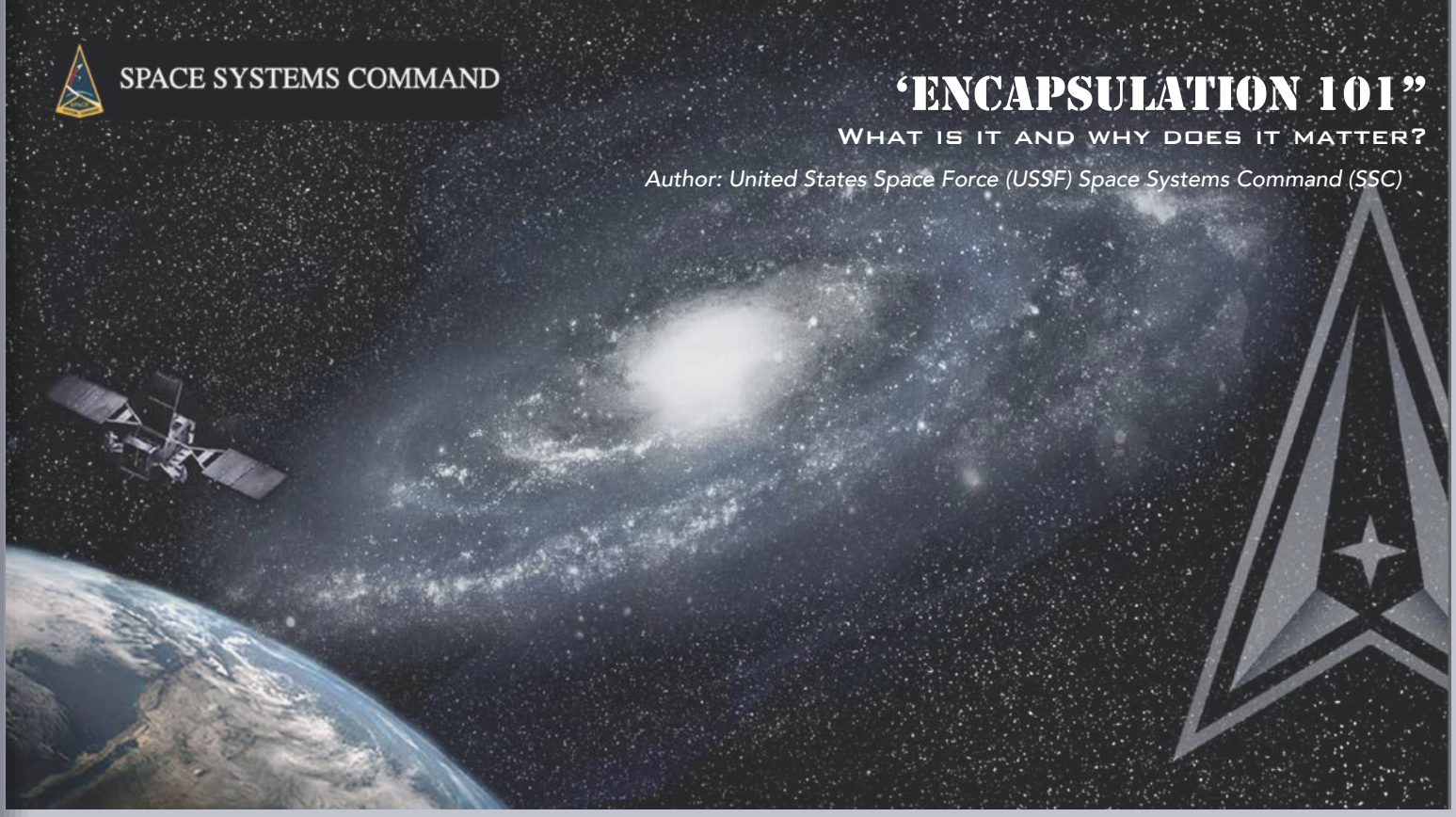
In a recent interview with the ***Government Satellite Report***, Gen. ***Curtis Michael Scaparrotti*** — a retired U.S. Army four-star general who served as the Commander of United States European Command — discussed how the innovation the commercial satellite industry is critical in building resilient network architectures.

"*Commercial satellite providers are the engines of innovation, providing capabilities today and on the horizon that are quite promising,*" said Gen. Scaparrotti. Speaking specifically about commercial satellite providers, Gen. Scaparrotti explained, "*They are developing capabilities that reduce vulnerabilities and increase the resiliency of networks by positioning, numbers, and capabilities of systems, intra-satellite capabilities, and the flexibility of ground stations.*"

Amit Katti, Principal Engineer at SES GS, shared Gen. Scaparrotti's opinion ***in a recent interview*** about Hydra — SES GS' new *Common Operational Picture* platform. "*An integrated [COMSATCOM and MILSATCOM] architecture allows the military to leverage the investments the commercial sector has made in innovative technologies,*" said Katti. "*Advanced commercial technologies have added benefits, including increased resilience to interference, jamming, or environmental effects, far more rapid resource allocation, improved situational awareness, and increased bandwidth utilization efficiencies.*"

For additional information on how COMSATCOM capabilities can help make the military's satellite architecture more resilient and capable, select this direct link to download a complimentary copy of the whitepaper, "O3b mPOWER for U.S. Government Missions."

This article first on GovSat and is reprinted with permission from ***SES GS and Government Satellite Report***.



'ENCAPSULATION 101"

What is it and why does it matter?

Author: United States Space Force (USSF) Space Systems Command (SSC)

Before the last Space Based Infrared System Geosynchronous Earth Orbit (SBIRS GEO) satellite is launched into space in a few months, one of the final stages of the process will be the encapsulation in May.

Encapsulation is when the payload — a satellite, piece of scientific instrument or other item to be launched into space — is surrounded by the "***fairing***" — a smooth, protective cover placed around the payload which protects it while reducing atmospheric drag on the rocket as it is launched into space.

Lt. Col. Matt Flahive

"*The fairing protects the satellite vehicle during the ascent,*" said Lt. Col. ***Matt Flahive***, Materiel Leader, Atlas V Launch System at SSC, who works with ***United Launch Alliance*** (**ULA**) on ***Space Systems Command*** (**SSC**) launches. "*You're passing through the atmosphere at a high rate of speed so there are heating and environmental concerns. The flight computer calculates when free molecular heating drops below a predetermined limit, and then commands the payload fairing to pyrotechnically 'unzip.' Performance of the payload fairing is critical to providing the mission assurance we need for our payloads.*"

Lt. Col. Ryan C. Laughton

"*This is the last opportunity to really work on the spacecraft,*" said Lt. Col. ***Ryan C. Laughton***, Materiel Leader, SBIRS GEO-5/6 Production at SSC. "*It's the last time most of the workers will lay eyes on the satellite before it's launched into space. Fairings are an absolutely vital part of the rocket and satellite build, and encapsulation signifies the end of production for the satellite and the start of the final stages of launch preparations.*"

This particular upcoming launch will be notable for being the sixth and final launch of the SBIRS series of satellites that provide missile warning, missile defense, technical intelligence and battlespace awareness data to the warfighter. [***SSC's Next Gen OPIR satellite constellation, now in production, will eventually replace SBIRS***.] SBIRS GEO 5 was launched in May of 2021, and operational control was transferred from SSC to ***Space Operations Command*** in February of 2022.

Like the previous SBIRS satellite, ***GEO 6*** is based on ***Lockheed Martin Space***'s modernized ***LM 2100*** spacecraft — an update that improves overall system production, affordability, and resiliency to provide overhead persistent infrared capabilities to U.S. warfighters and allies. The "*world class*" sensors for the satellite were built by ***Northrop Grumman***, Laughton said. United Launch Alliance is the launch vehicle provider for GEO 6, just as it was for GEO 5.

"*Encapsulation is the start of our integrated operations*," Flahive explained. "*The space vehicle and launch vehicle teams work together in the payload processing facility and they work in concert to complete the encapsulation, rolling into when we mate the encapsulated assembly to the launch vehicle, creating the rocket stack.*"

"*Nothing bonds a team together like launch because you're working through challenges and the ultimate goal is to get that satellite on orbit through this high-risk period*," Laughton said. "*These days, the fairing is likely to enclose multiple expensive, delicate payloads. For the SBIRS GEO-6 satellite, the airtight fairing will keep the satellite at a precise temperature and humidity for the entire period the space vehicle is on the ground until fairing separates.*"

"*We only use the fairing for just a few minutes during launch and then they're jettisoned, but we're encapsulating the payload for two to three weeks on the ground, and it provides that critical ground environment*," Laughton said. "*The fairings have to be strong but light — the heavier the fairing, the less payload you can get to orbit. They have to be air-tight and provide that secure environment. It's truly remarkable that we're able to do that. It's a work of art and a work of science to get it just right.*"

The encapsulation process will begin with the satellite being shipped to the ***National Reconnaissance Office***'s (NRO) secure integration facility in Florida, several months before the launch. There, it will be checked thoroughly and tested in a clean-room environment before being surrounded by the fairing, Laughton said.

"*We are laser-focused on cleanliness and contamination requirements*," Flahive said. "*We aim to protect the satellite vehicle throughout the entire process.*"

Dr. Walt Lauderdale

"*Access to the spacecraft is severely restricted after encapsulation*," said Dr. ***Walt Lauderdale***, chief, Falcon Division with SSC's Launch Enterprise, who works with SpaceX. "*Depending on the program, there may be some things they need to access through small doors in the payload fairing prior to launch, but for the most part, you're done with the major processing of the spacecraft. It's like sealing up a package for delivery.*"

"*The integrated operations include performing numerous tests to simulate the entire mission to make sure all the commands are planned and executed appropriately*," Flahive said. "*It typically takes approximately a week to 10 days for the encapsulation process to be completed.*"

"*We test the satellite before we encapsulate it to make sure there's been no damage in shipping and then once that's complete, we fuel it,*" Laughton said. "*Once you fuel it, almost anything you do becomes hazardous, so we have to limit the amount of movement. A few weeks later, after encapsulation, we move it onto the launch pad and then there will be more testing. Testing is crucial because there is no room for error. In addition to making sure the satellite and other payloads will arrive safely in orbit, the teams are aware that launch slots are in short supply and coveted, so the launch must go perfectly.*"

"*We don't get a second chance*," Lauderdale said. "*Unlike an airplane, where you might lose an engine and still be able to land, we don't have that for our payloads. If the rocket has a big problem, that payload is dead.*"

Artistic rendition of how a satellite is surrounded by the fairing, before being placed at the top of the rocket for launch.

"*The number one goal for my team is to keep the satellite safe, and then once it's out to the pad, you want to keep the launch vehicle and the satellite safe*," Laughton said. "*It takes both the launch vehicle and the space vehicle teams to make this happen.*"

The encapsulated assembly will then leave the NRO facility and be transported several miles to the vertical integration facility, Laughton said. Once we get it out there, a large crane carefully picks up the entire encapsulated assembly and pulls it several hundred feet into the air to mate it on top of the launch vehicle. The launch vehicle isn't fully fueled at this point, but it's still a delicate operation because the encapsulated assembly has a lot of fuel in it.

"*It's important that we do it right; if we somehow damage the vertical integration facility, now we've prevented other missions behind us from launching on an Atlas until they get the facility repaired. That's why we put so much care into it — all the missions behind us are counting on us to do it right,*" Laughton said.

Launch tempo continues to increase. In 2021, ***Space Launch Delta 30*** at ***Vandenberg Space Force Base*** had seven successful launches and is expected to have 22 this year. ***Space Launch Delta 45*** at Patrick Space Force Base had 37 successful launches in 2021 and is expected to have 67 in 2022.

"*When we work with SpaceX or ULA, we want them to succeed because everybody suffers when there's a launch failure,*" Lauderdale said. "*It's a full partnership and it's critical to our national capability. Right now, when you look at what this country can do, and what critical capabilities it can deliver on orbit in order to meet the threat, it is stunning.*"

Hosting a suite of sophisticated heat-seeking sensors, the Space Force's fifth Space Based Infrared System (SBIRS) satellite took off from pad 41 on Florida's Space Coast on an Atlas 5 rocket last year. SBIRS GEO 6, the last in the series, will launch later this summer. Photo is courtesy of SSC.

2022 MILSAT SYMPOSIUM

NEXT-GENERATION SPACE DEFENSE

Join the Community Protecting and Expanding Critical Space Assets

OCTOBER 13 – 14, 2022

MILSATSHOW.COM