Next Generation Space Defense

MILSATMAGAZINE

February 2025

Cover image is courtesy of L3Harris

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

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Deep Space Advanced Radar Capability makes tremendous progress in first year

Just one year after signing a ground-breaking trilateral agreement, the Deep Space Advanced Radar Capability partnership is completing facilities construction at the first of three sites that will host a global network of advanced ground-based sensors.

DARC is a partnership between the United States, the United Kingdom and Australia, designed to create an all-weather, global system to track very small objects in GEO to protect critical U.S. and allied satellite services. The trilateral ***Memorandum of Understanding*** was signed September 27, 2023, will last 22 years, and is a practical example of what the partners can achieve when working together to enhance mutual defense capabilities in the Indo-Pacific region. Construction of the first site, in Western Australia, was completed in December of 2024, three months ahead of schedule, with mission system integration and test activities now underway.

"*The collaboration between all parties for the DARC project has been outstanding and is an example of what can be done when we work with our partners on a common goal for the advancement of Space Domain Awareness across our three nations*," said *Michael Hunt*, assistant secretary Space Systems Branch for the Australian Department of Defence, who also serves as the Australian representative on the DARC steering committee.

Allied partnerships in space are increasingly critical, given emerging threats from adversaries and pacing challengers, noted *Lt. Col. Nicholas Yeung*, chief of Capabilities Development for ***Space Systems Command's International Affairs office***. DARC is just one of several key partnership efforts facilitated by SSC's IA office, and it's particularly critical as it addresses innate challenges in GEO coverage.

At 22,236 miles above the Earth, an object in GEO takes 24 hours to orbit the planet. This keeps the satellite "*parked*" in the same spot, appearing stationary to ground sensors. This makes GEO important "*real estate*" for several satellites, but because GEO is so far above the Earth, it's more difficult to monitor space debris and/or adversarial actions that could potentially disrupt or deny space-based capabilities in that orbit.

Yet another challenge is that the U.S. can only cover a limited portion of the sky based on its geography, which is one of the reasons international partnerships are so important. The DARC program demonstrates how allied partnerships can overcome both technical and geographic challenges while accelerating the delivery of advanced space technology in support of combined operations.

Commodore Dave Moody, head of ***Space Capability for U.K. Space Command,*** said, "*DARC leverages the geography and commitment of key partner nations to deliver persistent, comprehensive space domain awareness. One year on, the talent harnessed between the nations has begun to field a more capable technology that will protect and defend the international ways of life. Alongside the United States and Australia, the United Kingdom will continue to take deliberate steps that ensure DARC enables a collective ability to operate decisively in space.*"

DARC is a unique collaboration between the three countries to get after first-of-its-kind capability that can do something that not only is needed from an operational perspective, but has never been done before.

One of the main benefits of radar is that it operates 24 hours a day, in all weather and can make observations through clouds and during the daytime —something optical telescopes cannot do. An ongoing challenge of radar versus telescope, however, is that the further out your radar goes, the larger the power required to transmit and the bigger the receiver arrays must be. DARC addresses this challenge by using multiple smaller arrays that combine the signals from space to act as one large array. This ground-breaking concept was initially demonstrated by the USSF through its DARC technology demonstration at ***White Sands Missile Range*** in 2021.

"*The completed DARC system will enhance our Space Domain Awareness enterprise architecture by adding a critical element*," said *Brig. Gen. Chandler Atwood*, deputy commander of ***Space Operations Command***. "*DARC will ensure the U.S., its allies, and partners can effectively characterize the movement of objects traveling in, from and to space, allowing us to mitigate the risk of debris-causing events that could hold the world's space-enabled capabilities at risk. Increased Space Domain Awareness will also bolster our vital ability to attribute malign activity from irresponsible actors in the space domain when and if necessary.*"

Construction of the first site in Exmouth in Western Australia began in October of 2023. The site infrastructure has been completed, including the radar power plant. Spectrum licenses and airspace approvals for the Australian site also have been completed, as well as the first receiver and transmitter antennas. The first open-air transmit of the first antenna was completed in September 2024 and the Australian site is expected to become fully operational in 2027.

The speed at which the DARC construction and commissioning has occurred could only have been achieved through an open and collaborative relationship between the three nations and Australian industry.

Author: Lisa Sodders, Space Systems Command Public Affairs

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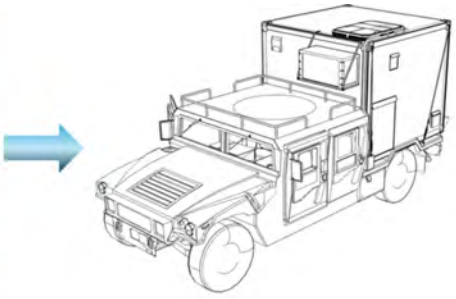
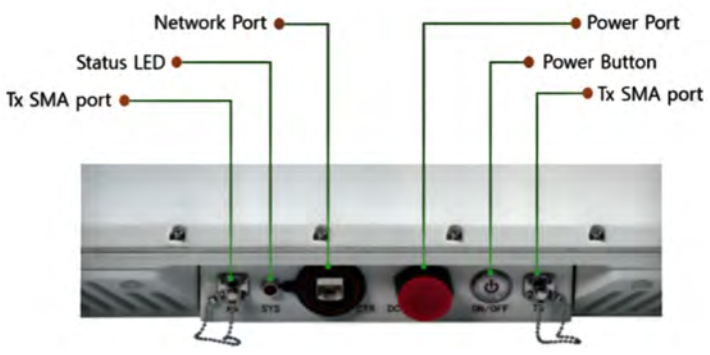
Global Konet contracted to upgrade Korean Marine Navy trucks with ESA antennas

Global Konet has been contracted to improve the mobile satellite vehicles of the Korea Marine Navy—these antennas are based on tactical trucks that are equipped with SATCOM terminals in containers in addition to dish antennas.

The Marine Navy's existing satellite system on the tactical trucks used a 2.4 meter, dish, X-band antenna for tactical containers in operational areas, and they required more than an hour of service preparation time after movement to operational locations.

With this upgrade, the military will leverage the Ka-band communications network of the new Anasis II satellite that will enable faster communication. The transition to Global Konet's flat-panel ***ESA OTM*** (***On-The-Move***) Omega2 antenna allows for service activation within 10 minutes and delivers services while in motion.





Additionally, the previous flyway dish antenna weighed 120 kg and required various components, such as TWTA, LNA as well as intermediate frequency converters. In contrast, the Omega2 antenna weighs 26 kg, with everything integrated, resulting in a more compact design and reducing implementation costs by one-third.

The advantages of this KONET OTM system include the ability to escape operational areas within 10 minutes, compared to several hours that were required for the previous dish antenna system, which was vulnerable to enemy exposure during satellite service. The Global Konet system allows for rapid evasion from missile, self-propelled artillery and drone attacks.

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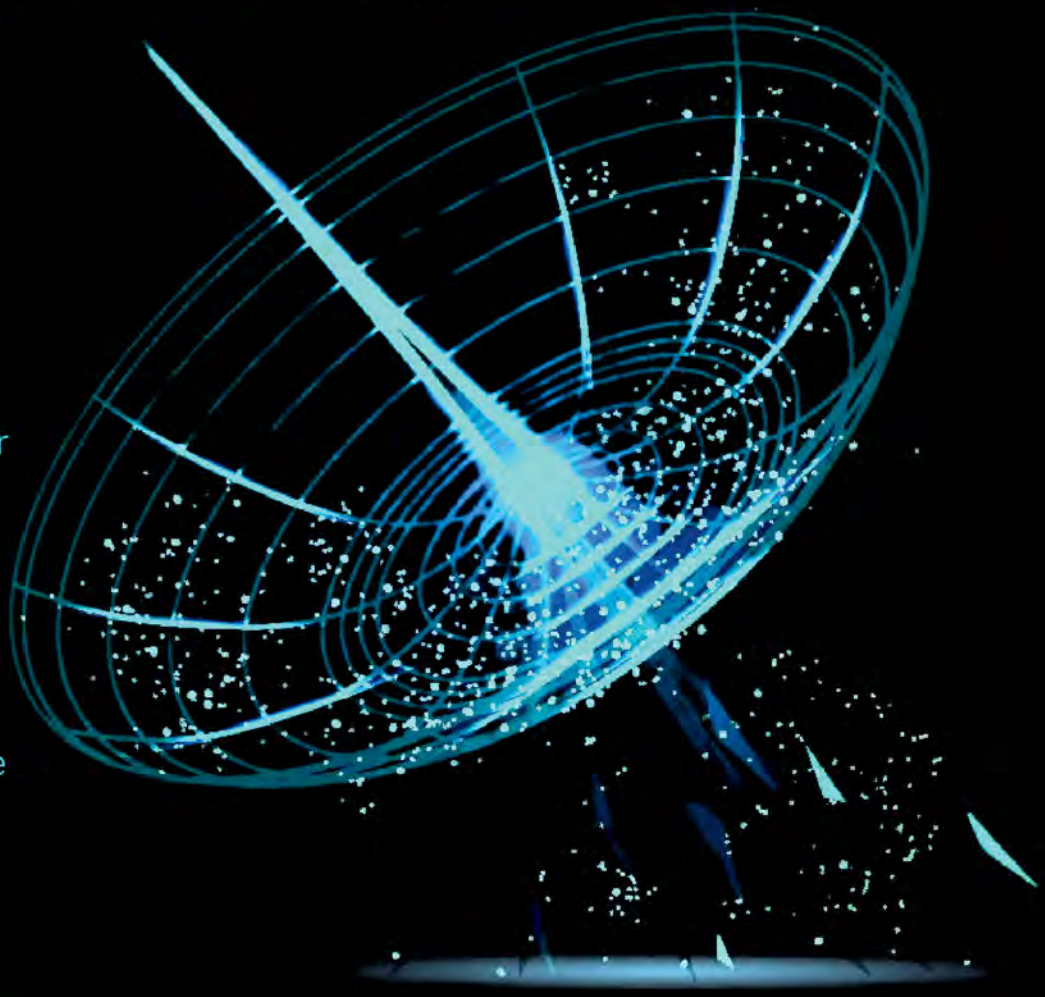

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Gilat to Invest up to $3.5 million in disruptive ESA based drone detection startup Crosense

Gilat expands its HLS and Defense strategic footprint with investment in cutting-edge deep-tech company

***Gilat Satellite Networks Ltd.* (NASDAQ: GILT, TASE: GILT) is investing as much as $3.5 million in Crosense, an early-stage startup revolutionizing drone detection and tracking.**

The investment is part of a funding round co-led by ***Frontier Capital,*** reinforcing strong industry confidence in Crosense's disruptive technology.

This move aligns with Gilat's recently declared strategic focus on expanding its presence in the ***Homeland Security*** (**HLS**) and ***Defense*** sectors.

Crosense is developing a disruptive new class of deep-tech, ***electronically steered antenna*** (**ESA**) based drone detection and tracking systems, addressing an urgent, unmet need for securing airports, military bases, and critical infrastructure against unauthorized drone activity.

Unlike traditional solutions, Crosense's passive, all-weather, real-time system will provide 24/7 hermetic coverage, ensuring accurate, scalable, and cost-effective detection in all terrains, including dense urban environments.

"The rapid rise of drone threats has created an immediate demand for more effective detection solutions, and Crosense's technology is poised to disrupt the market," said ***Roni Stoleru***, Chief Corporate Development Officer at Gilat. "*This investment reflects Gilat's commitment to the defense sector and our strategy to bring innovative, field-proven solutions to military and government customers worldwide. By supporting Crosense, we are reinforcing our role in safeguarding critical assets with next-generation technologies.*"

"*We are thrilled to have Gilat as our strategic partner and investor,*" said Crosense founder and CEO, ***Gil Zwirn***. "*Gilat's extensive knowledge and expertise, as well as its robust global marketing and sales channels will be instrumental in our journey. This collaboration is expected to propel Crosense forward, fostering innovation and growth, and amplifying our reach and impact.*"

www.gilat.com

Gilat headquarters

Insitu awarded an IDIQ contract mod for Blackjacks + ScanEagles

***Insitu Inc.* has been awarded a $102,353,293 modification (P00007) to a previously awarded firm-fixed-price, indefinite-delivery/indefinite-quantity contract (N0001922D0038).**

This modification increases the contract ceiling to procure 21 ***RQ-21A Blackjack*** air vehicles and 47 ***ScanEagle*** air vehicles, as well as associated payloads, turrets, support equipment, spares, tools, and training for both *Unmanned Aircraft Systems* in support of intelligence, surveillance, and reconnaissance for the Navy, Foreign Military Sales customers and other international business partnership capacity efforts.

Work will be performed in Bingen, Washington (88%), and various locations outside the continental U.S. (12%) and is expected to be completed in June of 2026. No funds will be obligated at the time of award; funds will be obligated on individual orders as they are issued. This modification was not competed. ***Naval Air Systems Command***, Patuxent River, Maryland, is the contracting activity.

Iran unveils tracker with military + civilian applications

The Iranian Sohair 1 tracking system has been unveiled in Tehran and features the ability to connect to Global Navigation Satellite System (GNSS) stations operated by the Iranian Armed Forces Geographical Organization.

Establishing communication with the permanent GNSS stations of the ***Armed Forces Geographical Organization*** to enhance tracking accuracy to the centimeter level is among the capabilities of this system.

Satellite trackers are one of the most important tools of positioning and tracking technology in the modern world, using the Global Positioning System to determine the precise location of objects or individuals. These trackers only connect to the *Global Navigation Satellite System* (**GNSS**), and their accuracy is within the meter range.

Currently, the Geographical Organization of Iran has nearly 170 permanent GNSS stations located throughout the country. The tracker, by receiving information from these stations, will be able to provide positioning within the centimeter range, which has applications in various military and civilian fields, including transportation and logistics.

The laboratory prototype of the precise tracker was designed and built at the Geographical Organization of Iran, with its industrial version developed in collaboration with Iranian knowledge-based companies.

Article originally posted by the ***MEHR News Agency***

Wideband RF Recorder saves data… and missions

When critical missions are on the line, having the appropriate technology in place makes all the difference. In today's rapidly evolving technology landscape, and dynamically expanding scope of operation, capturing every bit of information is imperative to mission success.

During a recent mission from one of the keystone pioneers of technology and exploration, a Wideband Systems' RF Recorder played a pivotal role in ensuring mission success, earning high praise across the site. From mission operations to test & development teams, the impact of Wideband's cutting-edge RF recording technology was recognized and appreciated.

During the operation of a cutting-edge mission, pushing the boundaries of technology as we know it, mission support teams encountered unresolvable discrepancies during data acquisition of the vehicle telemetry signals being captured by antennas at the ground station. This interruption during transitional phases of the mission threatened to derail critical mission objectives. This is where the WSI RF Recorder came into play, capturing the raw RF signals containing the mission data.

Operators were able to reconstitute the mission's signals and dub it into their standard equipment using the high fidelity of the RF signals captured in real-time during the mission. The ability to faithfully reconstruct the mission's RF signals proved invaluable, demonstrating why WSI's recorders are the preferred choice for high-stakes telemetry environments. Recognition Across the Base

Following the mission, feedback from organizational leadership, mission operations, support, and technical teams highlighted the recorder's essential role, and all acknowledged the impact, with comments emphasizing that Wideband "saved the day" by providing a safety net, and considerable cost-savings, for critical mission data.

Even departments outside the immediate mission scope took notice. The performance of the RF Recorder sparked conversations about its broader applications, such as high-data-rate operations, amongst others, opening the door for future discussions on expanded use cases.

Beyond this successful support effort, the event has reinforced the importance of high-fidelity RF recording and real-time signal analysis in modern mission environments. There is now increased interest in leveraging Wideband's solutions for reliably capturing critical mission data.

The aforementioned success case underscores Wideband Systems' commitment to delivering mission-critical telemetry solutions. Whether supporting flight tests, range and launch operations, or satellite tracking, WSI's recorders continue to set the standard for reliability and performance.

www.delta-telemetry.com

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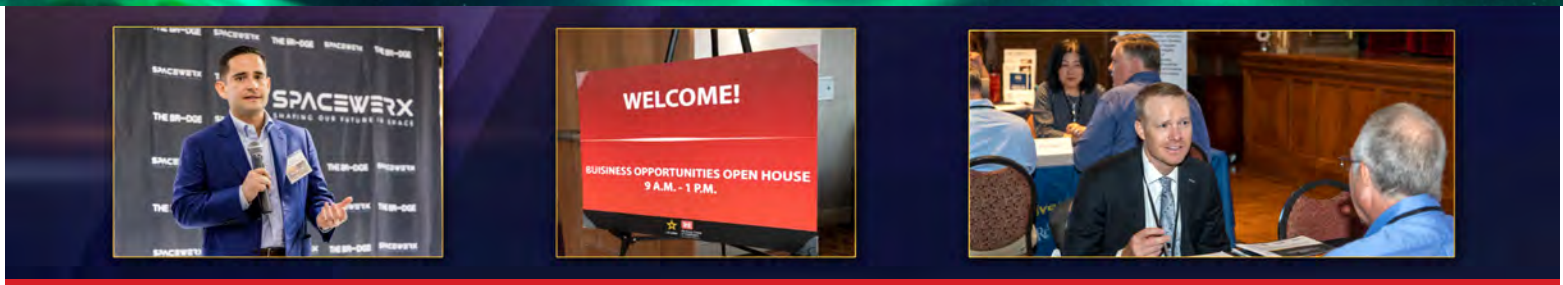


SSC building 'pathways to primes' for subcontractors through first-time initiative

U.S. Space Force (USSF) Space Systems Command's Small Business Office, in collaboration with SpaceWERX, recently hosted their inaugural Sub-contracting Forum to accelerate the space acquisition process by connecting small businesses with space and defense industry prime contractors and Department of Defense (DoD) experts in El Segundo, California.

SSC manages a $15.6 billion acquisition budget, working in partnership with industry to deliver systems varying from a new satellite or launch vehicle to ground-based sensors and communications equipment.

In most cases, the Department of Defense's (DoD) lead partner on such programs is a prime contractor from the private sector, often a large aerospace or defense company whose name is a household word. In turn, primes are supported by scores or even hundreds of subcontractors, usually smaller companies that supply components or services to the larger company, and whose contribution to the overall program is managed by the prime. The large and small business categories are defined by the federal government using a variety of criteria.

"*SSC, historically, has had a focus on buying the entire system: an entire satellite, or an entire satellite constellation*," said *Aaron Parra*, a contracting specialist who leads SSC's Small Business Office. "*Today, we are introducing agile, innovative small businesses to our supply chain via subcontracting opportunities both to broaden our access to cutting edge technologies and to work faster on behalf of our warfighters.*"

Expanding the number of potential subcontractors and potentially helping some of the same companies make the move to serving as a prime contractor is the responsibility of SSC's Small Business Office, which oversaw the award of contracts valued at almost $945 million in 2024 to qualified small businesses.

Although impressive, that amount is less than a tenth of the total SSC procurement budget that is open to small businesses—some $11.5 billion—most of which, instead, went to large businesses. The engagement at this event provided an opportunity for small businesses to engage prime contractors in support of USSF mission areas aimed at enhancing warfighting lethality and efficiency in support of nation defense.

Deidra Eberhardt, a senior SSC official who oversees the command's commercial, business, and acquisitions functions. "*This is a relationship that we need to nurture to improve the opportunities for small business and for fortifying the prime contractor supply chain.*"

At the forum, panelists discussed the roles of primes, how to bid as a subcontractor, and mentor-protégé programs for both primes and subcontractors facilitated by the Defense Department and the **U.S. Small Business Administration**.

"*We need you, our small businesses. We need to increase resiliency in our supply chain,*" said *Patricia Pierson*, ***Lockheed Martin Space***'s manager of Small Business Programs, who spoke at the forum. "*We're going to accomplish this by inserting more competition in our supply chain to reduce single source dependencies, utilizing new, innovative, small business partners.*"

SSC Small Business Director, Aaron Parra (left), moderates a panel aimed at informing small businesses about avenues to connect with primes. (U.S. Space Force Photo by Van Ha)

With the success of the forum, SSC's Small Business Office is planning for this to become an annual event in Los Angeles, and to potentially host similar events in other markets where the SSC operates, including California's Central Coast, home to Vandenberg Space Force Base, and Central Florida, where Patrick Space Force Base and Cape Canaveral Space Force Station are located.

"*We do have small business professionals at Patrick and Vandenberg, so we are hoping to do more localized outreach in those regions*," Parra said. "*There is a wide range of needs—and opportunities—at those installations and others across the country, and we really want to make certain we can bring subcontractors with the capabilities we need on board, no matter where they are located. This should be a win-win-win, all around, for all of us.*"

Resources for small businesses looking for opportunities with Space Systems Command or other DoD organizations:

Space Systems Command Commercial Space Office
The Commercial Space Office (COMSO) is responsible for accelerating commercial partnerships to deliver fight tonight capabilities aligned with warfighter needs.

Space Systems Command Small Business Office
The Small Business Office works specifically with small business owners who are interested in contracting opportunities with Space Systems Command.

Space Systems Command Front Door
The Front Door effort exists to help early-stage start-ups and innovative commercial enterprises explore opportunities to collaborate with USSF.

The Space Enterprise Consortium
The Space Enterprise Consortium, or SpEC, was created in 2017 through what was then the Air Force Space and Missile Systems Center, today's SSC, at Los Angeles Air Force Base (LAAFB).

Space Industry Days
Space Industry Days, and Reverse Industry Day events, provide industry an opportunity to receive presentations from USAF, USSF, and SSC's senior leadership on current and emerging opportunities.

Article author: Brad Smith, SSC Public Affairs

Square Peg expands RLS-2100 to meet transformative space economy demands

***Square Peg Communications** has added software enhancements to the company's RLS-2100 Radio Link Simulator—the simulator will be the first to enable up to 2 GHz bandwidth in a single compact solution for ultra-wide bandwidth hardware-in-the-loop testing and will also allow defense agencies, satellite operators, manufacturers and integrators to conduct dynamic and precise 5G non-terrestrial network (NTN) testing of new use cases, and enable seamless OpenAMIP modem to antenna integration.*

The three new features will ensure satellite communications operators are able to test and simulate their systems for reliability and resiliency under the most demanding conditions prior to deployment. They include:

2 GHz Bandwidth Support for Ultra-Wideband Testing
The RLS-2100 is the only platform offering 2 GHz bandwidth in a single compact device, enabling ultra-wideband RF testing. The added bandwidth is significant as data throughput demands increase, particularly in defense communications, Earth observation and other satellite applications. This capability enables military and government customers, with access to wide spectrum resources, and commercial LEO satellite operators to consolidate multiple carriers for greater efficiency and cost-reduction. Operators and integrators have the flexibility to add extra bandwidth or channels to the "future-ready" RLS-2100 later to test emerging ultra-wideband applications—delivering higher throughput, faster downloads and unmatched performance when needed.

Dynamic 5G NTN Testing to Synchronize Satellite Movement and Networks
A new real-time satellite ephemeris streaming feature enables operators to use the RLS-2100 to accurately test real-time 5G NTN satellite positions and to set up fully synchronized scenarios to relay data to user terminals through 5G protocol messages. This synchronized test platform enables critical verification of low-latency, high-speed connections in 5G systems. Square Peg pioneered this technology when it was previously selected by the European Space Agency (ESA) to develop an emulation environment for testing scenarios across multiple satellite constellations as part of its Space for 5G and 6G Strategic Program Line. In partnership with WORK Microwave, and with support from the Canadian Space Agency and ESA, Square Peg delivered a solution that models dynamics, controls channel impairments, and spans nearly 30 GHz, meeting ESA's advanced requirements.

OpenAMIP Integration for Realistic Antenna Control Simulation
Square Peg's RLS-2100 is also the first platform to offer fully-integrated OpenAMIP simulation, making testing in the lab as realistic as field conditions. Modern satellite systems rely on dynamic antenna adjustments, especially in mobile and maritime satellite networks. OpenAMIP integration lets satellite operators needing realistic test scenarios easily simulate these real-world antenna behaviors in a lab to avoid expensive failures in the field, while minimizing test setup complexity and facilitating optimal use of channel emulation resources.

> *"As satellite communications advances and continues to require higher bandwidth for an increasingly data-driven future, it also increases the complexity of testing and simulation prior to launching into orbit," said Michael Gertsman, president, Square Peg Communications. "Square Peg is leading the way with the RLS-2100 platform, adding breakthrough capabilities to meet the increased need for greater bandwidth, robust 5G NTN satellite communications testing and OpenAMIP integration for realistic simulation of antenna control — all from a single compact and cost-effective box."*

Square Peg Communications will showcase this technology at booth #1214 at the SATELLITE 2025, March 10-13.

About Square Peg Communications
Square Peg Communications specializes in satellite systems engineering and the development and manufacture of DSP-based ground, airborne and spaceborne satellite communications products for customers worldwide. Led by a senior team with many decades of industry experience, Square Peg has a proven track record of delivering state-of-the-art mobile satellite solutions including the industry-leading RLS-2100 radio link simulator, satellite terminal qualification equipment, satellite modems, and earth stations.

squarepeg.ca

UK's new satellite deal to boost military operations, jobs and growth

Armed forces personnel will have access to the latest space-based imagery for military operations, following a deal signed for a new satellite system, named Oberon.

The £127 million deal with ***Airbus*** will support around 200 skilled jobs in Stevenage and Portsmouth, boosting the UK's space capabilities and delivering on the Government's ***Plan for Change***.

The Oberon satellite system, made up of two ***Synthetic Aperture Radar*** (**SAR**) satellites, will be able to capture day and night-time images of the Earth's surface, strengthening the UK's ***Intelligence, Surveillance, and Reconnaissance*** (**ISR**) capabilities. Expected to launch in 2027, Oberon will have advanced imagery sensors, building on the capabilities of ***Tyche***, UK Space Command's first satellite which successfully launched in August last year.

The deal comes as UK Space Command has published the first images captured by Tyche. The images of Heathrow Airport, Sydney, Washington DC, and the California wildfires, demonstrate Tyche's ability to capture imagery from anywhere on Earth when Defense needs it.

Both satellites form part of the Ministry of Defense's space-based Intelligence, Surveillance, and Reconnaissance program, known as ISTARI, which will deliver a constellation of satellites and supporting ground systems by 2031.

These satellites will support military operations, for example by monitoring adversary activities, and contribute to other government tasks, including natural disaster monitoring, the development of mapping information, and tracking the impact of climate change around the world.

UK Space Commander, ***Major General Paul Tedman,*** said, *"Through UK Space Command, defense is partnering with industry and continuing to invest in advanced and innovative space technologies. Oberon, alongside Tyche and other satellites in our ISTARI constellation, will allow us to observe what's happening on Earth from space at any time and through any weather. This will enable and enhance UK and allied military operations around the world.*

"The contract for Oberon was awarded via competitive procurement to Airbus, which worked with Small and Medium-Sized Enterprises across the UK to leverage innovative new technologies for the 400 kg satellites. The antennas for the spacecraft will be supplied by Oxford Space Systems, which has developed carbon fiber structures that stow away in very small volumes for launch but spring into shape once in orbit.

"Oberon will play a key part in securing critical UK skills in the growing global space sector. The aerospace sector added almost £40 billion to the economy last year, a growth of 50% in the last 10 years, and employs tens of thousands of people. The project will also help inform the procurement strategy for future space capability requirements.

?Space-based intelligence, surveillance and reconnaissance offers unparalleled earth observation, operating over any part of the globe. Constellations of ISR satellites can use different sensors and cameras, allowing focus to move quickly from one area of the world to another. In contrast to conventional cameras, Oberon will use SAR to capture imagery in all-weather conditions.

Ben Bridge, Airbus Defense and Space UK Chairman, said,*"Oberon's satellites will give the UK a much-needed sovereign capability and greatly enhance its space surveillance autonomy. Airbus in the UK has more than 45 years' experience in the design and build of high-resolution radar satellites and, once in orbit, these spacecraft will play a vital role in keeping our Armed Forces safe around the world."*

Paul Russell, Space team leader at DE&S, said, *"This has been a superb team effort by members of DE&S, Space Command, DSTL and industry. With the award of the Oberon contract, we will deliver the next in a series game changing capabilities to UK Space Command providing the UK military with leading Space Based Synthetic Aperture Radar whilst helping to keep our nation safe and prosperous. We are looking forwards to working with Airbus as our Mission Partner to deliver this important capability together."*

gov.uk

Image captured in January 2025 by the Tyche satellite, taken at approximately 500km above the Earth, showing Heathrow Airport.

— SPACE SYSTEMS COMMAND BRIEFING —

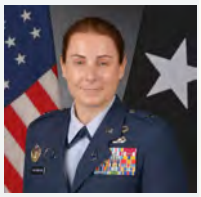
Lanes, Phases, and Tranches: USSF launch organization leans into modern mission assurance and agile integration to deliver on-orbit warfighter capability

Author: Linda Kane, Space Systems Command Public Affairs

On the heels of a record-setting year at its East and West Coast ranges, Space Systems Command's Assured Access to Space Program Executive Office gears up for more launches, additional launch partners, and ongoing advances in responsive space launch.

With a plume of blue, final preparations for the first operational Vulcan Centaur launch, and the scheduled start of back-to-back missions in support of the *Space Development Agency's (SDA) Tranche 1 Low Earth Orbit* (**LEO**) space architecture, the *United States Space Force (USSF)* launch enterprise is leaning into a new era punctuated by anticipated firsts and ongoing efforts to expand its stable of commercial launch providers.

*"We have an outstanding team of professionals dedicated to meeting our Nation's space access needs," said Brigadier General Kristin Panzenhagen, quad-hatted program executive officer for Assured Access to Space; commander of Space Launch Delta 45 (**SLD 45**); director of the Eastern Range; and director of Launch and Range Operations. "Our team is ready for an even higher launch cadence in 2025, assuring access to space for our nation and maintaining our position as the world's premier gateway to space."*



Brig. Gen. Kristin Panzenhagen

Some would say our Nation's launch enterprise is already on a roll. The USSF launch team, which falls under *Space Systems Command* (**SSC**), is responsible for delivering new and advanced space launch and mobility capabilities in support of the warfighter, managing the *Department of Defense* (**DoD**) *National Security Space Launch* (**NSSL**) *Program* and the *Rocket Systems Launch Program* (**RSLP**), and sustaining and operating the nation's East and West Coast launch complexes in support of ***DoD***, ***NASA*** and commercial space launches.

Last year, SLD 45 continued to "*set the pace for space*" as the host installation for ***Cape Canaveral Space Force Station***, the world's busiest spaceport. The SLD 45 team, composed of military and civilian **Guardians** and **Airmen** at *Patrick Space Force Base* and Cape Canaveral, oversaw a total of 93 launches from the Eastern Range, a new record and an increase of 35% over the previous year. (*Space Launch Delta 45's record-breaking launch count of 93 from Cape Canaveral Space Force Station for the year 2024 shown below.*)

A United Launch Alliance Vulcan rocket launches from Space Launch Complex-41 at Cape Canaveral Space Force Station, Florida, Oct. 4, 2024. This mission was the second certification mission required for ULA's certification process with the United States Space Force. (U.S. Space Force photo by Airman 1st Class Collin Wesson)

In addition to delivering 1,389 orbital assets into space, SLD 45 supported the first human spaceflight from the Cape since 1968. The ***Atlas V Starliner Crew Flight Test mission***, which launched from the Cape's ***Space Launch Complex – 41*** (**SLC-41**), sent two astronauts to the ***International Space Station*** (**ISS**) on June 5th in 2024.

Col. Nick Hague, astronaut

Several months later, the SLD 45 team supported the ***Crew-9*** mission, which sent the first USSF Guardian into space on September 28th. *Colonel Nick Hague,* a Guardian on active duty, was selected as the pilot for Crew-9 alongside Russian cosmonaut *Aleksandr Gorbunov*.

"I feel privileged to have the opportunity to cast a broader spotlight on everything that Guardians do to make human space flight possible," said Hague, currently on the ISS. "The average person might not understand that human space flight doesn't exist if Guardians aren't doing what they do on a day-to-day basis, whether it's launching us into space or the range support that we get [at SLD 45]."

On the West Coast, ***Space Launch Delta 30*** (**SLD 30**) also logged a launch cadence milestone with 51 launches in 2024. SLD 30 is the host installation for the *Western Launch and Test Range* based at ***Vandenberg Space Force Base (VSFB)***.

"Within just five years, our West Coast spaceport and test range has evolved from supporting four to six launches annually to executing more than 50 launches per year, transforming our operations to a high-capacity spaceport," said Colonel Mark Shoemaker, commander of SLD 30, VSFB, and the Western Launch and Test Range.

Col. Mark Shoemaker

All launches from VSFB carry a national security system, provide access to commercial space solutions as part of a hybrid space architecture, or assist with bolstering the nation's launch capabilities by increasing the reliability of the launch vehicles used for national security purposes.

Collectively, USSF's two space launch deltas supported 144 launches in 2024, breaking the world record for annual space launches for the second year in a row—a record previously held by the Soviet Union from 1982 to 2023.

In addition to the increased number of launches, 2024 broke new ground in space launch with the ***Rapid Response Trailblazer (RRT) mission***, significantly accelerating the launch of an NSSL-class payload on a ***Falcon 9*** rocket headed for *Medium Earth Orbit* (**MEO**). The NSSL program delivers the Nation's most critical national security assets to space. From planning to launch, execution typically takes two years, but the RRT mission was executed in under six months.

Col. Jim Horne

*"This mission successfully delivered a critical national security asset to a complex orbit on an expedited timeline in a remarkable demonstration of teamwork across multiple USSF organizations and commercial partners," said **Colonel Jim Horne**, senior materiel leader of launch execution for AATS.*

RRT's payload was a ***GPS III*** satellite originally slated for a late 2025 launch. The decision to expedite launch was made in July of 2024, followed by a concerted effort across multiple USSF organizations to pull an existing GPS III satellite from storage integration and on-console satellite, accelerate integration and launch vehicle readiness, and rapidly process it for launch. Key enablers spanned multiple disciplines and organizations, addressing technical matters, such as space vehicle-to-launch vehicle integration, on-console satellite control preparedness as well as nimble contracting and procurement actions.

*"The launch and spacecraft teams quickly aligned to execute this campaign and demonstrated the resiliency, communication and teamwork necessary to resolve schedule and technical challenges without compromising mission success," said **Dr. Walt Lauderdale**, Falcon systems and operations chief and launch mission director. "This partnership is an example of new and faster ways we can deliver launch in support of future warfighter needs. The Space Force quickly energized multiple organizations, and the joint team delivered a specific, important mission to orbit in record time."*

Dr. Walter Lauderdale

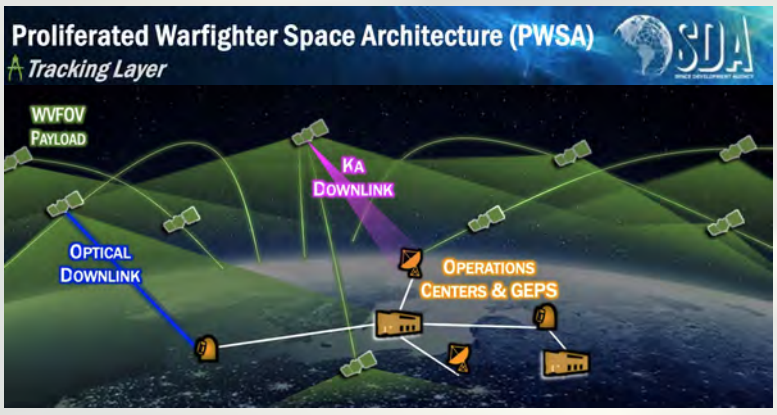
In addition to record launch cadences and achievements in rapid response readiness, 2024 is also notable as the year in which ***Space Force Guardians*** bid farewell to two workhorse rocket families that have supported the NSSL program over the years: the ***Atlas V*** and the ***Delta IV***. The Delta rocket family had a remarkable success rate over six decades of flights and concluded with 389 launches, whereas the Atlas V had a 100% launch success, founded on a heritage of more than 600 Atlas program launches.

What does 2025 have in store for SSC?

Plenty.

SSC's AATS office manages the NSSL program in partnership with the ***National Reconnaissance Office (NRO)***. The mission of the NSSL program is to acquire launch services to provide critical space support required to satisfy DoD warfighter, national security, and other Government space lift missions while fostering interagency and commercial cooperation.

For 2025, the NSSL launch manifest includes multiple missions in support of the ***Proliferated Warfighter Space Architecture (PWSA)*** under development by the SDA.



Satellite proliferation is a key resilience strategy that calls for the distribution of multiple, smaller assets of the same system, built faster and at a lower cost. Operationally, proliferation provides technical redundancy, eliminating single points of failure across space, ground and user systems. SDA's PWSA program will develop a proliferated architecture in LEO for the purpose of missile detection, missile tracking and networked communications, with spiral development executed in tranches.

The final four satellites in Tranche 0 were co-manifested with two MDA satellites on ***USSF-124***, an NSSL mission launching aboard a Falcon 9 on Valentine's Day, 2024. According to Lauderdale, the USSF-124 mission team was able to add the Tranche 0 satellites in under 30 days, less than six months from the then-scheduled launch date.

"This unprecedented responsiveness is a needed capability for the Space Force to confront today's threat environment," said Lauderdale. USSF-124 was also notable as it was the first Falcon 9 NSSL mission for 2024 using a flight-proven booster that previously supported six missions. "We began working this concept seven years ago, understanding the economic benefits and efficiencies that come with this formula and now we're executing to a common plan," said Lauderdale. "As we move forward together with SpaceX, we're methodically expanding reuse to leverage the benefits for the USSF and our space vehicle teammates."

The NSSL Phase 2 contract award includes task orders for 14 SDA ***Tranche 1*** missions: 11 using the ***SpaceX Falcon 9*** and three using ***United Launch Alliance***'s (**ULA**) ***Vulcan.***

"With multiple launches planned per year starting in 2025, the fast-paced cadence for launching these satellites not only supports the SDA strategy of rapid acquisition and fielding, but also builds momentum in efforts to make faster launch more routine as we realize the upturn in overall launch demand," said Horne.

This year is also expected to herald the ***Vulcan Centaur***'s debut NSSL missions.

The Vulcan Centaur is a next generation launch vehicle succeeding ULA's Atlas V and Delta IV rockets. It was developed through an innovative public-private partnership between the USSF and ULA to leverage commercial capabilities to support NSSL missions. This next generation launch vehicle offers higher performance with two powerful, LNG/LOX boost-stage engines; as many as six solid rocket motors; and two payload fairing options for cost-effective, multi-manifest mission solutions.

At Cape Canaveral, the Vulcan Centaur will launch from SLC-41, making it the first launch pad in history to serve two entirely separate rocket families at the same time. The new ***Vulcan Launch Platform*** will accommodate Vulcan's larger diameter and allow dual Vulcan and Atlas V operations from SLC-41 through the flyout of Atlas V missions.

Also notable is Vulcan's use of an all-American designed ***Blue Origin BE-4*** engine, marking the end of dependency on Russian made RD-180 engines used in Atlas V launch vehicles for NSSL missions. Combining the best of Atlas and Delta, Vulcan also leverages automated production techniques and greater use of additive manufacturing to reduce build time compared to its predecessors. ULA is contracted to launch 25 NSSL missions under the phase 2 Launch Services procurement contract.

2025 will also see Blue Origin's ***New Glenn*** space vehicle vie for NSSL certification alongside ULA's Vulcan Centaur and SpaceX's Falcon for NSSL's most complex launches. All commercial launch partners, including Blue Origin, must execute a successful certification process prior to carrying national security payloads into space. The comprehensive process includes multiple certification launches.

SLD 45 supported New Glenn's maiden flight—and its first certification launch—with lift-off on January 13th from ***Space Launch Complex 36*** (**SLC-36**) at Cape Canaveral. Named after *John Glenn*, the first American to orbit Earth, New Glenn's signature blue flame is created by the liquid oxygen and liquid methane content of its fuel.

This maiden flight marked the first launch from the Cape's SLC-36 in 20 years. SLC-36 was originally built to support the Atlas-Centaur family of launch vehicles in 1961 and was decommissioned and the facilities dismantled after the final Atlas II launch in 2005. In 2015, the complex was leased to Blue Origin, and construction to rebuild the site to support its New Glenn reusable launch vehicle began.

In addition to more launches with more launch service providers, SSC will continue to advance the USSF's ***Tactically Responsive Space*** (**TacRS**) mission, an increasingly essential component of national security in today's contested space environment. In 2024, SSC's ***Space Safari*** office, in conjunction with RSLP, concluded the ***VICTUS NOX TacRS mission*** (Latin for "*conquer the night*"). VICTUS NOX was designed to test the USSF's ability to deploy space assets "*as needed*" in response to a potential threat.

One aspect of TacRS requires the ability to quickly acquire, build, launch, and operate a satellite in response to a potential threat. From successful launch within 27 hours of a "go" order, through the completion of its space domain awareness mission, VICTUS NOX ticked off all four of these boxes, demonstrating an end-to-end capability to rapidly respond to adversary aggression. This mission also set a new speed record for small rocket launch to LEO, including time from contract to delivery; testing, fueling and mating to the launch adaptor; payload processing; and lift-off.

In 2025, the launch enterprise will double down on TacRS by planning for two demonstrations of 24 hour turnaround through the ***VICTUS HAZE*** mission. Last spring, the Space Safari Office, in partnership with the ***Defense Innovation Unit*** (**DIU**) and ***SpaceWERX***, awarded contracts for VICTUS HAZE to two space industry vendors: ***Rocket Lab National Security*** and ***True Anomaly***. The multi-vehicle demonstration is intended to further enable operationally relevant systems that can be leveraged for future urgent on-orbit needs.

True Anomaly and Rocket Lab will demonstrate their ability to build ***rendezvous and proximity operation*** (**RPO**) capable ***space vehicles*** (**SVs**) and ***command and control*** (**C&C**) centers with a delivery target no later than fall of 2025. Once the build phase is completed, the mission will enter several successive phases to include hot standby, activation, alert and launch phases.

While this is a coordinated demonstration, each vendor will be given unique launch and mission profiles. True Anomaly's ***SV*** will launch from either the Cape in Florida or Vandenberg in California via a rapid rideshare.

Rocket Lab will launch via their ***Electron*** launch vehicle from either Mahia, New Zealand, or Wallops Island, Virginia. Both SVs will quickly initiate operations after reaching orbit. Once on-orbit, the operations teams will conduct a variety of scenarios to demonstrate ***space domain awareness*** (**SDA**) and characterization capabilities.

From supporting more launches and new rockets, to collaborating for faster turnaround times and responsive launch, 2025 is shaping up to be a busy year for SSC as it continues to support the American warfighter and international allies by securing U.S. interests in, from and to space.

Lanes, Rockets and Contracts: NSSL Phase 3 Explained

*The **National Security Space Launch** (**NSSL**) program is a USSF program designed to provide assured access to space for the DoD and other U.S. national security payloads. Space Systems Command's **Assured Access to Space** organization manages the program, which launches satellites for NSSL, the USSF, and other organizations, such as the **Missile Defense Agency**, **Space Development Agency** and the **National Reconnaissance Office**.*

Launch services, including launch vehicles, are provided by commercial space enterprises that successfully complete a rigorous certification process. Contracts are awarded in phases to certified launch service providers.

*To balance the need for mission assurance with the benefits that come from diversifying commercial launch partners, NSSL's **Phase 3** launch award strategy has been divided into two lanes.*

Lane 1 *covers less-demanding missions and is designed to encourage new launch providers with annual "on ramps" to provide potential launch partners with time to mature their technologies and compete throughout the Phase 3 contract award period.*

At least 30 NSSL Lane 1 missions are expected to be completed over a five year base ordering period. Contenders need to demonstrate that their systems are mature and be able to demonstrate launch capability that will meet mission needs in 12 months from award.

Lane 2 *requires each provider to be able to handle the most challenging NSSL requirements. Contracts awarded in this lane include missions to more stressing orbits than Lane 1, necessitating higher performance launch systems and complex security and integration requirements.*

Lane 2 will consist of as many as three, competitively awarded, Indefinite Delivery Requirements contracts with a 5 year ordering period.

Whether it's onboarding new launch providers, supporting proliferated constellation strategies, or pushing the envelope of responsive space operations, SSC's Launch Deltas on the East and West Coasts are likely to face another record-breaking year in 2025.

NAVIGATING THE POWERS WITHIN SWARM OPS

Integrating advanced technologies such as swarm operations within the CJADC2 framework can lead to more intelligent implementations for military combat forces.

Author: Timothy Stewart, Director, Business Development, Strategic Accounts

The Emerging CJADC2 Initiative

To provide our military warfighters with the improved ability to detect and act on information across the battle space, the DoD has implemented the Combined Joint All-Domain Command and Control (CJADC2) initiative.

The CJADC2 vision establishes a tactical, secure, and unified command and control network in a cloud-based environment that enables rapid receipt and transmission of *intelligence, surveillance, and reconnaissance* (**ISR**) data to interconnected networks across all branches of defense.

Military forces leveraging swarm capabilities can achieve superior situational awareness and rapid response times, allowing for faster decisions to counter threats in contested,
rugged environments.

Understanding the complexity of integrating advanced technologies and tactics, techniques and procedures in swarm operations within the CJADC2 framework can ensure future mission success.

Figure 1 CJADC2 Action Chain and Process

A unified communications infrastructure, known as the ***Digital Backbone***, is playing a pivotal role in establishing the needed interconnected network of knowledge and data along
the CJADC2.

Five Technologies Enabling Swarm Operations Within CJADC2

The success of swarm operations relies on effectively harnessing specific technologies supported by the Digital Backbone, including:

- *Artificial Intelligence (AI)*
- *Time-sensitive Networking (TSN)*
- *Autonomous Systems*
- *Sensor Fusion*
- *Cybersecurity*

Artificial Intelligence

*Artificial Technologies (**AI**) technologies are critical enablers of swarm management within the CJADC2 structure. Through AI algorithms and **Machine Learning** (**ML**) techniques, military forces can enhance their ability to detect, analyze, and respond to swarm threats in real-time.*

*With the ability to analyze vast amounts of sensor data to detect patterns, anomalies, and potential threats, **AI-driven swarm management systems** can autonomously coordinate the actions of multiple agencies, optimizing their actions for maximum efficiency and effectiveness.*

AI-driven decision support systems enable proactive decision-making and rapid response strategies to provide actionable intelligence to military agents and orchestrate successful swarm operations, while minimizing risk in harsh environments.

Time-sensitive Networking

*Time-sensitive networking (**TSN**) enables real-time coordination essential for effective swarm operations within the CJADC2 foundation. TSN protocols prioritize data transmission to ensure low-latency communication for rapid decision-making and provides scalability so military forces can adapt their communication networks to the evolving demands of swarm technologies.*

Not only does the flexibility of TSN enable digital connectivity to armed forces but it also efficiently allocates bandwidth and resources to prioritize critical date transmissions, ensuring that essential information reaches decision-makers in real time.

While military operations become increasingly interconnected and data-intensive, using TSN protocols becomes vital for maintaining operation speed and achieving mission success in swarm environments. In order to overcome challenges of communication bottlenecks and delays, military forces can leverage TSN to enable agile and coordinated responses to dynamic swarm threats.

Drones / Autonomous Systems

By enhancing surveillance capabilities through consistent monitoring of areas at a high-risk to swarm activity and early detection of threats, autonomous systems have become a growing and transformative capability within the CJADC2 framework to manage the transition of swarm capabilities into military technologies.

AI-driven autonomous systems enable uncrewed systems to assess the intent and behavior of swarms, adjusting their tactics, and maneuvers to maintain a tactical advantage. They provide rapid deployment and maneuverability, allowing for swift responses to emerging enemy swarm scenarios.

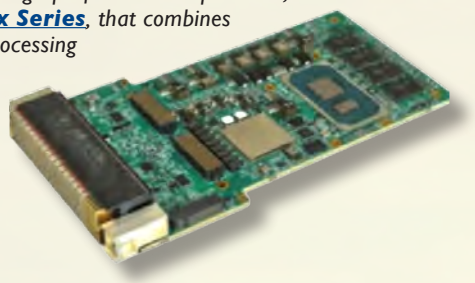
Autonomous systems allow for a wider operational footprint by augmenting the capabilities of human-rated platforms, extending reach, and enhancing the effectiveness of military operations across all domains. Through autonomous capabilities and robotics, there is an unparalleled scalability to analyze vast amounts of sensor data in real-time, enabling efficient adaptive responses to dynamic battlefield conditions.

Sensor Fusion

Swarm operations under the CJADC2 framework use sensor fusion to enable the aggregation and correlation of information from disparate sources, ranging from traditional radar to advanced cyber sensors. Combining inputs from all domains, land, air, sea, space, and cyber, sensor fusions compensate for individual limitations by providing an overall comprehensive understanding of the operational environment, enabling precise detection, and tracking of swarms in real-time scenarios.

To ensure the smooth distribution of information between crewed and uncrewed assets, command centers, and allied forces, data formats and communication protocols seamlessly facilitate communication and collaboration between systems and platforms to foster interoperability and synergy across diverse rugged domains.

*Rugged electronics that offer high performance capabilities, such as the **Aitech U-C850x Series**, that combines three pillars of modern data processing acceleration: CPU, iGPU and FPGA, can meet the demand of real-time data processing for rapid decision making across **command and control** (**C&C**) networks.*



Sensor data combined with the intelligence within the CJADC2 framework provides military commanders with a more comprehensive understanding of the battlefield to anticipate swarm movements, identify vulnerabilities, and formulate effective response strategies.

By using sensor fusion, military forces can prioritize strategic actions based on the threat of swarms and deploy resources where they are needed most, ultimately maximizing operational impact and minimizing risk.

Cybersecurity

Given the reliance on interconnected digital networks and communication systems, cybersecurity measures are imperative to the CJADC2 framework when managing swarm operations.

The digital connectivity of these interconnected systems exposes them to various cyber threats, ranging from infiltration and data breaches to disruption and sabotage, meaning cybersecurity measures are paramount in safeguarding military operations from adversaries intent on compromising swarm missions.

*Hardware-based cybersecurity frameworks, such as Aitech's **AiSecure**, prevents data breaches and firmware in products while allowing secure transmission and storage of sensitive data.*

Comprehensive and proactive cybersecurity policies are crucial to establish and govern secure swarm-related technologies within military operations.

To ensure stringent security measures, military branches must practice continuous threat intelligence gathering, vulnerability assessments, and penetration testing to identify and address weaknesses in network defenses to prevent, identify and mitigate potential cyber-attacks on swarm operations before they can compromise mission integrity.

Cybersecurity training and awareness programs give military personnel at all levels the knowledge and skills to effectively identify and respond to cyber swarm threats.

Optimizing CJADC2 Technologies for Swarm Operations

Collaborative efforts between military branches, allied forces, and industry partners in developing and implementing integrated technology solutions such as AI, TSN, autonomous systems, sensor fusion, and cybersecurity for swarm operations embody the spirit of joint experimentation and prototyping emphasized in the CJADC2 framework.

Harnessing these specific technologies using the Digital Backbone infrastructure to manage the rise of swarm operations enhances situational awareness, decision-making, and response coordination, echoing the objectives outlined in CJADC2 directives.

The increasing demand for high performance capabilities in space has led Aitech to shift from traditional space qualified COTS boards to pre-integrated, space-ready systems. The digitization of space electronics using COTS systems enables satellite and space program developers the ability to meet aggressive schedules using proven, reliable, cost-effective embedded designs that mitigate program and mission risks throughout the lifecycle of any satellite, spacecraft or in-orbit structure.

aitechsystems.com

COMMAND CENTER
PETER TERRY-BROWN
DIVISIONAL CEO, SPIRENT COMMUNICATIONS

The growing threat of GPS spoofing and what we can do about it

In a public letter last November, Spirent's CEO, Peter Terry-Brown, said that the threat from global positioning system (GPS) spoofing—cyberattacks that falsify GPS signals—could not be overstated, arguing that, "the global aviation sector could face billions of dollars in annual losses" if it's not addressed.

Peter Terry-Brown

Good day, Peter. Would you please explain to our readers how these attacks work and why you believe the threat is so serious?

PETER TERRY-BROWN

We've referred to GPS or GNSS spoofing as the most insidious problem in the industry—aerospace, communications, and so on—and I don't think that's an exaggeration.

Fundamentally, these attacks make an aircraft's GPS unit think the aircraft is occupying one place, when, actually, the aircraft is in another. As you can imagine, this can cause all sorts of issues for aircraft in flight, such as generating false alarms, forcing crews to execute additional maneuvers as well as increasing the risk of collisions and unplanned incursions into restricted airspace.

Additionally, the way spoofing attacks function is far more deceptive and ultimately more dangerous than simple GPS jamming. You end up with a scenario where an aircraft's GPS unit could, to all appearances, seem to be operating normally, even as it reports a false position, unless and until someone notices that something looks off.

Now, I want to emphasize that air and ground crews constantly drill on operating when aircraft have lost navigation or when automated safety systems are unavailable, so a crash caused by the loss of these systems is still unlikely. In fact, even as the number of flights has increased 14-fold since 1970, from roughly 310 million passengers annually to around 4.5 billion, we've seen a marked decrease in incident rates. During the 1970s, there were roughly six fatal accidents per million commercial flights. By 2020, that figure was less than two per million commercial flights.

Nevertheless, spoofing poses a significant threat, simply due to how pervasive GPS and GNSS have become in modern aircraft and *ATC* [*air traffic control*] operations, for both military flight operations and civil commercial operations.

Look at all the automation and safety systems a typical airliner depends on—**ADS-B** [*automatic dependent surveillance – broadcast*] flight tracking systems, ground proximity warning systems, **TAWS** [*terrain awareness and warning systems*], **AHRS** [*attitude and heading reference systems*], runway overrun protection, autopilot... all of these systems and many others depend on accurate positioning information.

When GPS is spoofed, it can cause all sorts of issues, both in terms of safety and efficiency. Making matters worse, some of these systems don't recover, even after leaving the affected airspace. In the commercial sector, for instance, many systems can't even be reset midflight if they've been impacted by a GPS spoofing attack.

GPS is thoroughly baked into so many of the avionics that we depend on for the safe and efficient operation of every military and commercial flight. Disrupt it, and you add a lot of extra overhead for pilots and crews, who now have to figure out which systems they can trust, and we have seen numerous incidents of aircraft having to operate without key automation and safety systems.

Controllers also now have to sort genuine position reports from spoofed ones and identify affected aircraft. A military aircraft or a commercial airliner that's lost **RNP** [*required navigational performance*] due to a spoofing attack can disrupt an entire military operation or a civil airport. Flights may need to be diverted or have airspace around them cleared during an approach.

This creates knock-on effects for other flights and crews, adds delays, increases fuel burn, and creates all these second-order problems and costs, even apart from the safety risk.

This definitely is a major problem and the concern is certainly more than justified. Can you explain why these attacks are happening?

PETER TERRY-BROWN

Readers know that military attacks aimed at jamming or manipulating wireless signals have been around as long as signals have been used in warfare. In that sense, this is not a new challenge. What is new is how dependent aircraft have become on GPS signals, and more broadly, the rapidly expanding role of uncrewed aircraft in modern warfare.

When you look at conflicts around Ukraine, the Middle East, and elsewhere, drones are a huge part of offensive and defensive combat operations. Now, if you can knock out an adversary drone's navigation systems—or even better, make it believe it's someplace it's not—that's a win.

You could, for example, make a drone believe it's in protected airspace, such as an airport, so that it grounds itself or refuses to take off. Or, you could misdirect automated vehicles so that they navigate into buildings or deliver their payloads to the wrong location. These are significant potential outcomes, so it was inevitable that combatants would try to exploit GPS spoofing. At this point, these attacks are just a feature of warfare—and they're not going away.

The other element that's new here and that's driving us to really try to make people sit up and take notice, is just how much this problem is bleeding outside of the areas of military conflict. There are thousands of square miles of airspace around the globe that are being affected by GPS spoofing right now, as we speak. This is becoming a huge problem for civil aviation, too, as well as any other business or technology that relies on GPS in an affected area.

How pervasive is GPS spoofing?

PETER TERRY-BROWN

Well, that's the problem. It's become extremely widespread, and growing more so. Industry groups reported an incredible 400% increase in spoofing incidents over the first six months of 2024, affecting as many as 1,350 flights each day. We've been tracking this problem ourselves the past few years, and when you see how much spoofing activity is currently out there, it's eye-opening.

In one region around the Mediterranean Sea, for instance, in one three-hour period last September, we tracked 183 flights that were actively being spoofed. That was 40 different airlines, as well as private jets. And in more than half of those aircraft, onboard GPS units were still reporting good integrity, even as they were being spoofed.

As alarming as what we're seeing now though, imagine what this problem could look like a few years down the road. If these attacks are already disrupting hundreds of aircraft daily, what happens when there are thousands or tens of thousands of drones operating over every city, playing a key role in military operations, shipping, agriculture, and other sectors? You can already order basic GPS jamming and spoofing equipment on the Internet, so it's not hard to imagine how this trend will play out.

The problem is going to get much larger, while constantly changing in complexity and location. The impact on all aviation will inevitably be significant, and we need to be doing more to get ahead of these insidious attacks.

What should the industry be doing about these threats?

PETER TERRY-BROWN

Ultimately, we need to make the ***positioning, navigation, and timing*** [**PNT**] functions of aircraft much more resilient against these types of attacks. The good news is that the industry is already making solid progress in this regard.

For example, one of the most promising interventions, ***CRPA [controlled reception pattern antenna]*** systems, is in the process of being removed from the heavily restrictive **ITAR** [*International Traffic in Arms Regulations*] classification and reclassified under the less onerous ***EAR*** [***Export Administration Regulations***] controls.

Currently, this change is slated to go into effect on September 15, 2025. When fully ratified, it could have a significant benefit for civil aviation, where CRPA is likely the most complete long-term solution.

Among other interventions that have been discussed publicly, technologies like encrypted and/or authenticated signals, dual-frequency **GNSS** systems, and the addition of alternative and complementary sensors can make successful spoofing attacks far less likely.

At ***Spirent***, we've led the industry in pioneering **GNSS** simulation technology for the last 40 years, supporting applications ranging from satellites, to lunar, to military, to automotive, and more. We've been helping organizations test against spoofing threats for 30 years. We're more than prepared to help system developers and integrators develop novel solutions to address the GPS spoofing threat.

If there's a major barrier we face, it's that, while militaries have decades of preparation, experience, and equipment to deal with GPS spoofing, civil aviation is entering unknown territory. It's not as simple as just transferring that equipment and practice from one domain to the other. There are regulations to adhere to, hardware updates required, and large fleets of aircraft that are in constant operation. Plus, we're still basically at the start of this process.

Even now, many in the industry are shocked to learn that spoofing affects so many commercial flights. The first step has to be raising awareness, which we and other industry groups have been working to accomplish. The reality, however, is that even when industry leaders appreciate the scale of the problem, and even when they commit to hardening GPS systems, it could take years to test and integrate new systems into commercial fleets.

While we pursue these long-term efforts, we also need to find creative ways to deal with GPS spoofing attacks in the here and now. Pilots need to be confident in their onboard navigation and PNT-dependent systems, but they also need to know when those systems are likely to be unreliable and what to do in each individual circumstance. ATC needs to be aware of impacted flights and when to prioritize other systems over, for instance, ADS-B. The entire industry needs clarity short-term and long-term mitigation strategies.

One of the interventions that Spirent has developed to help address the immediate need is our ***GNSS Spoofing Detection & Alerting Service***. This service takes available real-time data from a range of sources, including, but not limited to, ADS-B, and maps affected areas. The service also collates information on the reported impacts of the attacks on different types of aircraft.

The service integrates with pilots' existing electronic flight bags and ground-based systems, meaning no new hardware is required. It issues alerts whenever a flight is approaching a region with current GPS spoofing activity, similar to alerts for extreme weather or turbulence. Once they know they'll be traversing an impacted area, aircraft crews can take steps to protect navigation systems or navigate around it.

Controllers and airline operators can also use these services to monitor attack patterns, so they can adapt operations, reroute flights when necessary, and update testing and training to ensure that pilots, crews, and aircraft are prepared for these attacks.

Services such as these don't fully eliminate the GPS spoofing problem, but we have to look at this in both immediate and longer terms. The longer-term solutions will, we hope, totally solve this critical issue—doing nothing while we wait for these solutions is not an option.

Incorporating near-term and long-term strategies is the key to maintaining the operational safety and efficiency of aviation, military and civil.

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NASA TESTS DRONES TO PROVIDE MICROMETEOROLOGY + TO AID IN FIRE RESPONSE

Author: Milan Loiacono, science communication specialist for the Earth Science Division at NASA Ames Research Center.

In August of 2024, a team of NASA researchers and partners gathered in Missoula, Montana, to test new drone-based technology for localized forecasting, or micrometeorology. Researchers attached wind sensors to a drone, NASA's Alta X quadcopter, aiming to provide precise and sustainable meteorological data to help predict fire behavior.

The NASA Alta X quadcopter sits in a field in Missoula, Montana, outfitted with a structure engineered at Langley Research Center to carry a radiosonde (top left) and an anemometer (top right) into the air. The drone and its payload were part of the August 2024 FireSense campaign, which looked at the applicability of using controllable, repeatable airborne measurements to more accurately predict fire and smoke behavior. Image Credit: NASA ARC/Milan Loiacono

Wildfires are increasing in number and severity around the world, including the United States, and wind is a major factor. It leads to unexpected and unpredictable fire growth, public threats, and fire fatalities, making micrometeorology a very effective tool to combat fire.

This composite image (*above, right*) shows the NASA Alta X quadcopter taking off during one of eight flights it performed for the 2024 FireSense **uncrewed aerial system** (**UAS**) technology demonstration in Missoula, Montana.

Mounted on top of the drone is a unique infrastructure designed at NASA Langley to carry a ***radiosonde*** and an ***anemometer***—two sensors that measure wind speed and direction—into the sky.

UAS Pilot in Command Brayden Chamberlain flashes a 'good to go' signal to the command tent, indicating that the NASA Alta X quadcopter is prepped for takeoff. Photo: NASA/Milan Loiacono

The campaign was run by NASA's FireSense project, focused on addressing challenges in wildland fire management by putting NASA science and technology in the hands of operational agencies.

"*Ensuring that the new technology will be easily adoptable by operational agencies such as the U.S. Forest Service and the National Weather Service was another primary goal of the campaign*," said ***Jacquelyn Shuman***, FireSense project scientist at ***NASA's Ames Research Center*** in California's Silicon Valley.

The FireSense team chose the Alta X drone because the ***U.S. Forest Service*** already has a fleet of the quadcopters and trained drone pilots, which could make integrating the needed sensors—and the accompanying infrastructure—much easier and more cost-effective for the agency. The choice of the two sensors for the drone's payload was also driven by their adoptability.

The first, called a radiosonde, measures wind direction and speed, humidity, temperature, and pressure, and is used daily by the **National Weather Service**. The other sensor, an anemometer, measures wind speed and direction, and is used at weather stations and airports around the world.

The two sensors mounted on the NASA Alta X quadcopter are a radiosonde (left) and an anemometer (right), which measure wind speed and direction. The FireSense teams hopes that by giving them wings, researchers can enable micrometeorology to better predict fire and smoke behavior. Photo: NASA/Milan Loiacono

Both sensors create datasets that are already familiar to meteorologists worldwide, which opens up the potential applications of the platform.

"*Anemometers are everywhere, but are usually stationary*," said ***Robert McSwain***, the FireSense ***uncrewed aerial system*** (**UAS**) lead, based at ***NASA's Langley Research Center*** in Hampton, Virginia. "*We are taking a sensor type that is already used all over the world, and giving it wings*."

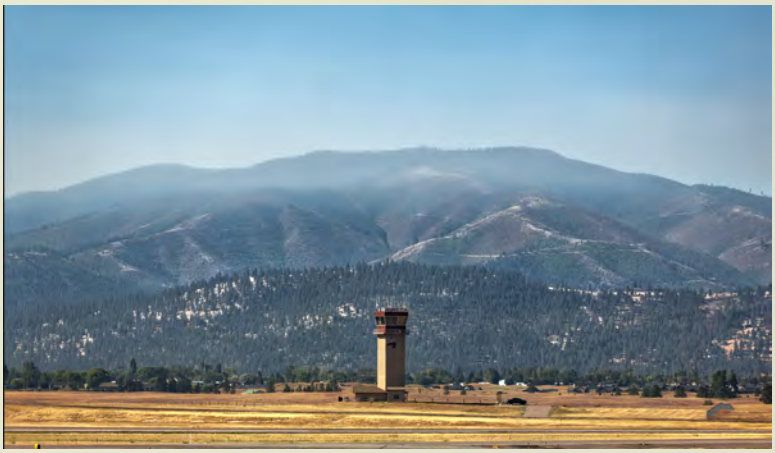
Traditionally, global weather forecasting data is gathered by attaching a radiosonde to a weather balloon and releasing it into the air. This system works well for regional weather forecasts. However, the rapidly changing environment of wildland fire requires more recurrent, pinpointed forecasts to accurately predict fire behavior—the perfect niche for a drone.

"*These drones are not meant to replace the weather balloons*," said ***Jennifer Fowler***, FireSense's project manager at Langley. "*The goal is to create a drop-in solution to get more frequent, localized data for wildfires – not to replace all weather forecasting. A weather balloon is going to be a one-off, and the attached sensor won't be recovered. The instrumented drone, on the other hand, can be flown repeatedly.*"

The NASA Alta X quadcopter sits in a field in Missoula, outfitted with a special structure to carry a radiosonde (sensor on the left) and an anemometer (sensor on the right) into the air. This structure was engineered at NASA's Langley Research Center to ensure the sensors are far enough from the rotors to avoid interfering with the data collected, but without compromising the stability of the drone. Photo: NASA/Milan Loiacono

Drones can be piloted to keep making measurements over a precise location —an on-site forecaster could fly one every couple of hours as conditions change—and gather timely data to help determine how weather will impact the direction and speed of a fire. Fire crews on the ground may need this information to make quick decisions about where to deploy firefighters and resources, draw fire lines, and protect nearby communities. A reusable platform, such as a drone, also reduces the financial and environmental impact of forecasting flights.

Before such technology can be sent out to a fire, it needs to be tested. That's what the FireSense team did this summer.



Smoke from the nearby Miller Peak Fire drifts by the air control tower at Missoula Airport on August 29, 2024. Miller Peak was one of several fires burning in and around Missoula that month, creating a smoky environment which, combined with the mountainous terrain, made the area an ideal location to test FireSense's new micrometeorology technology. Photo: NASA/Milan Loiacono

McSwain described the conditions in Missoula as an "*alignment of stars*" for the research: the complex mountain terrain produces erratic, historically unpredictable winds, and the sparsity of monitoring instruments on the ground makes weather forecasting very difficult. During the three-day campaign, several fires burned nearby, which allowed researchers to test how the drones performed in smoky conditions.

NASA Langley drone crew members Todd Ferrante (left) and Brayden Chamberlain calibrate the internal sensors of the NASA Alta X quadcopter before its first test flight. Photo: NASA/Milan Loiacono

Once those data sets were created, they needed to be transformed into a usable format. Meteorologists are used to the numbers, but incident commanders on an active fire need to see the data in a form that allows them to quickly understand which conditions are changing, and how. That's where data visualization partners come in. For this Missoula campaign, teams from MITRE, NVIDIA, and Esri joined NASA in the field.

Measurements from both the balloon and the drone platforms were immediately sent to the on-site data teams. The MITRE team, together with NVIDIA, tested high-resolution artificial intelligence meteorological models, while the Esri team created comprehensive visualizations of flight paths, temperatures, and wind speed and direction. These visual representations of the data make conclusions more immediately apparent to non-meteorologists.

Development of drone capabilities for fire monitoring didn't begin in Missoula, and it won't end there.

"*This campaign leveraged almost a decade of research, development, engineering, and testing*," said McSwain. "*We have built up a UAS flight capability that can now be used across NASA.*"

The NASA Alta X and its sensor payload will head to Alabama and Florida in the spring of 2025, incorporating improvements identified in Montana. There, the team will perform another technology demonstration with wildland fire managers from a different region.

To view more photos from the FireSense campaign, ***access this direct link...***

The FireSense project is led by NASA Headquarters in Washington and sits within the Wildland Fires program, with the project office based at NASA Ames. The goal of FireSense is to transition Earth science and technological capabilities to operational wildland fire management agencies, to address challenges in U.S. wildland fire management before, during and after a fire.

science.gsfc.nasa.gov/earth/

Author Milan Loiacono is a science communication specialist for the Earth Science Division at NASA Ames Research Center.

The NASA Alta X quadcopter descends over the mountains during one of eight launches for the FireSense uncrewed aerial system (UAS) Technology Demonstration in Missoula, Montana. Image Credit: NASA ARC/Milan Loiacono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