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CONVERGING ON THE JAMMER

Dual-Satellite GPS Interference Localization from Space

+

TRACKING TORNADOES WITH GIS

MAY/JUNE 2026 | Vol 37 | No 3
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VOL. 37 NO. 3 GPSWORLD.COM

MAY/JUNE 2026

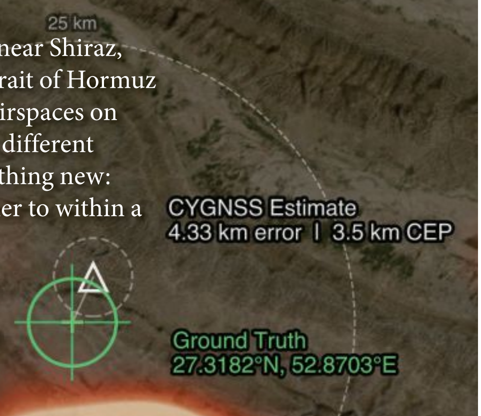
Sean Gorman

COVER STORY

BY SEAN GORMAN

On a January morning in 2026, a GPS jammer powered up near Shiraz, Iran. It was not the first, and it would not be the last. The Strait of Hormuz corridor has become one of the most persistently jammed airspaces on Earth. But this time, two satellites were watching from very different vantage points, and together they would demonstrate something new: that spaceborne sensors can localize a terrestrial GPS jammer to within a few kilometers, using physics alone.

This article presents the first direct comparison of Cyclone Global Navigation Satellite System (CYGNSS) — a NASA GNSS reflectometry constellation — and NASA-ISRO Synthetic Aperture Radar (NISAR) — an L-band synthetic aperture radar for GPS jammer localization. The results challenge assumptions about which modality performs better and reveal that the answer depends on a question most analysts forget to ask.



Corporate Profiles

Eight marketplace leaders describe their corporate capabilities in special advertiser-sponsored pages throughout the Buyers Guide. Also, look for highlights from additional sponsors.

ON THE COVER

Testing non-traditional satellites to localize GPS jammers near Shiraz, Iran. (Credit: Sean Gorman)

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MAY/JUNE **2026**

ONLINENOW

NEWSLETTER EXCERPT

ICAO Urges Action on Drones, Missiles and GNSS Jamming Threats to Civil Aviation

BY JESSE KHALIL ASSOCIATE EDITOR

The International Civil Aviation Organization (ICAO) is calling for stronger measures to protect civilian aircraft from military threats, warning that the risk of weapons targeting civilian planes is increasing worldwide.

ICAO Secretary-General Juan Carlos Salazar told delegates at the 2026 World Overflight Risk Conference in Vallarta, Malta, that emerging military technologies — including long-range weapons systems, unmanned aircraft systems (UAS), GNSS radio frequency interference, and advanced air defense systems — pose growing risks to civil aviation.

"We must now reach beyond the boundaries of aviation as we have known it," Salazar said, adding that increasingly sophisticated weaponry is creating conditions in which civilian aircraft face a heightened risk of being targeted or caught in crossfire.

While praising the aviation industry's ability to reroute flights and maintain operations during the recent Middle East crisis, Salazar said operational flexibility alone cannot address the underlying security threats posed by weapons systems.

ICAO

ICAO Secretary General Juan Carlos Salazar (center) discussed recent global and regional developments affecting aviation with H.E. Myriam Spiteri Debono, President of Malta (right), following his keynote address to the World Overflight Risk Conference in Vallarta, Malta, on April 21, 2026. The Secretary General was accompanied by Nicolas Rallo, Director of the ICAO European and North Atlantic Regional Office (left).

He commended states and airspace users for measures taken to mitigate safety and security risks during the escalation in the Middle East, noting that more than 10 states partially or fully closed their airspace, significantly disrupting international air transport.

"This commitment to resilience, adaptation, safety and security is the foundation of our industry," he said, calling for concrete steps to prevent civil aviation facilities, airports and aircraft from being targeted. ◍

Read more at **gpsworld.com/opinions/**.

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Keeping your information up to date will ensure you won't miss an issue. Our editorial team reports on current, relevant industry topics — including the latest disruptive tech and current events affecting the industry — in print and online.

They also cover positioning, navigation and timing (PNT) technology and developments, which work with GNSS to achieve greater accuracy, availability, integrity and robustness. These include inertial sensors, eLoran, lidar, electronic compasses, cellular signal positioning, video signal positioning, odometers, wheel-speed sensors, ultra-wideband, RFID, Bluetooth and more. Coverage not only includes the U.S. Global Positioning System, but it also chronicles the development of GLONASS, BeiDou and Galileo, as well as regional sysems, including QZSS and NavIC.

In this current era of heightened GNSS interference, we are also staying on top of the numerous groundbreaking projects to complement GNSS or provide alternative PNT methodologies. From new ways to process signals to additional constellations in low-Earth orbit, we are your companion to sharing this critical information (see this issue's cover story on page 12).

Uses of GPS have spread across the landscape, the seas, into air space, into outer space, driven by designers and engineers crafting new solutions for challenging problems. Wherever the industry is heading, *GPS World* will be there to cover it.

***— GPS World* staff**

Lockheed Martin

GPS III SV10 launches from Cape Canaveral, Florida, in the early hours of April 21.

Final GPS III Satellite Launches into Orbit

The U.S. Space Force and Lockheed Martin launched on April 21 the GPS III Space Vehicle 10 (SV10), marking the final satellite in the GPS III series and bringing the GPS constellation to its largest size to date.

Signal acquisition was achieved shortly after launch. The spacecraft is being managed at Lockheed Martin's Denver-based launch and checkout operations center while it undergoes initial testing before integration into the operational network.

SV10 includes enhancements designed to improve the accuracy and resiliency of the constellation. Among its payloads is an optical crosslink demonstration designed to test direct satellite-to-satellite communication in orbit, a capability intended to strengthen system robustness.

The launch represents the fourth consecutive GPS mission conducted on an accelerated schedule.

GPS III satellites provide improved performance over earlier generations, including increased positioning accuracy, stronger resistance to jamming, and the addition of secure M-code signals for military users. The constellation supports positioning, navigation and timing (PNT) services for military, civil and commercial applications worldwide.

SV10 also carries a demonstration digital rubidium atomic frequency standard, an advanced clock designed to improve onboard timekeeping precision.

The deployment of SV10 concludes the GPS III series and precedes the next-generation GPS IIIF satellites. The upcoming series is expected to introduce additional capabilities, including enhanced anti-jamming features such as Regional Military Protection.

More than 30 GPS satellites are currently in orbit, providing global PNT services to billions of users across defense, infrastructure and commercial sectors.

ESA's Celeste IOD-1 Satellite Transmits First Navigation Signal

At 10:38 CET on April 8, the Celeste IOD-1 satellite, developed by GMV and Alén Space under the European Space Agency's (ESA) Celeste In-Orbit Demonstrator (IOD) program, successfully transmitted its navigation signal for the first time.

The reception of the signal from the Celeste IOD-1 satellite, confirmed by ESA teams at ESTEC, marks a key milestone for the program as it confirms the satellite's successful commissioning in orbit. The signal also was received at GMV's monitoring station in Lisbon.

The first two IOD satellites of the Celeste program — built by GMV and Thales Alenia Space, respectively — were launched March 28 at 10:14 CET from Rocket Lab's Launch Complex 1 in Mahia, New Zealand. Separation from the launch vehicle took place one hour later, marking the start of the initial operations phase (LEOP) and commissioning, carried out by GMV for the IOD-1 satellite from the mission control center in Tres Cantos.

Celeste is ESA's strategic program to demonstrate the benefits of an additional low-Earth orbit (LEO) navigation layer that complements Galileo and EGNOS, with the goal of improving the accuracy, resilience and security of PNT services in Europe.

The in-orbit demonstrator (IOD) represents the program's first phase and will validate key LEO-PNT technologies in flight ahead of potential future operational deployment.

The Celeste IOD phase is being carried out in parallel by two European consortia and will include a total of 11 satellites plus one in-orbit spare. As one of the prime contractors, GMV is responsible for the end-to-end mission for six of the demonstrator satellites, including system definition and design, the space and ground segments, the user segment, and operations.

SURVEY & MAPPING

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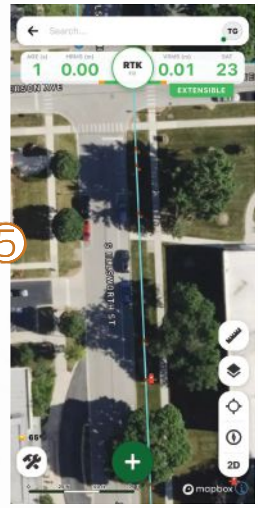

1. GNSS RECEIVER

ENCLOSED MULTI-FREQUENCY BOXED RECEIVER

The AsteRx EB offers high-accuracy positioning and GNSS heading for industrial robots, port logistics, marine and scalable automation applications. Its IP67 enclosure protects the receiver from harsh weather conditions, while built-in advanced GNSS+ algorithms ensure reliable operation in environments challenging for GNSS, such as areas with foliage or near GNSS interference sources.The RAIM+ integrity monitoring system ensures truthful positioning — essential for autonomous navigation. The compact enclosure of AsteRx EB enables easy installation, reducing time-to-market. In a dual-antenna configuration, AsteRx EB delivers sub-degree GNSS heading for systems that require orientation in addition to RTK positioning. The built-in AIM+ anti-jamming and anti-spoofing technology protects the receiver from intentional or unintentional GNSS interference.
Septentrio, septentrio.com

2. GNSS RTK PLATFORM

REAL-TIME KINEMATIC DELIVERS CM-LEVEL MEASUREMENTS

The Facet FP is a high-precision GNSS receiver designed to deliver centimeter-level accuracy with a focus on long-term flexibility, ease of use and open-source innovation. It combines multi-band, multi-constellation GNSS support with fully open-source firmware — the platform can adapt as technologies advance. Built to last, all models are contained in a robust waterproof cast-aluminum housing, with an internal structure designed for compatibility with the company's Flex system of GNSS modules. This gives users the choice between three different modules, plus the choice of having tilt-compensation, offering six different options with a range of price points, securities and accuracies for various needs and applications.
SparkPNT, sparkfun.com/pnt

3. GNSS ANTENNA

HIGH-PRECISION, HIGH-ACCURACY, ROBUST

The A65 GNSS antenna delivers exceptional accuracy, interference protection and robust GNSS tracking performance. Designed as a drop-in replacement for the widely deployed A45 antenna, the A65 offers users a seamless upgrade path to the latest precision technology. The industry collaboration reflects a shared focus on combining advanced RF design with real-world application insight to address increasingly complex GNSS operating environments, with both teams working closely from the earliest stages of development to meet demanding original equipment manufacturer (OEM) performance requirements. The antenna architecture, including the stacked patch quad feed element and RF front end, provides Calian's XF Filtering. Hemisphere GNSS contributed application expertise, system integration requirements and performance validation within real-world machine control, agriculture, marine and survey environments.
Hemisphere GNSS, www.hemispheregnss.com
Calian Group Ltd., calian.com

4. AIRBORNE LIDAR

LONG RANGE FOR UAV MAPPING AND AERIAL SURVEYING

The AlphaAir 6 airborne lidar system is designed for UAV-based laser scanning, drone lidar mapping and aerial surveying in high-relief and complex terrain. Combining prism scanning technology with a high-grade inertial navigation system (INS), the AlphaAir 6 delivers a maximum ranging capability of up to 2,100 m and supports efficient data capture at typical flight altitudes of 400 m to 600 m above ground level. It integrates an upgraded laser engine and a high-grade IMU with 0.3°/h bias stability to improve trajectory accuracy and point cloud quality. This design removes the need for pre-mission IMU calibration and supports stable, efficient data collection for topographic mapping, corridor mapping, and wide-area aerial survey workflows. It is available in single-camera and dual-camera configurations.
CHC Navigation, chcnav.com

5. GNSS MAPPING APP

MAKES SMARTPHONES DATA-COLLECTION TOOLS

The FastXY mapping application for iOS and Android enables standard mobile devices to serve as professional-grade data-collection tools for geospatial information system (GIS) and architecture, engineering and construction (AEC) professionals. FastXY allows users to collect point, line and polygon data with devices they already own. It delivers advanced capabilities including 3D basemaps, construction staking, topographic surveying, on-the-fly datum transformations, and survey-grade elevations. A built-in Bluetooth data parser allows users to configure the app to collect data from any instrument supporting BLE Bluetooth or RS-232 — echosounders, radiation sensors, laser rangefinders, barcode scanners — and marry that data with precise GNSS coordinates.
Digital Mapping Group, fastxy.com

Q+A with Safran Electronics & Defense
Quentin Ceruti

Enabling Advanced GNSS Receiver Validation with Wavefront Simulation

To start, can you explain what wavefront simulation means in the context of GNSS testing?

Wavefront simulation is about validating spatial truth, not just signal availability. Instead of injecting GNSS signals into a single radio frequency (RF) input, it recreates how signals physically arrive at a multi element antenna system, including phase, relative delay, and angle of arrival across each element.

This distinction is essential for control reception pattern antenna (CRPA) based receivers, where performance depends on spatial processing. Wavefront simulation ensures that the receiver experiences a geometrically and temporally correct RF environment — something traditional single antenna simulation simply cannot deliver.

What has changed in GNSS receiver design that makes wavefront simulation essential today?

GNSS architectures are evolving rapidly. Multielement CRPA systems are now standard in defense and aviation and becoming mainstream in commercial applications that demand resilience.

These systems rely on beamforming, null steering, and angle of arrival estimation to counter interference. Validating those techniques requires a test environment where threat direction, dynamics and density can be tightly controlled and repeated. Wavefront simulation makes that possible, reducing reliance on expensive, unpredictable, or even impossible field testing while providing deeper insight into system limits.

What are the main technical challenges, and how are modern systems addressing them?

The defining challenge is maintaining phase coherence and timing alignment across channels. Even minor inconsistencies can invalidate spatial processing results.

Safran addresses this with its GSG Wavefront solution, a software defined CRPA test system built for phase coherent, multi channel simulation. Using a shared local oscillator architecture and continuous real time calibration, GSG Wavefront preserves alignment throughout dynamic scenarios. Powered by Safran's Skydel simulation engine, it computes geometric delays and phase offsets in real time based on satellite motion, antenna geometry, and threat behavior.

This architecture is designed for conducted testing — connecting directly to CRPA antenna electronics — and complements OTA validation performed in anechoic chambers, giving engineers confidence that lab results reflect real world physics.

Can you give a concrete example where wavefront simulation makes a real difference?

The clearest and most common example is CRPA anti jam and anti spoof validation. With Safran's GSG Wavefront, engineers can inject authentic multi constellation GNSS signals into each antenna element while simultaneously introducing multiple jammers or spoofers from defined angles of arrival and with dynamic trajectories.

In a conducted test configuration, this allows precise assessment of null forming performance, tracking robustness, and position stability under extreme jammer to signal ratios. The same scenarios can later be exercised OTA in an anechoic chamber, validating antenna level behavior.

What would be nearly impossible to reproduce consistently in the field becomes routine in the lab. Wavefront simulation turns CRPA validation into a disciplined engineering process — one where limits are explored systematically instead of discovered by surprise or by accident.

As GNSS resilience becomes mission critical, how should engineers be thinking differently about CRPA validation?

It's all about confidence. Confidence must be earned through evidence. Wavefront simulation, particularly when integrated into a scalable platform like Safran's GSG Wavefront, enables engineers to prove not only that a CRPA works, but why it works and where its boundaries truly lie.

Quentin Ceruti, Product Manager


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COVERSTORY

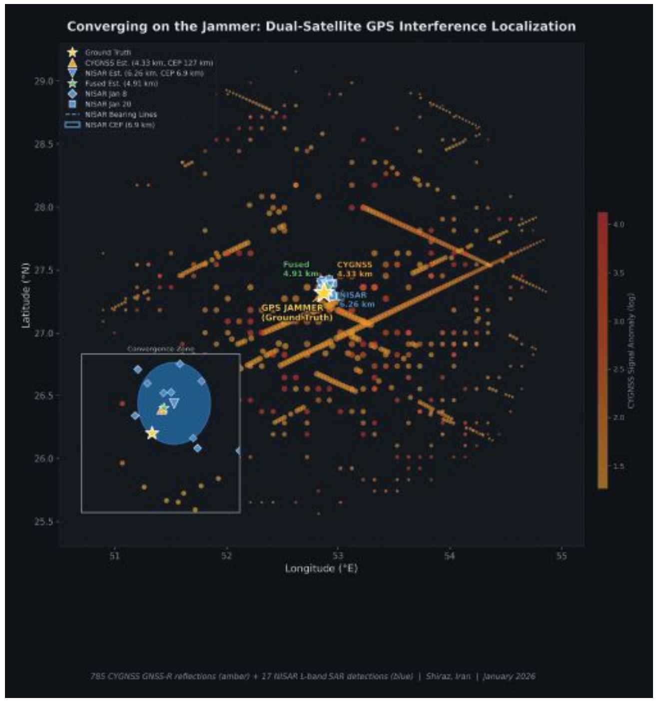
CONVERGING ON THE JAMMER

Dual-Satellite GPS Interference Localization from Space

BY SEAN GORMAN

On a January morning in 2026, a GPS jammer powered up near Shiraz, Iran. It was not the first, and it would not be the last. The Strait of Hormuz corridor has become one of the most persistently jammed airspaces on Earth. But this time, two satellites were watching from very different vantage points, and together they would demonstrate something new: that spaceborne sensors can localize a terrestrial GPS jammer to within a few kilometers, using physics alone.

This article presents the first direct comparison of Cyclone Global Navigation Satellite System (CYGNSS) — a NASA GNSS reflectometry constellation — and NASA-ISRO Synthetic Aperture Radar (NISAR) — an L-band synthetic aperture radar for GPS jammer localization. The results challenge assumptions about which modality performs better and reveal that the answer depends on a question most analysts forget to ask.



All figures by Sean Gorman

FIGURE 1 **Jammer localization tracks from both CYGNSS and NISAR satellite constellations.**

The Setup: Known Jammer, Known Position

Validation requires ground truth. With help from the PNT community, we identified a GPS jammer operating near 27.32°N, 52.87°E (approximately 50 km southwest of Shiraz) that was active on Jan. 8 and Jan. 20, 2026, with confirmed quiet periods on Dec. 15 and Dec. 27, 2025. The jammer's position was established through independent signals intelligence.

This gave us a controlled experiment: two "jammer ON" dates and two "jammer OFF" baseline dates, with satellite coverage from both CYGNSS and NISAR spanning the full period.

Two Satellites, Two Physics

CYGNSS is a constellation of eight microsatellites that measure GPS signals reflected off Earth's surface. Each spacecraft carries a delay-Doppler receiver that maps reflected signal power across a grid of delay and Doppler bins, known as the delay-Doppler map, or DDM. When a terrestrial jammer is active, it floods the GPS band with noise, elevating the DDM noise floor and suppressing the coherent surface reflection. The effect is detectable hundreds of kilometers from the jammer, creating a wide-area footprint in the reflected signal data.

NISAR operates an L-band SAR at 1.257 GHz, just 30 MHz from the GPS L2 frequency at 1.2276 GHz. When a GPS jammer's broadband emissions leak into NISAR's receive band, they create characteristic streaks in the SAR imagery. The streaks are elongated in the cross-track (range) direction, not along-track, a counterintuitive result that follows directly from SAR signal processing. In azimuth (along-track), the jammer is a fixed-point source with a valid Doppler history, so the SAR azimuth processor focuses it correctly, similar to any ground target. But in range (cross-track), the jammer's broadband noise does not match the SAR's chirp waveform, so range compression smears the energy across many range bins rather than compressing to a point. The result is a streak perpendicular to the flight direction, whose along-track centroid encodes the jammer's latitude and whose cross-track extent encodes a range arc, which is the distance from the orbit ground track (**FIGURE 1**). The bearing of each streak encodes the jammer's direction relative to the satellite's ground track.

The two sensors could hardly be more different. CYGNSS sees the jammer's effect on reflected GPS signals, offering an indirect measurement spread across hundreds of specular reflection points. NISAR sees the jammer's emissions directly in its own receiver, which is a more precise measurement, but only along the satellite's narrow ground track. **FIGURE 2** shows both detection sets converging on the jammer location.

CYGNSS: 785 Detections, 4.33 km Error

We processed all CYGNSS Level 1 data within 200 km of the jammer location on both ON and OFF dates. Four detection methods contributed observations:

- **DDM noise floor (419 detections):** The pre-computed ddm_noise_floor variable, calibrated against the thermal noise reference, proved the strongest discriminator. Near-jammer values exceeded 15,000 counts against a ~10,000 mean background.
- **Spatial noise grid (299):** A 10 km gridded analysis identified cells with anomalously elevated noise relative to adjacent cells.
- **SNR hole detection (66):** Coherent surface reflections were suppressed near the jammer, creating spatial "holes" in the SNR field.
- **NBRCS drop (1):** Surface reflectivity dropped approximately 16% near the jammer, though this method produced few threshold exceedances.

Across four DDM channels per spacecraft and multiple passes, this yielded 785 total anomalous observations on the jammer-ON dates.

Localizing using a simple centroid of all 785 detection positions placed the jammer 32.1 km from truth, with too many distant, low-SNR detections diluting the estimate. Instead, we fit a parametric $1/r^2$ inverse-distance model:

I(r)=Ar2

where A is a free amplitude parameter and r is the distance from a candidate jammer position. We jointly optimized the jammer position and amplitude using SciPy's Nelder-Mead optimizer across all 785 observations, weighted by intensity. The optimizer converged on a position 4.33 km from ground truth, providing a 27.7 km improvement over the centroid (**FIGURE 3**).

The Baseline: Zero False Positives

On the jammer-OFF dates (Dec.15 and Dec. 27, 2025), the pipeline produced exactly zero detections using the same thresholds, geographic area, and satellites: a completely clean result. This suggests that the 785 detections are unlikely to be sensor artifacts or geographic anomalies. They disappear when the jammer turns off.

NISAR: 17 Detections, 6.26 km Error

NISAR's approach is fundamentally different. Rather than measuring hundreds of reflected signals across a wide area, it captures direct emissions in a narrow swath, but with far greater geometric precision.

We processed NISAR L2 GCOV (geocoded covariance) products from Track 157, Frame 15 (ascending) for three dates: the Dec. 27 baseline and the Jan. 8 and Jan. 20 jammer-ON passes. The detection pipeline used eigenvalue decomposition of the polarimetric covariance matrix:

1. λ_1 ratio thresholding: In jammer-contaminated pixels, the dominant eigenvalue λ_1 of the 2×2 [HH, HV] covariance matrix rises sharply relative to the scene mean, indicating an unpolarized additive source.

2. Cross-polarization ratio (HV/HH): GPS jammer emissions are unpolarized, disproportionately elevating the HV channel. Anomalous HV/HH ratios flag contaminated azimuth lines.

3. Iterative outlier trimming: Three rounds of 1.5σ clipping removed scattered false detections, leaving 17 high-confidence streak centroids.

With detections from two passes on different dates, we had two independent bearing lines. Each pass's streak centroids defined an azimuth-

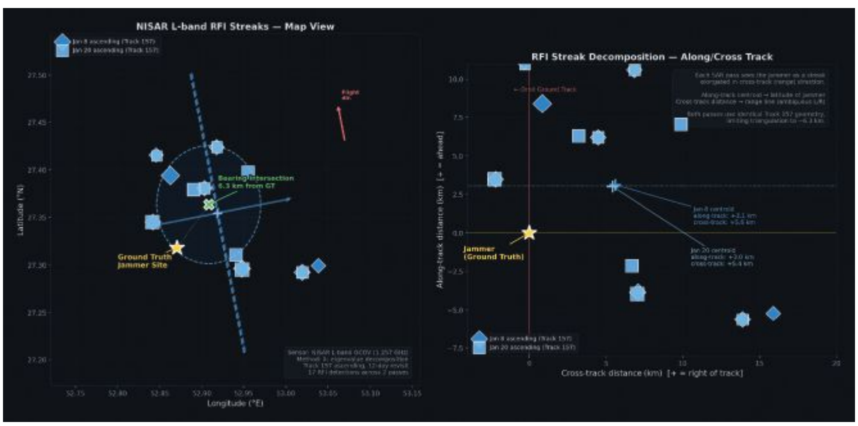


FIGURE 2 Crosstrack visualization for NISAR RFI streaks.

Images: SiTime

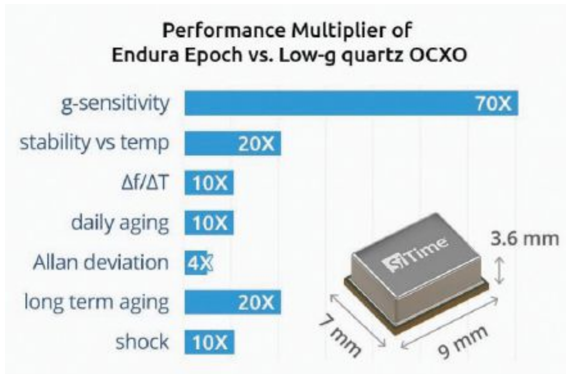
When GNSS is Contested, Timing Determines Mission Success

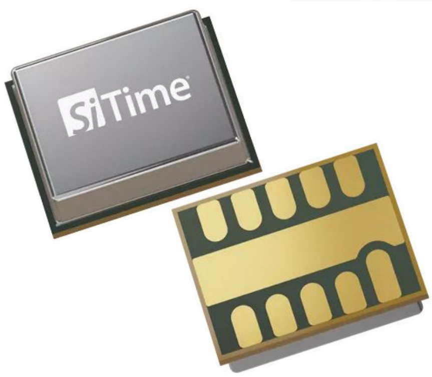
GNSS is not assured in contested environments. Jamming, spoofing and signal obstruction degrade or deny positioning, navigation and timing (PNT). When external references fail, system performance depends on local sensors. Timing integrity determines how long platforms maintain synchronization, reduce navigation drift, and enable communications continuity during GNSS disruption.

SiTime Endura Precision Timing Solutions are built for contested environments. MEMS-based timing devices maintain frequency and phase through vibration, thermal transitions, and shock within strict size, weight and power (SWaP) constraints. With up to 20x longer holdover and 20x better PNT accuracy, these solutions maintain operation during GNSS disruption and accelerate reacquisition once signals return.

ENDR-TTT Endura Super-TCXO

Designed for GNSS resilience at the receiver level, the ENDR-TTT delivers an ultra-stable frequency reference under dynamic conditions. With ±50 ppb stability over −55°C to +125°C, vibration resistance of 0.004 ppb/g g-sensitivity 22 mW, and >95,000g shock survivability, it maintains timing accuracy where legacy oscillators fail. ENDR-TTT is the preferred local oscillator for User Equipment, Munitions, and Dismounted solutions due to its environmental resilience, low SWaP, and superior time holdover.





SiT7101 Endura OCXO

For extended holdover and system-level synchronization, the SiT7101 provides up to 8 hours of holdover with ±1.5 µs time error. It maintains ±1 ppb stability under thermal and airflow variation, with digital frequency control via I²C/SPI supporting phase alignment in radar, communications, and guidance systems through extended GNSS outages. For longer holdover, the SiT7101 OCXO, SiT95316/7 network synchronizer, and TimeFabric software enable a PPSDO solution supporting up to 24-hour holdover within ±1.5 µs time error. SiT7101 is the preferred local oscillator for land, air, sea, and space-based mounted platforms.

Timing for Mission-Critical Systems

From precision-guided systems to autonomous platforms and communications infrastructure, mission success depends on timing that operates through GNSS denial. SiTime delivers precision timing that maintains PNT integrity across contested environments.

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aligned cluster whose major axis pointed toward the jammer. A PCA fit to the two clusters extracted the bearing: 308.1° from the Jan. 8 pass and 316.2° from Jan. 20. Their intersection — computed via scipy optimization of the angular residual — landed 6.26 km from ground truth (**FIGURE 4**).

The along-track/cross-track decomposition reveals why the 6.26 km error is a geometric ceiling for this dataset, not a processing limitation. Both passes come from the same Track 157 ascending orbit on a 12-day repeat cycle. The intensity-weighted along-track centroids land at +3.0 km and +3.1 km north of the jammer, a direct stable latitude measurement. The cross-track centroids land at +5.4 km and +5.6 km east of the orbit ground track, a range measurement. But because both passes share identical orbit geometry, the two range arcs are nearly parallel. The bearing difference between passes (308.1° vs 316.2°) is only 8.1°, producing a shallow intersection angle and poor cross-range resolution. A single descending pass, which would cross the ascending track at approximately 60-70°, would transform the geometry from two near-parallel lines to a genuine triangulation, potentially reducing the localization error to sub-2 km. Unfortunately, no descending NISAR pass covering this jammer site was available in the beta archive, which ends on Jan. 20, 2026.

The CEP (circular error probable, the radius containing 50% of repeated estimates) was 6.88 km, meaning if we ran this analysis on many similar jammers, half our estimates would fall within ~7 km.

Who Wins?

CYGNSS wins, and not just on accuracy.

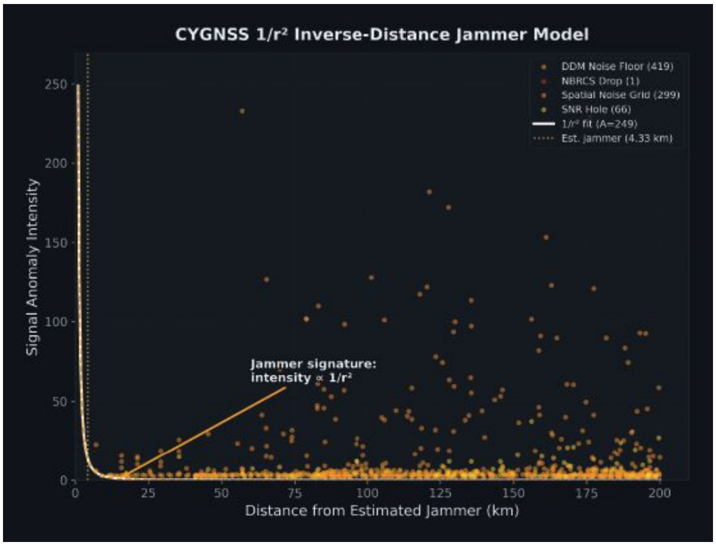

FIGURE 3 **Scatterplot of interference insensity versus distance for CYGNSS.**

A naive confidence metric for the $1/r^2$ fit would be the scatter of the 785 input detections (CEP = 127 km). But the detections are not the estimate; they are the inputs to a model fit. The relevant confidence question is: How stable is the fitted position?

We answered this with a 500-iteration bootstrap: resample the 785 detections with replacement, re-run the $1/r^2$ optimizer each time, and measure the spread of the resulting position estimates. The bootstrap CEP, the median radial distance across 500 fitted positions, was 3.48 km. The optimizer converges stably to within a few kilometers of the same location regardless of which detections are included.

This means CYGNSS achieves 4.33 km error with 3.48 km confidence, both better than NISAR's 6.26 km error and 6.88 km confidence.

The bootstrap CEP also reveals what the raw scatter obscures: the $1/r^2$ fit is constrained primarily by the ~80 high-intensity detections within 30 km of the jammer. The remaining 700 distant, low-intensity detections contribute little to the position estimate — they are correctly downweighted by the intensity-weighted least squares. The fit's stability comes from the physics: a $1/r^2$ signal has steep gradients near the source, providing strong positional constraints where it matters most.

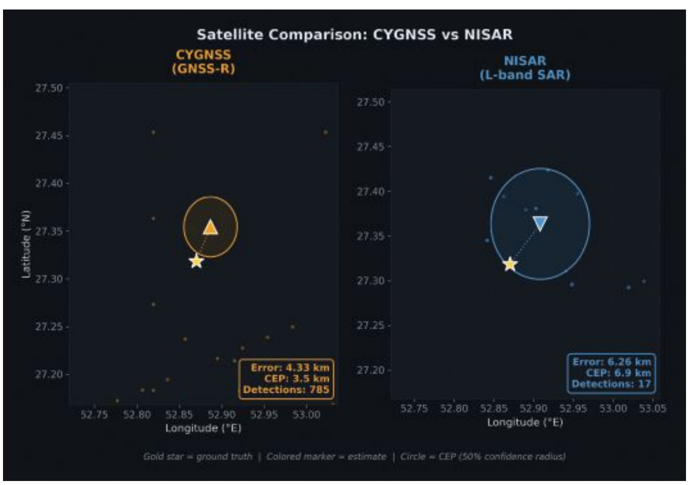

FIGURE 4 **Error and CEP Metrics Comparison for CYGNSS and NISAR.**

Bayesian Fusion: Can We Get Both?

The obvious next question: Can we combine CYGNSS's wide-area sensitivity with NISAR's geometric precision? We implemented four fusion strategies, all designed to work without ground truth:

- **Bayesian Gaussian posterior:** Model each sensor's

estimate as a 2D isotropic Gaussian with σ = CEP/1.1774. The posterior is the product of the two Gaussians: an analytical precision-weighted mean.

- **NISAR-prior constrained $1/r^2$:** Re-run the CYGNSS optimizer with a Gaussian regularization term pulling toward the NISAR estimate, sweeping the regularization weight λ from 0.01 to 10.
- **NISAR-proximity re-weighted $1/r^2$:** Apply a Gaussian kernel centered on the NISAR estimate to the CYGNSS detections before fitting, effectively upweighting observations consistent with the SAR result.
- **Joint CEP-balanced:** Combine the CYGNSS gradient signal with NISAR cluster proximity, weighted by $(\sigma\_CYGNSS/\sigma\_NISAR)^2$.

With the bootstrap CEP, the precision ratio flips. The CYGNSS Gaussian (σ = 2.95 km) is now 2× tighter than NISAR (σ = 5.84 km). The Bayesian posterior, the precision-weighted mean, lands at 4.69 km, pulling toward CYGNSS's better estimate while incorporating NISAR's independent geometric constraint. **FIGURE 5** shows the fusion: two comparable Gaussians whose product is tighter than either alone.

The fused result (4.69 km error, 7.85 km CEP) is not quite as accurate as CYGNSS alone (4.33 km), because NISAR's 6.26 km estimate pulls it slightly away from truth. But operationally, the fusion provides a cross-validated answer: two independent physics arriving at similar locations builds confidence that neither sensor is producing an artifact.

The key insight is that the bootstrap CEP unlocked meaningful fusion. When the raw scatter CEP (127 km) was used, NISAR dominated the posterior 343:1 and fusion added nothing. With the fit-based CEP (3.48 km), both sensors contribute, and the posterior reflects genuine multi-modal evidence.

Operational Implications

For CYGNSS: CYGNSS excels at both detection and localization. Its 785 detections across a 200 km radius, with zero false positives on baseline dates, provide unambiguous jammer detection. The $1/r^2$ fit achieves 4.33 km accuracy with a bootstrap-verified 3.48 km CEP, meaning an analyst can trust the result to single-digit kilometer precision without ground truth. CYGNSS's eight-satellite constellation also provides sub-daily revisit, enabling near-real-time monitoring.

For NISAR: NISAR provides independent geometric confirmation. With just two passes over an active jammer, the bearing intersection achieved 6.26 km accuracy with a 6.88 km CEP. The 6.26 km result is constrained by orbit geometry, not by detection sensitivity. Our two ascending passes from Track 157 produced nearly parallel range arcs with only 8.1° of bearing separation. Adding a single descending pass would provide a crossing angle of 60° to 70° and could reduce localization error to sub-2 km — transforming NISAR from a confirming sensor into a precision localization tool in its own right. The limitation in this study was data availability: The NISAR beta archive contained only ascending Track 157 passes over the jammer site. NISAR's 12-day repeat cycle and fixed ground track also mean the jammer must be active when the satellite passes overhead. NISAR's current value is as a confirming sensor — when both modalities converge on the same location, confidence increases beyond what either achieves alone.

For Fusion: With comparable CEPs (3.48 km vs 6.88 km), fusion now produces genuinely blended estimates. The Bayesian posterior at 4.69 km reflects real multi-sensor information. Future improvements, such as more NISAR passes with diverse bearings, or CYGNSS multi-week accumulation, would tighten both estimates further.

For the Adversary: These results demonstrate that GPS jammers operating in contested airspace are observable and localizable from orbit using openly available civilian satellite data. The 4.33 km CYGNSS result is approximately 2× better than the published state of the art for GNSS-R jammer localization (~9 km grid resolution, Chew et al., 2023), and the NISAR bearing intersection approach has not been previously demonstrated for jammer geolocation.

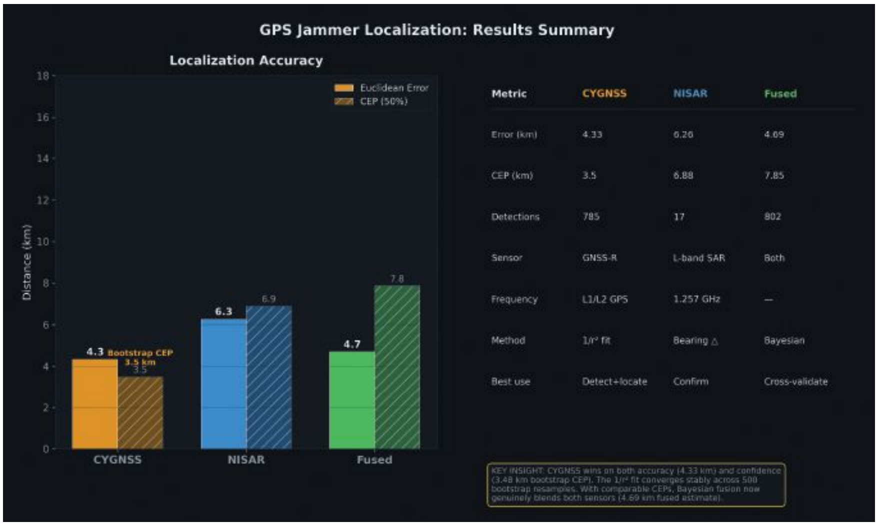

FIGURE 5 Summary statistics for jammer localization with CYGNSS, NISAR and fused approach.

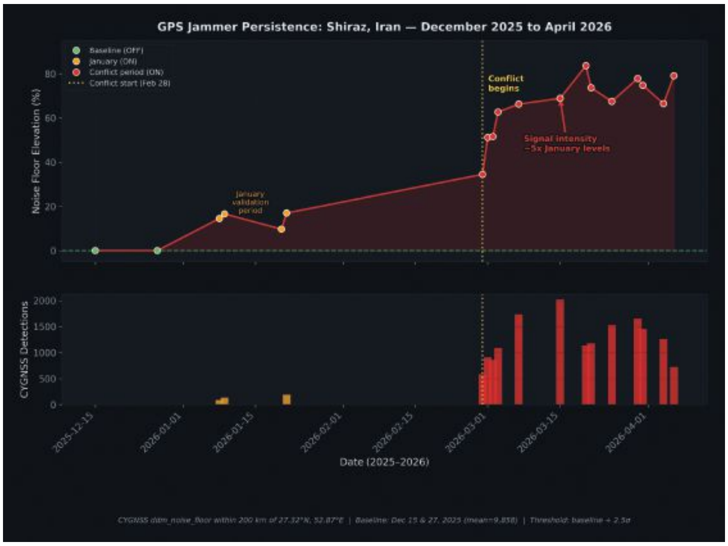

FIGURE 6 A timeline of jammer activity for Shiraz, Iran, from December 2025 to April 2026.

Still Broadcasting: Jammer Persistence Through Conflict

The validation analysis used January 2026 data. But on Feb. 28, armed conflict erupted in the region. Did the jammer survive?

We ran the CYGNSS noise floor detection pipeline for each day from Feb. 28 through April 6, comparing against the December 2025 baseline. The answer is unambiguous: The jammer is not only still active — it is operating at dramatically higher power.

In January, the jammer elevated the CYGNSS noise floor by approximately 15% above baseline. By early March, days after the conflict began, noise elevation had jumped to 50% to 60%. By mid-March, it reached 70% to 84%, where it remained through early April. Detection counts tell the same story: 89 to 192 per day in January, rising to 1,000 to 2,000 per day during the conflict (**FIGURE 6**).

The escalation was immediate. On Feb. 28, noise elevation was +34.5%, already double the January level. By March 3, it had reached +62.7%, and by April 6, it peaked at +79.1%. The signal has remained at 5× the January intensity through the most recent available data (April 6, 2026).

Several interpretations are consistent with this pattern:

- **Power increase:** The operator increased jammer output power, perhaps in response to the conflict or as a defensive posture against GPS-guided munitions.
- **Additional jammers:** Multiple units may have been co-located or deployed nearby, creating an aggregate signature larger than any single device.
- **Duty cycle change:** The jammer may have shifted from intermittent to continuous operation.

What is clear is that the jammer we localized in January was not incapacitated by the conflict. It was amplified. CYGNSS's sub-daily revisit capability makes this kind of persistent monitoring possible using entirely passive, civilian satellite data — no tasking, no cooperation with the target state, and no risk to reconnaissance assets.

Context and Prior Work

CYGNSS-based RFI detection builds on work by Chew et al., 2023, who demonstrated grid-level jammer detection at approximately 9 km resolution using DDM noise floor anomalies. Our $1/r^2$ parametric fit extends this from detection to localization, achieving sub-5 km accuracy by exploiting the physics of signal power decay.

At the other end of the precision spectrum, Murrian et al., 2021, demonstrated ~220 m jammer localization using ISS-mounted Doppler measurements of raw intermediate-frequency (IF) data. This approach achieves an order of magnitude better precision than our methods but requires specialized hardware and raw signal access not available on current operational satellites.

The NISAR bearing intersection approach demonstrated here is, to our knowledge, the first published use of L-band SAR RFI streaks for jammer triangulation. The key insight is that NISAR's proximity to GPS L2 (just 30 MHz separation) makes it an unintentional but effective GPS interference sensor.

Summary

Two satellites, two physics, one jammer. CYGNSS sees the interference footprint across hundreds of kilometers and localizes the source through inverse-distance physics. NISAR sees the emissions directly in its SAR receiver and triangulates through bearing intersection. Both achieve sub-7 km accuracy independently; together, they cross-validate and build the confidence that operational use demands.

The jammer near Shiraz is still there — louder than ever. The satellites are still watching.

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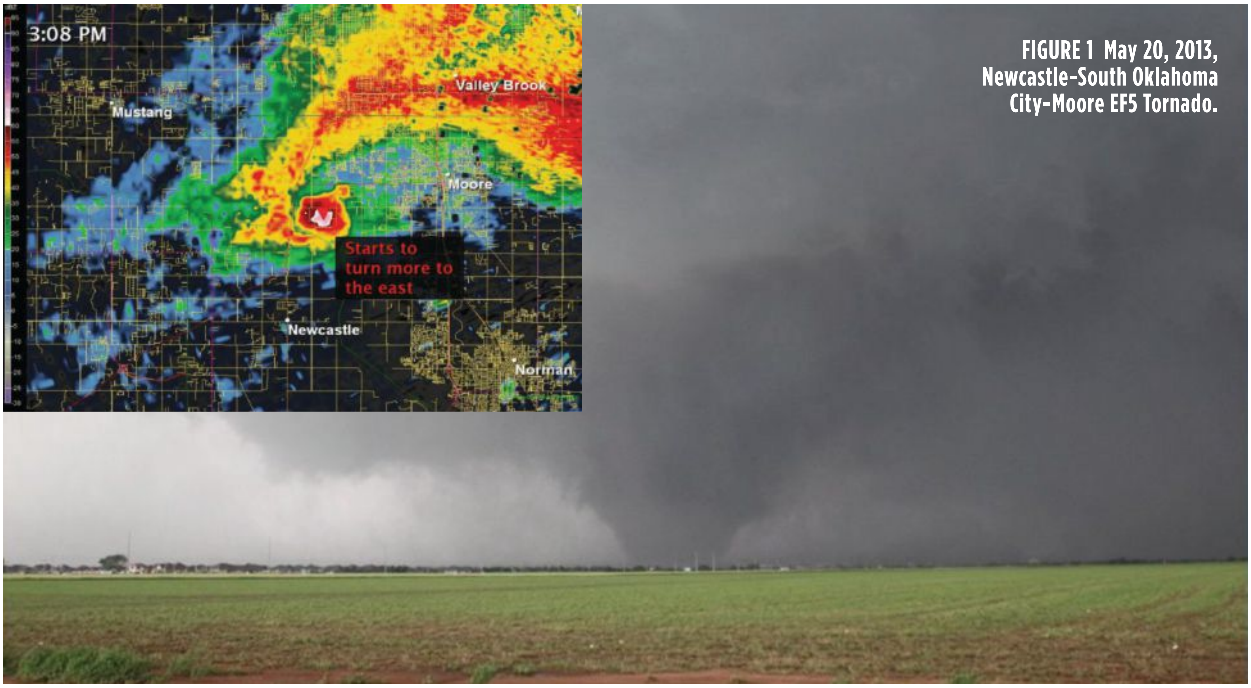


FIGURE 1 May 20, 2013, Newcastle-South Oklahoma City-Moore EF5 Tornado.

Gabe Garfield, weather.gov

Tracking the Whirlwind

BY WILLIAM H. TEWELOW, GISP

3:13 a.m. Pulsing alarms. NOAA weather alert: TORNADO WARNING! TAKE IMMEDIATE SHELTER!

Without hesitation, the family awakened from their sleep, grabbed wallets, smartphones, car keys and hurriedly descended the stairs into the shelter. Doors sealed, the children crawled into their shelter beds. The mother and father, listening to the weather radio, heard their county's name in the emergency broadcast. They looked at the smartphone's weather map blinking with the text alert. A large swath of rain covered the area, painting yellows and reds inside a field of green. At the trailing edge of the storm, where skies were beginning to clear, the storm's red tail began curling into a ball, moving directly toward them. Inside the ball, a dark red deepened into a growing magenta core. White pixels appeared within the magenta tail. Its path was unchanged and it was closing.

The man and woman huddled together watching the storm radar app on his mobile device not thinking about how their situational awareness is a confluence of spatial wizardry and atmospheric thermodynamics. The WSR-88D NEXRAD (Level III) radar scans a 143-mile radius, sweeping 14 elevation angles every five minutes to create a composite view of the surrounding weather. Colors correspond to the intensity of reflected hydrometeors (forms of precipitation) ranging from 0 dBZ, light rain in blue and green, to 75 dBZ, hail in magenta, and at 95 dBZ, it is physical debris carried aloft showing as white. Assembling the radars from across the country creates a seamless national weather mosaic (**weather.gov/Radar**). The dot on the smartphone's weather app marking their own position is GNSS, orbiting far above. In his hand both the NEXRAD and GNSS are blended in real-time as he watches the Tornado Vortex Signature (TVS) move toward his family and his house. Beyond the closed shelter doors, tornado sirens wail, mixed with peals of thunder. The warnings are no longer county names but names of towns. There are people for whom such a moment is not hypothetical. Scott Bagenzie knows exactly what comes next, not from imagination but from experience. On Monday, May 20, 2013, at 2:56 p.m. Central Time, an EF5 tornado touched down northwest of Newcastle, Oklahoma, rapidly intensifying as it carved a path to Moore. The tornado lasted 36 minutes and covered 17 miles (**FIGURE 1**). Scott was caught by it, and I had the privilege of hearing him tell me what it is actually like to be inside those moments of sheer terror the rest of us only read about. He left work at 2:15 p.m. despite National Weather Service warnings for the counties flanking Oklahoma City. As he closed his car door, the sirens at the Mike Monroney Aeronautical Center went off. Security tried stopping him. He drove anyway.

*"I was dodging cars left and right as people were taking pictures out to the southwest. I called Mari and said, hey, I'm running to the house to make sure the pets are taken care of. And she said, You crazy ***, take care of yourself."*

He pulled into his driveway, secured two cats in the closet and the dogs in the front bathroom, then stepped outside to see where the tornado was. His neighbor, who had an underground shelter in his garage, called out from next door: Get in over here! Scott went. As soon as the latch clicked behind them, debris began hitting the house above.

Weather as GIS

Weather is the most common topic of greetings. It is often the front page on newspapers. Television news is incomplete without a weather report, and weather is among the most downloaded apps on smartphones. In many ways, the first GIS was weather, starting in the mid-1800s, long before computers, GNSS and GPS, hand-plotting data points, and then hand-drawing lines of equal pressure, temperature, humidity and winds on charts.

In the 1990s as a U.S. Navy weather specialist, I drew these charts by hand, plus four upper air charts learning how 3D spatial volumes interact. That was manual GIS. Now, in 2026, weather continues leading geospatial innovation via phased array radars, dual-pole radars (horizontal and vertical scans), acoustic atmospheric sensors, and predictive modeling for weather and climate, all of them layering atmospheric data using complex algorithms to forecast a dynamic fluid medium moving over an irregular spinning sphere that is unevenly heated. It is remarkably accurate, pushing the edges of geospatial predictive modeling.

> Live tracking tornadoes with GIS census tracts can know in real-time the impact on populations to immediately begin rescue operations, clean-up and recovery.

The Architecture of Violence

The primary driver of powerful tornadoes is atmospheric thermodynamics unique to North America. Dry air crossing over the Rockies, cold arctic air pulled south by the jet stream, and warm moist air drawn north from the Gulf of America converge in a cauldron that can boil a normal convective storm into a sustained mesoscale supercell producing EF-5 tornadoes, the most powerful on record. Even though they make up less than one percent of all tornadoes, it is rare for EF5 tornados to occur anywhere else on Earth.

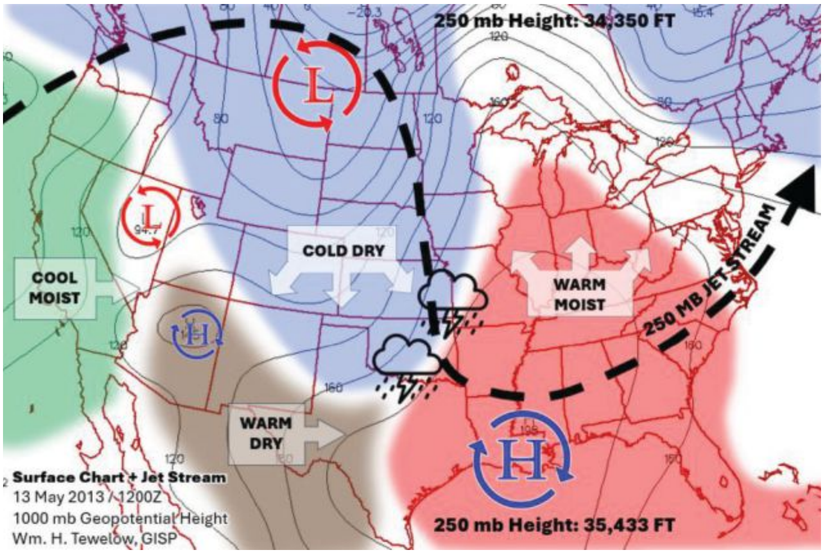
The Enhanced Fujita (EF) scale for measuring them was developed in 1971 by Theodore Fujita, a Japanese engineer whose forensic study of atomic bomb blast damage at Nagasaki and Hiroshima led to his damage-based framework for measuring tornado intensity.

The jet stream, a river of air riding a thermal pressure gradient in the upper atmosphere, creates vorticity as cold dense arctic air plummets south, wedging beneath the warmer Gulf air and forcing it upward along the frontal boundary, before the jet stream curves back north. **FIGURE 2**, the 300 mb (mb stands for millibars of pressure) chart, shows this process has caused a low pressure over Texas sitting in a 1,200-foot-deep ravine. A jet streak will form as air rushes into the ravine increasing the jet stream's speed, which draws in rising convection currents that can spawn mesoscale storm cells and set up the potential genesis of severe tornadoes.

When a funnel cloud forms, it is the visible physics of pressure dropping the temperature to the dew point causing condensation. The dropping pressure forms a bowl shape. Air flows into the dropping pressure, and the base of the cloud rotates cyclonically. As the rotation increases, centrifugal force of the colder dense rotating air pushes out the warmer higher-pressure air, further lowering the pressure at the core and deepening the bowl. That continues as the base descends into higher pressures at the surface, tightening the bowl into a cone. The difference in pressure between air outside the cone and what's inside the vortex core can be 100 mb. That is basically a hole and wind rushes in to fill that void, but centrifugal force acts against the air. A tornado is born.

Wraiths of Destruction

On May 31, 2013, 11 days after Moore, a multiple-vortex tornado



William Tewelow | Chart from NOAA NWS

FIGURE 2 **This NOAA chart shows a height of 250 millibars (mb) of pressure over Tornado Alley in the U.S.**

formed near El Reno, Oklahoma. Along its periphery, small vortices spun around the rotating edge, circling, combining, breaking apart, vanishing and reforming, like wraiths of destruction dancing in a ring. The column darkened, descended and enveloped its own micro-vortices, forming the largest tornado ever recorded: 2.6 miles wide at its base.

It grew so rapidly that experienced TWISTEX storm chasers attempting to place instrument disks behind it were consumed as it expanded from 1.6 miles to 2.6 miles wide. A father, his son, and a colleague were killed; their car was found eight miles away. Storm chasers are not thrill-seekers. WSR-88D NEXRAD, even at its lowest scan angle, already sits at 14,000 ft at its range limit because of the Earth's curvature; spotters provide the ground truth radar cannot. Instruments such as Ground-based Local Infrasound Data Acquisition (GLINDA) extend that capability further: Tornadoes produce infrasound as low as 0.5 Hz, with a correlation between tornado size and frequency that may one day provide an early warning radar cannot.

I asked Scott whether he felt the tornado before he heard it. *"I couldn't feel it,"* he said, *"but I could hear the sound of the train coming."* I pressed him to describe it beyond the cliché. He thought for a moment, then said, *"It's not a cliché. That is what it sounds like. It sounds like a freight train, and the sound of the house being torn apart."*

The Roar Grows

Back in the shelter, the physics unfolded exactly as Scott described. Unaware of the sensation, a deep groaning sound resonates miles ahead of the tornado. A low constant roar grows louder as it approaches. Explosions pop as transformers blow. The shelter is pitch black except for the phone screen, that small glowing window showing a white ball of catastrophe moving toward them. The roar grows louder. Ears pop. Temperature drops. The house shakes. The roar of the freight train is so loud the screams inside the shelter cannot be heard. The doors rattle. The whirlwind is trying to break in. Then the roar fades, almost to silence, an eerie quiet.

In Scott's shelter, the sequence was identical. His ears popped suddenly and painfully; they hurt for a full day afterward. In an EF5 tornado, pressure drops from roughly 950 mb in the surrounding air to 850 mb at the vortex core. The 100 mb passing over him was equal to a 3,000-ft pressure drop. It is the equivalent of instantly ascending two Empire State buildings stacked on top of each other, like falling straight up into the sky. Fighting against that force, Scott and his neighbor held shut the shelter latch as the doors bounced on their hinges.

"I don't know how well those are constructed. I didn't take any chances."

Nearby, employees sheltering in a bank vault were physically holding the vault door closed as the tornado passed a thousand feet away. The vault's timed lock could not engage. Five or six people leaned against a door designed to stop a robbery, fighting powerful thermodynamic forces.

Then Scott no longer had to hold the latch. The truck on the other side of the garage wall had been pushed against the hatch from outside, pinning them in. When they finally forced it open and stepped out. There was nothing.

"She just started screaming. She said, 'No way, it didn't do that.' I told her, yeah, there's nothing left."

The entire event, from first debris strike to silence, lasted roughly one minute. At 28 miles per hour, a tornado traverses one mile in two minutes, plowing through a neighborhood in seconds.

Mapping the Aftermath

The question the rest of us ask from a safer distance is: What is the true pattern of destruction across time and geography? To answer it, I built a Tornado Severity Index (TSI) using National Weather Service tornado data. On average, there are 970 tornadoes per year, 81% are EF0 and EF1; 18% are EF2 and EF3; and the catastrophic EF4 and EF5 make up 1%.

The NWS database reports the start and end coordinates, path width, magnitude, fatalities, injuries, and damages to property and crops. Working with the coordinate pairs, I calculated the distance and radial bearing of each path. But the EF scale alone tells only part of the story: A powerful tornado crossing an empty field and a moderate tornado crossing a dense neighborhood are not equivalent human events.

I did not want the TSI to be another version of the EF scale, so the weighting was based entirely on the human toll. The formula is total fatalities (F) at 100% plus injuries (I) at 10%, =F + (I x 0.1) and normalized on a scale of 1 to 100. Economic damage was originally part of the equation, but the data are inconsistent and unreliable across reporting jurisdictions. The resulting composite doesn't measure the strength of tornadoes, but rather their human impact (see **FIGURE 3**). The dataset of tornadoes from 1950 to 2024 is 71,813. Filtering it down to those tornadoes that had a human consequence where the TSI>1 reduced it to 2,362 tornadoes. I reduced it further to 1,625 including only those with one or more fatalities. This was made into a heatmap. The data were further reduced to 301, only filtering out all except where TSI>10. The heatmap color scale was weighted to the TSI Score. It shows where the highest concentration of intense tornadoes occurs.

The results confirm Tornado Alley from Texas up through Oklahoma, and it also reveals Dixie Alley, an even more destructive corridor of severe tornadoes over Mississippi, Alabama and Tennessee. These areas align with the deep spring meridional jet stream discussed earlier. The northern side of the jet stream enhances cyclonic flow for storms in the area. The peak region of vorticity is where the jet stream turns back north again over Dixie Alley. Additionally, the rising terrain in that area causes orographic lifting and more rain, many times hiding the tornadoes within the pouring rain.

GIS reveals what the physics predict: a narrow corridor of atmospheric geometry where conditions for catastrophic tornadoes are optimized, running through the same communities, year after year.

For the sake of context, the Joplin, Missouri tornado on May 22, 2011, that caused 158 fatalities, 1,150 in-

William Tewelow

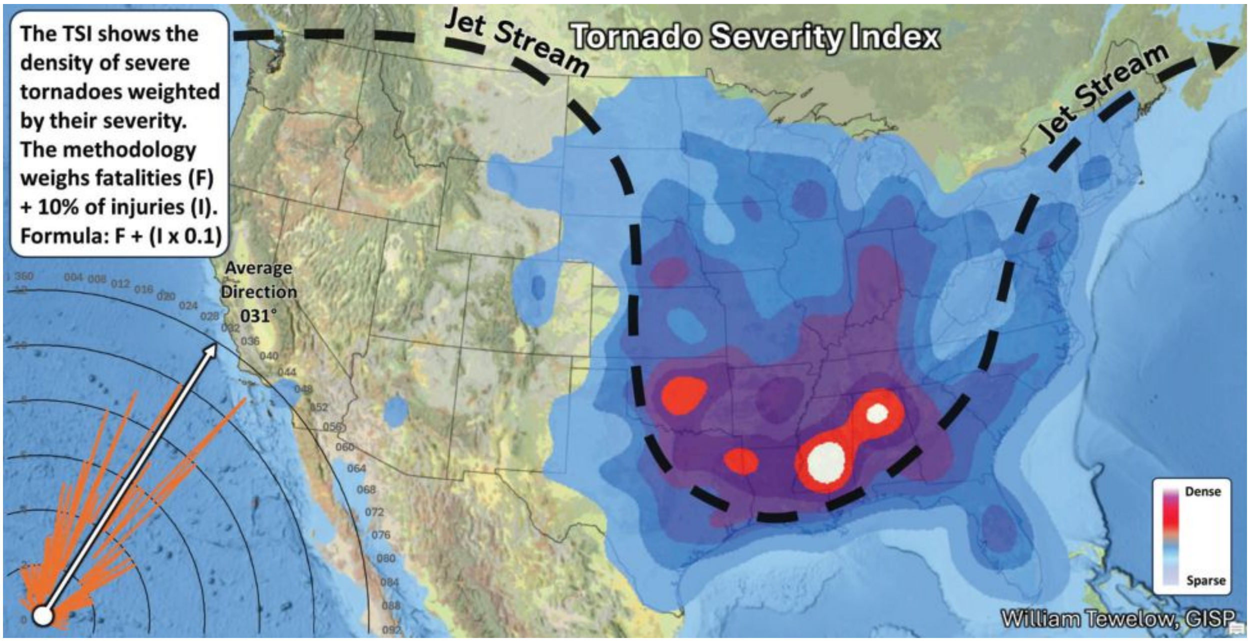


FIGURE 3 The Tornado Severity Index (TSI) takes the human cost into account.

juries, and damages of $2.8 billion ranks at the top of the TSI. The Moore tornado only scored 16.6 due to far fewer fatalities.

The dataset reveals the physical signatures of severe tornadoes. On average, they peak in mid-May at 5:30 p.m. with a strength of EF4.2, carve a path 36 miles long and 2,073 feet wide, and each one causes 13 fatalities, 173 injuries, and losses of $71.5 million. Severe tornadoes do not travel west. They do travel a spectrum where most of them fall within a range from 016° to 060° with an average path of travel northeast at 031°. This is why Scott was right to question the reports of the El Reno tornado tracking southeast: What appeared to be southward motion was lateral growth. The tornado was not moving south; it was becoming enormous. *"Pretty much sucking everything up,"* Scott said, with confidence born out of his experience.

The Pattern and the Person

The TSI heatmap is a record of moments like Scott's, representing a convergence of humans caught up in brutal atmospheric physics, where air becomes violent. The science explains the experience. It cannot prevent the next EF5; the thermodynamics will prevail.

What GIS adds is pattern, memory and prediction. The TSI with directional analysis gives emergency managers, planners and underwriters insights for understanding where storm physics and humans intersect most acutely, and therefore where shelter codes and warning systems must be most robust.

The family in their shelter, watching the white dot approach on the glowing screen, is experiencing the culmination of decades of geospatial and meteorological investment: NEXRAD networks, GNSS constellations, real-time data fusion in a consumer app. But as Scott will tell you, the most important instrument was the steel latch on the shelter door, and what mattered most was the neighbor who held it open for him as the tornado approached.

Tornadoes are Earth's thermodynamic engines of absolute chaos. *"I'm not interested in tornadoes,"* Scott told me. *"Once burnt, you don't play with the matches anymore."* Scott moved out of Oklahoma in 2013. The science is fascinating. People press right up to the edge of it, but the experience when science becomes personal is sheer terror.

Live tracking tornadoes with GIS census tracts can know in real-time the impact on populations to immediately begin rescue operations, clean-up and recovery.

GIS cannot capture the whirlwind, but it can track the most violent of them: northeast at 031°, seven football fields wide for 36 miles.

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GPS Networking

Images: GPS Networking

Mil-spec splitters

GPS Networking designs and manufactures GPS/GNSS signal distribution and re-radiation equipment out of Pueblo, Colorado. We've been at it since 1991, and we're one of a handful of companies worldwide focused exclusively on getting GPS signals where they need to go.

Our core product lines are GPS splitters and GPS re-radiating kits. These devices support all major GNSS constellations and frequencies, including L1, L2 and L5 Our splitters take a GPS source signal and distribute it to multiple receivers, with amplification to maintain signal integrity across every port. Our re-radiating kits solve a harder problem: bringing live GPS coverage into areas where signals can't reach, such as aircraft hangars, underground facilities and shielded server rooms.

Our products are built to mil-spec standards, and we hold an AS9100 certification. Most of our products ship within one to three days. We serve customers in aviation, military and defense, telecommunications, datacenter timing, precision surveying, and anyone else who needs a GPS signal.

Where we really earn our keep is in customer service. We design custom signal distribution systems for complex installations and provide direct engineering support to customers worldwide. Multipath interference, signal attenuation and feeding dozens of receivers from one antenna. Give us a call.

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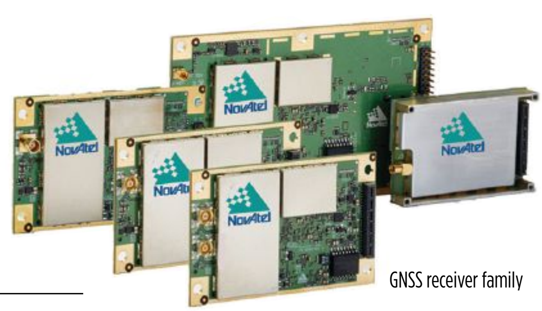
Hexagon | NovAtel

Hexagon | NovAtel focuses on providing assured positioning and autonomy solutions across land, sea, and air applications with high-precision positioning technology, correction services, sensor fusion, and post-processing solutions to help customers overcome positioning and navigation challenges.

Images: NovAtel



GNSS receiver family

At the heart of NovAtel's innovations are its global navigation satellite systems (GNSS) technologies. These include high-precision receivers, antennas, inertial navigation systems (INS), and global and regional correction services. We also specialise in anti-jamming and anti-spoofing technologies, as well as software for receiver management and post-processing.

HIGH-PRECISION GNSS RECEIVERS AND ANTENNAS

NovAtel's OEM7 receiver family is designed to deliver reliable and precise GNSS-based positioning. The receivers work seamlessly with antennas, INS, and correction services to ensure high-precision results for diverse applications.

NovAtel receivers are built for resilience, incorporating solutions like SPAN GNSS+INS technology for continuous 3D positioning, velocity, and attitude data, and the GNSS Resilience and Integrity Technology (GRIT) firmware suite to defend against interference, jamming, and spoofing using advanced algorithms.

Choosing the right antenna is crucial for optimising system performance. NovAtel's GNSS antenna range includes compact, lightweight options for aviation and robust models for agriculture and machine control.

GLOBAL AND REGIONAL CORRECTION SERVICES

NovAtel's global TerraStar precise point positioning (PPP) services are supported by over 100 GNSS reference stations worldwide, ensuring top-quality global corrections. Additionally, the regional Hexagon SmartNet network RTK services provide unparalleled coverage. SmartNet+ includes RTK ASSIST, which maintains operations for up to 20 minutes during cellular outages. SmartNet PRO upgrades to RTK ASSIST PRO for unlimited outage protection, and PPP when outside network RTK coverage.


CPT7 GNSS+INS enclosure

ANTI-JAMMING AND ANTI-SPOOFING TECHNOLOGY

NovAtel's anti-jamming and anti-spoofing technologies ensure continuous positioning by detecting and characterising interference and spoofing threats. The GNSS Anti-Jam Technology (GAJT) portfolio offers protection for platforms operating in contested environments, from drones to tanks.

RECEIVER MANAGEMENT AND POST-PROCESSING SOFTWARE

For receiver management, the NovAtel Application Suite offers a comprehensive tool for monitoring receiver status, GNSS satellite tracking, positioning, inertial outputs and interference detection.


GAJT family

NovAtel's Waypoint software is a trusted post-processing tool, leveraging GNSS, INS, and corrections to deliver accurate post-mission trajectories and mapping.

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LabSat

Test Anywhere with LabSat

LabSat GNSS simulators deliver multi-constellation, multi-frequency testing that is reliable, repeatable, and consistent. With a one-touch Record & Replay feature, LabSat offers an efficient, cost-effective solution for GNSS receiver testing and development.

LabSat 4 — Advanced Testing with Precise Customization

LabSat 4 features three individually configurable RF channels with selectable quantization up to 12-bit I&Q and bandwidth up to 60 MHz, giving engineers precise control over recordings and file sizes.

Additional capabilities include external data integration via CAN, CAN-FD, and RS232; digital event capture; saveable custom record settings; and multi-system synchronization for dual-antenna testing. A user-friendly web-based interface simplifies configuration and operation.

SatGen Simulation Software

SatGen GNSS Simulation Software gives LabSat users the freedom to build fully custom scenarios, defining position, route, speed, date, and time to simulate virtually any location in the world.

Supporting all signals across the upper and lower L-band, SatGen generates GNSS RF I&Q or IF scenario files that transfer seamlessly to LabSat for replay.

Route creation is straightforward, with tools for road, pedestrian, and rail navigation using Google Maps, Bing Maps, or OpenStreetMap. The intuitive interface makes it easy to create scenarios, view almanac data, and edit visible satellites. Scenarios can also be queued and run consecutively, streamlining the test workflow.

Real-Time Testing with LabSat 4 and SatGen

When timing is critical, LabSat 4 paired with SatGen delivers real-time GNSS signals stamped with the current UTC time. In four straightforward steps, engineers can generate and stream live scenarios for precise validation of time-dependent systems using a familiar, reliable test setup.

Images: LabSat

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Safran Electronics & Defense

At the intersection of critical infrastructure and national defense, Safran Electronics & Defense solutions govern and protect time and location integrity of systems that shape the world. With more than 40 years of experience and a growing portfolio of innovative positioning, navigation and timing (PNT) solutions, Safran's customer-first culture pushes the boundaries of quality, performance and service. When accuracy, precision and security are non-negotiable, Safran is the partner industry leaders and governments trust to deliver.

Images: Safran Electronics and Defense

MIRA™ Micro Rubidium Atomic Clock

MIRA™ is a compact, low-power rubidium atomic clock from Safran Electronics & Defense, delivering high-precision timing for defense, aerospace, telecom, and industrial uses. It combines strong accuracy, resilience, and reliable performance in harsh or GNSS-denied environments, making it well suited for critical systems like telecom networks, radar, navigation, and UAVs.

GEONYX - Inertial Navigation System

Geonyx is designed for the most demanding artillery systems, such as howitzers (towed, tracked, truck-mounted), multiple rocket launchers, mortars, and light guns.

SecureSync - Timing Synchronization Platform

SecureSync harnesses Safran's leading PNT technology into one flexible, modular platform designed to synchronize critical defense and commercial infrastructure that requires extreme reliability and security.

WR-Z16 - Sub-nanosecond Timing

WR-Z16 is a reliable and precise time fan-out solution implementing the White Rabbit protocol (basis for the new IEEE-1588-2019 high-accuracy default profile) on 1G Ethernet-based networks. Picosecond-level frequency distribution is available through a fully digital clock.

8230AJ – Anti-Jam Antenna

The 8230AJ is a mountable and weather-proof anti-Jamming antenna that rejects signals for the lower elevation angles where most of the interference comes from.

ICONYX™ IMU

Designed for precision and reliability, ICONYX™ integrates three Safran's HRG Crystal™ gyroscopes and three closed-loop MEMS accelerometers, delivering exceptional accuracy with best in class SWaP for demanding missions requiring proven, combat-tested technology.

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Septentrio, part of Hexagon

Septentrio, part of Hexagon, designs and manufactures resilient, high-precision positioning technology for demanding applications, with a strong focus on robustness, multi-frequency signal processing and multi-constellation support. At the core of its receivers is the latest GNSS technology delivering reliable centimeter-level positioning and time. Septentrio receivers are known for their outstanding performance, high level of security and resilience in challenging environments. That is why its products serve in various demanding applications including UAV, robotics, construction and mining, survey and mapping, maritime, logistics and and mission-critical applications and are part of critical infrastructure worldwide.

Images: Septentrio, part of Hexagon

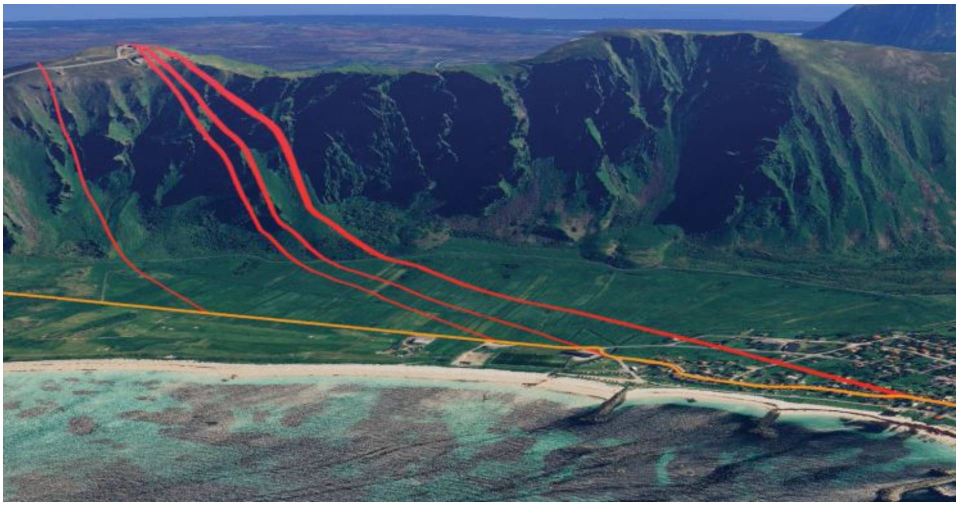


Figure: Car test shows that the Septentrio receiver (orange) is resilient to GNSS spoofing of type meaconing, while competitor receivers are spoofed to the top of the hill."

ASSURED PNT FOR DEFENSE, SECURITY, AND CRITICAL APPLICATIONS

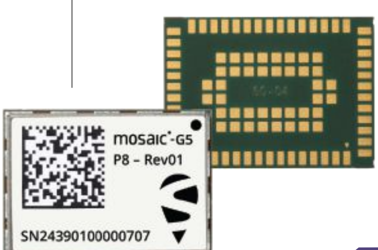
AIM+ anti-jamming and anti-spoofing technology ensures positioning resilience even in Navigational Warfare (NAVWAR) environments where GNSS signals are limited or degraded.

Septentrio offers Blue UAS Framework-listed options for programs that require NDAA-compliant, DoD-cleared components; procurement guidance is available via the Blue List portal.

All our GNSS and GPS receivers are developed under Septentrio's ISO 9001:2015 certified quality system.

MOSAIC MODULES

Septentrio's mosaic-X5 and mosaic-G5 modules are compact multi-band, multi-constellation GNSS receivers in low-power surface-mount modules with a wide array of interfaces, designed for industrial mass market applications. They are capable of tracking all GNSS constellations and support current and future signals.



AsteRx RB3 and RBi3 Pro/ Pro+ GNSS Receivers offer, reliable centimeter-level positioning, with the RBi3 models also providing precise orientation. Designed for harsh environments, they withstand extreme temperatures, corrosion, shock, and vibration without compromising performance.

The rugged IP69K receivers are designed for the harshest environments, offering high-accuracy all-in-view positioning. Other features include: inertial sensor providing heading, pitch and roll angles with dual antenna, GNSS+ algorithms for reliable performance and tracking despite heavy vibrations and in GNSS challenging environments, flexibility to be used either as a rover or a base station (Pro+ models only) and an update rate of up to 100 Hz.

More information can be found on our website.

HEXAGON | septentrio

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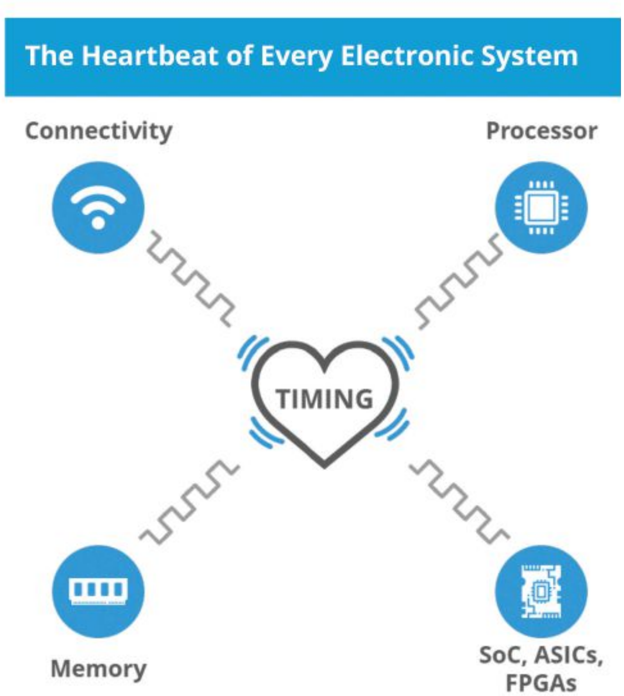
SiTime

SiTime is the Precision Timing company. Our semiconductor MEMS programmable solutions offer a rich feature set that enables customers to differentiate their products with higher performance, smaller size, lower power, and better reliability. With more than 4 billion devices shipped, SiTime is changing the timing industry.

About Precision Timing – Timing is the heartbeat of all electronics, ensuring performance, resilience and scalability. For decades, quartz devices, non-silicon technology, have kept systems in sync, but they struggle in harsher, more demanding environments. MEMS-based Precision Timing delivers greater accuracy, smaller size and resilience. Today, MEMS timing powers over 400 applications, including high-growth ones in AI datacenters, automated driving, industrial and humanoid robots, wearables and IoT.

PNT performance breaks first at the edges of the operating envelope, not in nominal lab conditions. When GNSS degrades or disappears, your system depends on local timing to hold frequency and phase through vibration, maneuvering, thermal transitions, and shock, while still meeting size, weight and power (SWaP) limits.



Images: SiTime

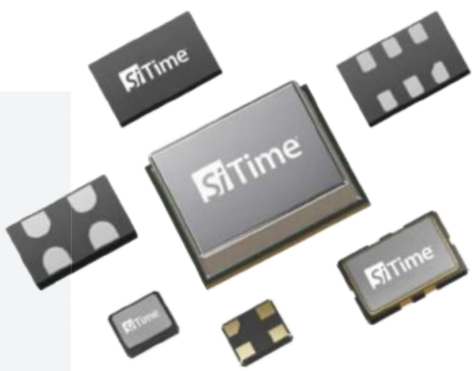
SiTime builds timing for these environments using silicon MEMS devices manufactured in standard semiconductor foundries. The result is timing performance that remains stable under vibration, temperature extremes, and platform stress, with reliability and long-term availability suited to industrial and defense programs.

High Performance

Environmental / Heat Resilience

MEMS, Analog, and Systems Innovation

Programmability, Optimized Manufacturing



SiTime Precision Timing Portfolio

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UHU Technologies

Images: UHU Technologies

The Northstar GPS Health Monitor

The UHU1000

UHU Technologies is a privately owned engineering research and development company that designs products to detect and mitigate GPS spoofing and jamming. Our company has strong roots in Signals Intelligence (SIGINT) and radio location, with years of experience producing high-performance hardware. We are applying our expertise to the protection of GPS receivers for critical infrastructure and Naval Information Warfare Systems Command (NAVWAR) applications using techniques borrowed from the SIGINT world.

Our patented techniques assure the integrity of GPS through spatial processing; for each signal we receive, we compute the angle of arrival and compare it to the known satellite location for that signal. Angle of arrival is the only signal feature that cannot be spoofed. Through additional signal processing, we spatially null (subtract) any spoofers or jammers and mitigate the threat.

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465 St Jean St
Ste 702
Montréal QC H2Y 2R6
Canada
514-394-7851
information@silicomlabs.com
silicom.fr/en

Silicon Sensing Systems
Clittaford Rd
Southway
Plymouth PL66DE
United Kingdom
44-0-1752-723330
sales@siliconsensing.com
siliconsensing.com

Branch Location:

1-10 Fuso-cho
Amagasaki Hyogo 660-0891
Japan
sssj@spp.co.jp
siliconsensing.com

SingularXYZ Intelligent Technology
Gaojing Rd No 599
Bldg A
Shanghai 201702
China
86-21-6083-5489
singularxyz@singularxyz.com
singularxyz.com

SkyTraq Technology
4F No 26 Minsiang St
Hsinchu City TW 300
Taiwan
886-3-567-8650
info@skytraq.com.tw
skytraq.com.tw

Skyworks Solutions
20 Sylvan Rd
Woburn MA 01801
781-376-3000
sales@skyworksinc.com
skyworksinc.com

SoftNav Systems
PO Box 5001
St. Raymond QC G3L 4R8
Canada
418-622-3477
info@softnav.com
softnav.com

Sokkia Corp
16900 W 118th Ter
Olathe KS 66061
800-4-SOKKIA
sales@sokkia.com
sokkia.com

Space Foundation
4425 Arrowswest Dr
Colorado Springs CO 80907
719-576-8000, 800-691-4000
nreed@spacefoundation.org
spacefoundation.org

Branch Location:

1700 N Moore St
Ste 1105
Arlington VA 22209
202-618-3060, 800-691-4000
spacefoundation.org

Sparton
425 N Martingale Rd
Ste 2050
Schaumburg IL 60173
800-SPARTON
info@sparton.com
sparton.com

Spectra Geospatial
10368 Westmoor Dr
Westminster CO 80021
888-477-7516
sales@spectrageospatial.com
spectrageospatial.com

SpectraDynamics
1849 Cherry St
Unit 2
Louisville CO 80027
303-665-1852
sales@spectradynamics.com
spectradynamics.com

Spectratime
Austin TX
512-470-3980
sales@spectratime.com
spectratime.com

Spectrum Instruments
570 E Arrow Hwy
Ste D
San Dimas CA 91773
909-971-9710
sales@spectruminstruments.net
spectruminstruments.net

Spirent Communications
Aspen Way
Paignton Devon TQ4 7QR
United Kingdom
sales@spirent.com
spirent.com/pnt

Spirent Federal Systems, Now Part of Keysight
1402 W State Rd
Pleasant Grove UT 84062
801-785-1448
info@spirentfederal.com
spirentfederal.com

Stanford Research Systems
1290-D Reamwood Ave
Sunnyvale CA 94089
408-744-9040
davea@thinksrs.com
thinksrs.com

STMicroelectronics
30 Corporate Dr
Ste 300
Burlington MA 01803
888-787-3550
st.com

Branch Location:

19111 Victor Pkwy
Livonia MI 48152
734-953-1700
st.com

Surrey Satellite Technology
Tycho House 20 Stephenson Rd
Surrey Research Park
Guildford Surrey GU2 7YE
United Kingdom
44-14-8380-3803
info@sstl.co.uk
sstl.co.uk

Suzhou Foif Co
18 Tong Yuan Rd
Suzhou Jiangsu 215006
China
86-512-6523-4905
internationalsales@foif.com.cn
foif.com

Swift Navigation
201 Mission St
Ste 2400
San Francisco CA 94105
415-636-7490
sales@swiftnav.com
swiftnav.com

Branch Location:

168 Hoddle St
Melbourne 3067
Australia
415-636-7490

Syncworks
6 S Roscoe Blvd
Ponte Vedra Beach FL 32082
904-280-1234
vforgetta@syncworks.com
syncworks.com

Synergy Systems
9950 Scripps Lake Dr
PO Box 262250
Ste 106
San Diego CA 92131
858-566-0666
oeminfo@synergy-gps.com
synergy-gps.com

Syntony GNSS
5 Chemin De Chevrefeuille
Toulouse 31300
France
33-0-5-81-319-919
contact@syntony.fr
syntony-gnss.com

T

Taoglas
Unit 5 Kilcannon Business Centre
Old Dublin Rd
Enniscorthy Y21 XW56
Ireland
35-38-7056-6387
dconnolly@taoglas.com
taoglas.com

Branch Location:

8525 Camino Santa Fe
Ste A&B
San Diego CA 92121
858-450-0888
nasales@taoglas.com
taoglas.com

TDK Trusted Positioning
1000 Vetrans Place NW
Ste 405
Calgary AB T3B 2B9
Canada
403-992-8379
phil.gabriel@tdk.com
trustedpositioning.tdk.com

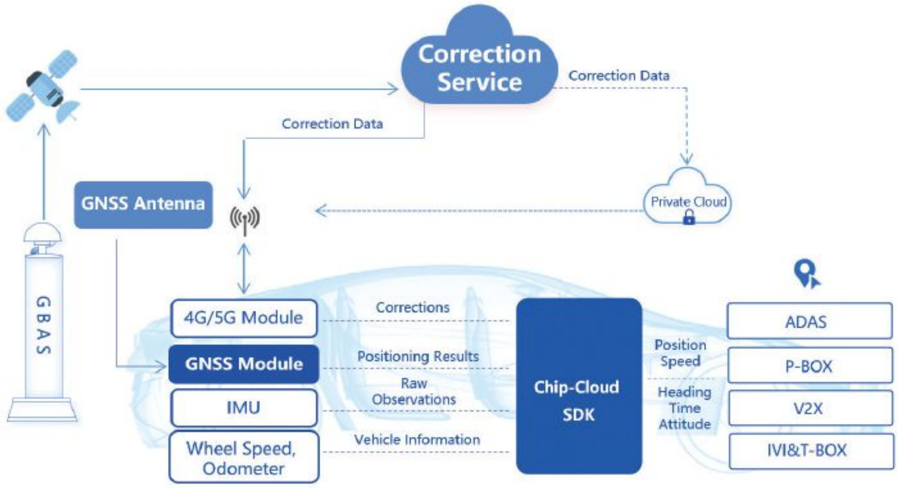
TeleOrbit GmbH
Sandrartstr 6
Nürnberg Bavaria 90419
Germany
49-911-300-339-80
sales@teleorbit.eu
teleorbit.eu

TeleType GPS
44 School St
Boston MA 02108
617-542-6220
contact@teletype.com
teletype.com

Telit
Cannon Place
78 Cannon St
London EC4N 6AF
United Kingdom
northamerica@telit.com
telit.com

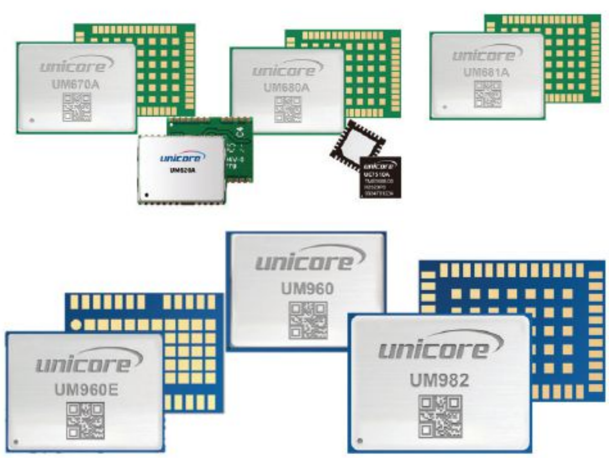
Images: Unicore

Unicore



Founded in early 2009, Unicore is a high-tech subsidiary of BDStar dedicated to the research and development of advanced satellite positioning core algorithms and highly integrated chips. Driven by independent innovation, the company offers a comprehensive portfolio of GNSS chips and modules, delivering positioning capabilities ranging from centimeter-level to meter-level accuracy to meet diverse industrial demands worldwide.

Unicore's business spans a wide range of applications, including intelligent driving, in-vehicle navigation, precision agriculture, drones, surveying and mapping, robotics, and other industrial sectors. Its product lineup features self-developed GNSS SoC chips, high-precision RTK modules, and integrated navigation modules.



In the automotive sector, over a decade of dedicated development has yielded significant results. Collaborating with global Tier 1 suppliers and OEMs, Unicore's automotive-grade solutions have been integrated into dozens of vehicle models from renowned brands, achieving mass production across multiple platforms.

Breakthroughs have also been made across various professional industrial fields. For instance, the UM960 series RTK modules, designed for robotic lawnmowers, surpassed 1.5 million units in annual shipments by 2025.

Committed to sustainability and customer-centric services, Unicore strives to become a world-leading provider of spatiotemporal information core products and solutions. With a vision to empower the intelligent era through its core technological strengths, the company remains at the forefront of innovation and industrial advancement.

Unicore's parent company BDStar is accelerating the establishment of"Intelligent Location Digital Base (iLDB®)" based on the "Chip-Cloud" strategy. This approach aims to deliver highly reliable and precise GNSS chips/modules, antennas, and data services for various applications, including industrial, automotive, and consumer markets.

unicore
a BDStar company

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86-10-6993-9828

Email:
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Web:
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Telit Cont'd
Branch Location:
8th Floor
Shinyoung Securities Bldg
6 Gukjegeumyung-Ro8-Gil
Seoul Yeongdeungpo-Gu 150-884
South Korea
82-2-368-4600
apac@telit.com

Telogis Fleet Mgmt Software
85 Enterprise
Ste 450
Aliso Viejo CA 92656
866-835-6447
team@telogis.com
telogis.com

TerraGo
45610 Woodland Rd
Ste 350
Sterling VA 20166
866-453-1609
info@terragotech.com
terragotech.com

Tersus GNSS
666 Zhangheng Rd
Level 2
Shanghai Pudong District 201203
China
8621-5080-3061
sales@tersus-gnss.com
tersus-gnss.com

Branch Location:
809 San Antonio Rd
Ste 10
Palo Alto CA 94303
415-800-3664
sales@tersus-gnss.com
tersus-gnss.com

Thales
75-77 Ave Marcel Dassault
Campus Thales Bordeaux
Merignac 33700
France
avionics@fr.thalesgroup.com
thalesgroup.com

Time & Frequency Solutions
25 Eastways
Witham Essex CM8 3AL
United Kingdom
44-13-7651-4114
enquiries@timefreq.com
timefreq.com

TimeTools
2 Silverend Business Park
Brettell Ln
Brierley Hill West Midlands DY5 3LG
United Kingdom
44-19-0289-7400
sales@timetoolsltd.com
timetoolsltd.com

TMYTEK
3F No 3 Yuandong Rd
Banqiao District
New Taipei City 220
Taiwan
08-22-69168
cici.tang@tmytek.com
tmytek.com

TomTom
150 Baker Ave Ext
Concord MA 01742
978-287-9555
info@tomtom.com
tomtom.com

Topcon Positioning Systems
7400 National Dr
Livermore CA 94550
925-245-8300
channelmarketing@topcon.com
topconpositioning.com

TowCentric
16511 Eaglewood Shadows Dr
Sugar Land TX 77498
832-877-4162
aanzehra42@gmail.com
towcentric.com

Track Your Truck
21754 S Center Ave
New Lenox IL 60451
888-434-3848
trackyourtruck.com

Trimble
10368 Westmoor Dr
Westminster CO 80021
720-887-6100
sales_info@trimble.com
trimble.com

Branch Location:
85 Leek Crescent
Richmond Hill ON L3X1M9
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applanix.com

Trimble OEM GNSS
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Westminster CO 80021
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Tronics Microsystems
400 Rte de Souveyron
Crolles 38920
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tronicsgroup.com

Tualcom
Mustafa Kemal Mahallesi 2119
Cadde No 11
Cankaya Ankara 06530
Turkiye
90-312-485-22-85
tualcom.com

U

u-blox AG
Zuercherstrasse 68
8800 Thalwil
Switzerland
41-44-722-7444
info@u-blox.com
u-blox.com

UHU Technologies
1201 Executive Dr W
Richardson TX 75081
972-905-0437
info@uhutechnologies.com
uhutechnologies.com
See our ad on pages 7 and 39

Unicore Communications
F3 No 7 Fengxian E Rd
Haidian Yongfeng
Beijing 100094
China
86-10-6993-9828
info@unicorecomm.com
unicore.com
See our ad pages 41 and the inside back cover

Union Leasing
425 N Martingale Rd
Schaumburg IL 60173
847-240-1500
info@unionleasing.com
unionleasing.com

UrsaNav
85 Rangeway Rd
110 Bldg 3 Ste 110
North Billerica MA 01862
781-538-5299
stephen.bartlett@ursanav.com
ursanav.com

Branch Location:
44160 Scholar Plaza
Ste 380
Leesburg VA 20176
703-623-5212
cschue@ursanav.com
ursanav.com

US Radar
121 Amboy Rd
PO Box 319
Matawan NJ 07747
732-566-2035
info@usradar.com
usradar.com

USGlobalsat
14740 Yorba Ct
Chino CA 91710
909-597-8525
sales@usglobalsat.com
usglobalsat.com

UTC Aerospace Systems
14300 Judicial Rd
Burnsville MN 55306
952-892-4000
communications@utas.utc.com
utcaerospacesystems.com

V

VectorNav Technologies
10501 Markison Rd
Dallas TX 75238
512-772-3615
sales@vectornav.com
vectornav.com

W

Wang Electro-Opto Corp
805 Franklin Ct SE
Ste B
Marietta GA 30067
770-955-9311
products@weo.com
weo.com

Wingtra
Giesshübelstrasse 40
Zurich 8045
Switzerland
hello@wingtra.com
wingtra.com

WORK Microwave GmbH
Rudolf-Diesel-Ring 2
Holzkirchen 83607
Germany
49-802-4640-8222
xidus@work-microwave.com
gnss-simulator.com

Branch Location:
2220 Northmont Pkwy
Ste 250
Duluth GA 30096
770-241-2645
waylon.sun@work-microwave.com
work-microwave.com

X

Xsens
Pantheon 6A
Enschede 7521 PR
Netherlands
31-88-97367-00
info@xsens.com
xsens.com

Branch Location:
101 N Pacific Coast Hwy
Ste 306
El Segundo CA 90245
310-481-1800
info@xsens.com
xsens.com

Y

Yellowscan
525 Ave St Sauveur Du Pin
St. Clement De Riviere 34980
France
33-4-11-93-14-00
yellowscan.com

Z

ZMicro
9820 Summers Ridge Rd
San Diego CA 92121
858-831-7000
techsupport@zmicro.com
zmicro.com

ACCESSORIES

Allis Communications Co
ComNav
Epson America
EVE Energy
First RF Corp
GigOptix
Gladiator Technologies
GPS Networking
iCONN Systems
Instock Wireless Components
ISA Telematics GmbH
Jiashan Jinchang Electronics
Karel Electronics
L3Harris Corp
Leica Geosystems AG
Micro Engineering Tech
National Instruments
NavCom, A John Deere Co
Nexteq Navigation
Omnetics Connector Corp
Optical Zonu Corp
Ranger SST
Rockwell Collins
Skyworks Solutions
Tersus GNSS
ZMicro

Cable Assemblies

AeroAntenna Technology
Allis Communications Co
Brandywine Communications
C-Nav
GPSTrackit.com
Hirschmann Car Communication
Janus Remote Communications
Larsen Antennas/Pulse Electronics
Leica Geosystems AG
Linx Technologies
Mobile Mark
NavCom, A John Deere Co
NavSync
Omnetics Connector Corp
Panorama Antennas
PCTEL
Rojone Pty
USGlobalsat

Communications Datalinks/ Modems

Janus Remote Communications
John Deere AMS
Leica Geosystems AG
NavCom, A John Deere Co
NavSync
Optical Zonu Corp
QinetiQ
Rojone Pty
Satel Oy
Satel Survey USA
Skyworks Solutions
u-blox AG

Connectors

Allis Communications Co
ComNav
GPSTrackit.com
Hirschmann Car Communication
ikeGPS
Janus Remote Communications
Larsen Antennas/Pulse Electronics
Linx Technologies
NavSync
Omnetics Connector Corp
Panorama Antennas
Rojone Pty
USGlobalsat

Power Supplies/Converters

C-Nav
GPSTrackit.com
ikeGPS
Leica Geosystems AG
NavCom, A John Deere Co
NavSync
Skyworks Solutions
USGlobalsat

ANTENNAS

Advanced Navigation
Allis Communications Co
Allystar Technology (Shenzhen)
Antcom Corp
Antenova
Arbiter Systems
Borealis Precision
Calian GNSS (Formerly Tallysman Wireless)
Chelton
ComNav
Foxcom
GPS Source
GPSAntennas.com
Gutec AB
Hemisphere GNSS
JAVAD GNSS
KCS BV
Leica Geosystems AG
Maruwa America Corp
Maxtena
Meinberg Funkuhren GmbH & Co KG
Microlab
Multicom
NavCom, A John Deere Co
NovAtel
Optical Zonu Corp
Parsec Technologies
Quectel
RFOptic
Rockwell Collins
Rohde & Schwarz GmbH & Co KG
Skyworks Solutions
Synergy Systems
Taoglas
TeleOrbit GmbH
Trimble OEM GNSS
UHU Technologies
Wang Electro-Opto Corp

Antijam/Interference Suppression Units

AeroAntenna Technology
Allis Communications Co
Antcom Corp
BAE Systems
Calian GNSS (Formerly Tallysman Wireless)
CAST Navigation, Now Part of Spirent Federal
GlobalTop Technology
GPSAntennas.com
Harxon Corp
L-3 Interstate Electronics
Micro-Ant
NavCom, A John Deere Co
NovAtel
NVS Technologies AG
QinetiQ
Reelektronika BV
TeleOrbit GmbH
Thales
Tualcom
Wang Electro-Opto Corp

GPS, External

AeroAntenna Technology
Allis Communications Co
Altus Positioning Systems
Antcom Corp
Arbiter Systems
Calian GNSS (Formerly Tallysman Wireless)
Chemring Technology Solutions
ComNav
DataGrid
FEI-Zyfer
ftech Corp
Garmin International
Globalsat Technology Corp
GlobalTop Technology
GPSAntennas.com
GPSTrackit.com
Harxon Corp
Hemisphere GNSS
Hirschmann Car Communication
ikeGPS
Inventek Systems
Janus Remote Communications
KCS BV
Laird Technologies
Larsen Antennas/Pulse Electronics
Leica Geosystems AG
Linx Technologies
Micro-Ant
Microlab
Mobile Mark
Motorola
Multicom
NavCom, A John Deere Co
Novariant
NovAtel
NVS Technologies AG
Panorama Antennas
Parsec Technologies
PCTEL
Reelektronika BV
Rojone Pty
Sokkia Corp
Spectratime
Surrey Satellite Technology
Synergy Systems
TeleOrbit GmbH
Time & Frequency Solutions
TomTom
u-blox AG
USGlobalsat
Wang Electro-Opto Corp

GPS, Integrated

AeroAntenna Technology
Allis Communications Co
Altus Positioning Systems
BAE Systems
Brandywine Communications
Calian GNSS (Formerly Tallysman Wireless)
ComNav
DataGrid
FEI-Zyfer
ftech Corp
Garmin International
GlobalTop Technology
Harxon Corp
Hemisphere GNSS
Hirschmann Car Communication
ikeGPS
Infospectrum
Inventek Systems
Janus Remote Communications
KCS BV
Laird Technologies
Larsen Antennas/Pulse Electronics
Leica Geosystems AG
Linx Technologies
Micro Modular Technologies
Micro-Ant
Mobile Mark
NavCom, A John Deere Co
Novariant
NovAtel
Panorama Antennas
Parsec Technologies
PCTEL
Rojone Pty
Sokkia Corp
Spectratime
TeleOrbit GmbH
Time & Frequency Solutions
Trimble OEM GNSS
u-blox AG
USGlobalsat
Wang Electro-Opto Corp

GPS/Communications

AeroAntenna Technology
Allis Communications Co
Altus Positioning Systems
Antcom Corp
Blue Sky Network
Brandywine Communications
Calian GNSS (Formerly Tallysman Wireless)
ComNav
CSR plc
FEI-Zyfer
Garmin International
GPSTrackit.com
Hirschmann Car Communication
Inventek Systems
Janus Remote Communications
Japan Radio Co
John Deere AMS
KCS BV
Laird Technologies
Larsen Antennas/Pulse Electronics
Leica Geosystems AG
Linx Technologies
Micro-Ant
Mobile Mark
NavCom, A John Deere Co
Panorama Antennas
PCTEL
RFOptic
Rojone Pty
Skyworks Solutions
Spectratime
TomTom
u-blox AG
Wang Electro-Opto Corp

COMPLEMENTARY PNT

Inertial Labs, a VIAVI Solutions Co
Iridium
LKD Aerospace
SandboxAQ
Silicon Sensing Systems

CONNECTED CAR
Averna
GPSAntennas.com
Infospectrum
KVH Industries
STMicroelectronics
Swift Navigation
Taoglas
Xsens

Components (including Software)
Infospectrum
Xsens

Integrated Systems
Averna
GPSAntennas.com
Infospectrum

DIFFERENTIAL GPS
ComNav Technology
Emlid
Eos Positioning Systems
Geneq
Geodetics
Geomatics USA
Geometer International
Geostar Navigation
Hemisphere GNSS
Inertial Sense
KCS BV
Sapcorda Services GmbH
Satel Oy
SingularXYZ Intelligent Technology
Swift Navigation
Tersus GNSS

DGPS-Capable Radiobeacon Receivers
Garmin International
Geneq
Hemisphere GNSS
KCS BV
NVS Technologies AG
Satel Oy
Sokkia Corp

Ephemeris Information
Baseband Technologies
Geodetics
i-cubed
Rx Networks

Real-Time DGPS Correction Services
AXIO-NET GmbH
C-Nav
Geodetics
Hemisphere GNSS
KCS BV
NVS Technologies AG
OmniSTAR
Rx Networks
Swift Navigation

Real-Time DGPS Receivers
Altus Positioning Systems
Blue Sky Network
C-Nav
Communication & Navigation
DataGrid
Eos Positioning Systems
Esterline CMC Electronics
Geneq
Geodetics
Geomatics USA
Geometer International
Geostar Navigation
Hemisphere GNSS
Inertial Sense
KCS BV
Motorola
Novariant
NVS Technologies AG
Satel Oy
Sokkia Corp
Swift Navigation

Reference Stations
AXIO-NET GmbH
Broadcom Corp
Communication & Navigation
DataGrid
Geneq
Geodetics
KCS BV
Novariant
NVS Technologies AG
Rx Networks
SingularXYZ Intelligent Technology
Swift Navigation

DIGITAL COMPASSES
Advanced Navigation
Globalsat Technology Corp
GlobalTop Technology
Honeywell
PNI Sensor Corp
Silicom
STMicroelectronics
ZMicro

ELECTRONIC CHARTS/ MAPS
Geocortex by VertiGIS
Silicom
TomTom

GENERAL SERVICES AND PRODUCTS
Chronos Technology
GEICO
Geocortex by VertiGIS
OHB Austria GmbH

Insurance
GEICO

GEOPHYSICAL
Carlson Software
Emlid
Fredericks Co
SandboxAQ

INSTRUMENTATION INTEGRATED WITH GPS
AutonomouStuff
DT Research
ELPROMA
Geodetics
Geomatics USA
GPS Source
Inertial Labs, a VIAVI Solutions Co
Juniper Systems
Laser Technology
Meitrack Group
Microlab
NextNav
Phase One
Remote GeoSystems
RIEGL Laser Measurement Systems GmbH
Seven Solutions
Silicon Sensing Systems
Spectratime
Spectrum Instruments
Stanford Research Systems
Telit
UTC Aerospace Systems

Automated Machine Control
Applanix
AutonomouStuff
Communication & Navigation
Geodetics

Bar-Code Scanner
Juniper Systems
Ricoh Americas Corp

Camera
Applanix
AutonomouStuff
DT Research
ftech Corp
Juniper Systems
NavSys Corp
Phase One
Remote GeoSystems
Ricoh Americas Corp

Datalogger
Applanix
AutonomouStuff
Communication & Navigation
ELPROMA
ftech Corp
Geomatics USA
Juniper Systems
NavSys Corp
Remote GeoSystems

Infrared/Multispectral Sensors
Applanix
AutonomouStuff
ELPROMA
Remote GeoSystems

Integrity Monitoring
Applanix
Broadcom Corp
ELPROMA
Geodetics
Remote GeoSystems
Thales

Ionospheric Calibrators
Geodetics

Laser Rangefinders
Applanix
AutonomouStuff
Laser Technology
Phase One
Remote GeoSystems
RIEGL Laser Measurement Systems GmbH

PC/Laptop/Handheld Computer
4P Mobile Data Processing
Applanix
DT Research
ELPROMA
Geodetics
Juniper Systems
Maxim Integrated Products
Remote GeoSystems

Sonar
Applanix
AutonomouStuff

Time and Frequency Stability
ELPROMA
GPS Source
Seven Solutions
SiTime Corporation
Spectratime
Spectrum Instruments

Variable-Rate Controllers

Videography (including Time/Position Captioning)
Applanix
Phase One
Remote GeoSystems

Wireless Communications
Applanix
AutonomouStuff
Beijer Electronics
Broadcom Corp
Calian GNSS (Formerly Tallysman Wireless)
ELPROMA
FEI-Zyfer
Geodetics
Juniper Systems
Maxim Integrated Products
Microlab
NavSync
NextNav
Qualcomm
Remote GeoSystems
Ricoh Americas Corp
Satel Survey USA
Spectratime
Spectrum Instruments
Telit

INTEGRATED NAVIGATION EQUIPMENT
Allystar Technology (Shenzhen)
Bynav Technology Co
EMCORE Corp
General Dynamics Mission Systems
Inertial Labs, a VIAVI Solutions Co
Inertial Sense
KVH Industries
LKD Aerospace
Matrix XYZ Positioning
MostaTech
Oxford Technical Solutions (OxTS)
Parker LORD
Physical Logic
PolyExplore
SBG Systems
Sensonor
Septentrio
Shaanxi Ericco Inertial System
Spirent Communications
Tronics Microsystems
UrsaNav
UTC Aerospace Systems
VectorNav Technologies
Xsens

Dead Reckoning
Applanix
CSR plc
Honeywell
Inertial Labs, a VIAVI Solutions Co
Inertial Sense
NavSys Corp
Parker LORD
SBG Systems
Septentrio
Xsens

Inertial
Applanix
CAST Navigation, Now Part of Spirent Federal
EMCORE Corp
General Dynamics Mission Systems
Honeywell
Inertial Labs, a VIAVI Solutions Co
Inertial Sense
LKD Aerospace
MostaTech
NavSys Corp
Oxford Technical Solutions (OxTS)
Parker LORD
Physical Logic
PNI Sensor Corp
Reelektronika BV
SBG Systems
Sensonor
Septentrio
Sparton
Tronics Microsystems
UTC Aerospace Systems
VectorNav Technologies
Xsens

Loran-C/eLoran
Reelektronika BV
UrsaNav

Radiobeacon
Locata

MAPPING
Azimap
Eos Positioning Systems
ESSP SAS
Inertial Labs, a VIAVI Solutions Co
L3Harris Corp
Laser Technology
Nearmap US
Oxford Technical Solutions (OxTS)
Phase One
Phoenix LiDAR Systems
PolyExplore
Propeller Aero
RIEGL Laser Measurement Systems GmbH
Spectra Geospatial
Trimble

Data Conversion
Azimap
i-cubed

Digital Mapbases
Azimap
deCarta
i-cubed

Geographic Information Systems (GIS)
Azimap
i-cubed
L3Harris Corp
Laser Technology
Spectra Geospatial
TeleType GPS
Trimble

Imagery
Azimap
deCarta
i-cubed
Nearmap US
Trimble

Interfaces
Azimap
i-cubed

Market Analyses/Reports
Azimap

Systems
Azimap
Oxford Technical Solutions (OxTS)
RIEGL Laser Measurement Systems GmbH

Travel Information Databases
iTRAK Corp
TeleType GPS

PHOTOGRAMMETRY/GPS INTEGRATED SYSTEMS
Inertial Labs, a VIAVI Solutions Co
Lidar USA
Nearmap US
Propeller Aero
Ricoh Americas Corp
SoftNav Systems
Trimble
US Radar

PUBLICATIONS, GUIDES, VIDEOS, TRAINING SOFTWARE, INSTITUTES
Artech House Publishers
Institute of Navigation (ION)

RECEIVER COMPONENTS
Greenray Industries
iCONN Systems
Instock Wireless Components
Iridium
Microchip Technology
Parsec Technologies
Rakon Limited
RFOptic
SiTime Corporation
Telit
Unicore Communications

Bandpass Filters
Maxim Integrated Products

Chips/ICs
Iridium
Maxim Integrated Products
Microchip Technology
Parsec Technologies
Qualcomm
SiTime Corporation
SigNav Pty
Unicore Communications

Interfaces
Beijer Electronics
Maxim Integrated Products

Modules
Inventek Systems
Iridium
Maxim Integrated Products
Micro Modular Technologies
Microchip Technology
Parsec Technologies
SiTime Corporation
SigNav Pty
Telit
Unicore Communications

Quartz Crystals
Greenray Industries
Maxim Integrated Products
Microchip Technology
Rakon Limited
Time & Frequency Solutions

RF Amplifiers/Preamplifiers
Maxim Integrated Products
Microchip Technology
Parsec Technologies
RFOptic

Rubidium Oscillators
Microchip Technology

RECEIVER PERFORMANCE ANALYSIS
Averna

RECEIVERS
Advanced Tracking Technologies
Analog Devices
Antenova
Arbiter Systems
Baseband Technologies
Borealis Precision
Bynav Technology Co
Carlson Software
CHC Navigation (CHCNAV)
ComNav Technology
DT Research
Effigis Geo Solutions
eSurvey GNSS
etherWhere
F4 Tech
Foxcom
Furuno USA
Geneq
General Dynamics Mission Systems
GEOsat GmbH
Geostar Navigation
Global FOXCOM
Greenray Industries
Gutec AB
IFEN GmbH
IP-Solutions Satellite Applications, Japan
Jackson Labs Technologies
JAVAD GNSS
Juniper Systems
Kolmostar
Matrix XYZ Positioning
Multicom
NovAtel
oneNav
Oscilloquartz
PP-Solution
Precise Time and Frequency
Quectel
Rakon Limited
Rokubun SL
Satlab Geosolutions
Septentrio
Seven Solutions
SingularXYZ Intelligent Technology
Suzhou Foif Co
Synergy Systems
Syntony GNSS
TeleOrbit GmbH
Topcon Positioning Systems
Trimble OEM GNSS
Unicore Communications
UrsaNav

Attitude/Direction Finding
Baseband Technologies
Borealis Precision
Carlson Software
etherWhere
Gutec AB
NovAtel
Septentrio
Syntony GNSS
TeleOrbit GmbH
Trimble OEM GNSS
Unicore Communications
UrsaNav

Automatic Vehicle Location
Advanced Tracking Technologies
Baseband Technologies
etherWhere
GPS Insight
iTRAK Corp
Septentrio
Topcon Positioning Systems
Trimble OEM GNSS
Unicore Communications

Aviation
Analog Devices
BAE Systems
Baseband Technologies
Esterline CMC Electronics
etherWhere
General Dynamics Mission Systems
Jackson Labs Technologies
Multicom
NovAtel
Septentrio
Syntony GNSS
Topcon Positioning Systems
Trimble OEM GNSS
UrsaNav

Computer GPS Cards/Modules
Antenova
Baseband Technologies
etherWhere
Jackson Labs Technologies
Oscilloquartz
Septentrio
Syntony GNSS
Unicore Communications

Digital Signal Processor Integrated Chips (DSP-IC)
Baseband Technologies
TeleOrbit GmbH

Geodetic/Geophysical
Carlson Software
CHC Navigation (CHCNAV)
eSurvey GNSS
Gutec AB
Septentrio
TeleOrbit GmbH
Topcon Positioning Systems
Unicore Communications

GIS
Carlson Software
CHC Navigation (CHCNAV)
Effigis Geo Solutions
eSurvey GNSS
F4 Tech
Geneq
GEOsat GmbH
NovAtel
Oscilloquartz
Septentrio
Suzhou Foif Co
Topcon Positioning Systems
Unicore Communications

Handheld
Analog Devices
Baseband Technologies
CHC Navigation (CHCNAV)
DT Research
Effigis Geo Solutions
eSurvey GNSS
etherWhere
F4 Tech
Geneq
GEOsat GmbH
Greenray Industries
Gutec AB
L3 Interstate Electronics
Suzhou Foif Co
Syntony GNSS
Topcon Positioning Systems
Unicore Communications
UrsaNav

Land Vehicle Navigation/ Route Guidance
BAE Systems
Baseband Technologies
Carlson Software
eSurvey GNSS
General Dynamics Mission Systems
L3 Interstate Electronics
NovAtel
Septentrio
Syntony GNSS
TeleOrbit GmbH
TeleType GPS
Topcon Positioning Systems
Trimble OEM GNSS
Unicore Communications

Marine
Analog Devices
Baseband Technologies
CHC Navigation (CHCNAV)
eSurvey GNSS
etherWhere
Geneq
Greenray Industries
Jackson Labs Technologies
NovAtel
Septentrio
Syntony GNSS
Topcon Positioning Systems
Trimble OEM GNSS
UrsaNav

Military
Analog Devices
BAE Systems
Baseband Technologies
Carlson Software
Collins Aerospace
etherWhere
General Dynamics Mission Systems
Greenray Industries
Jackson Labs Technologies
L3 Interstate Electronics
Multicom
Northrop Grumman
NovAtel
Precise Time and Frequency
Septentrio
Syntony GNSS
Topcon Positioning Systems
Trimble OEM GNSS
UrsaNav

OEM Modules/Engines/ Chipsets
Analog Devices
BAE Systems
Baseband Technologies
Borealis Precision
Bynav Technology Co
Carlson Software
CHC Navigation (CHCNAV)
Esterline CMC Electronics
eSurvey GNSS
Geostar Navigation
Gutec AB
Jackson Labs Technologies
Japan Radio Co
Loctronix Corp
NovAtel
Oscilloquartz
Septentrio
SiTime Corporation
SigNav Pty
SkyTraq Technology
TeleOrbit GmbH
Topcon Positioning Systems
Trimble OEM GNSS
Unicore Communications

PCMCIA Cards
Oscilloquartz

Radio Frequency Integrated Chip (RF-IC)
Analog Devices
Baseband Technologies
etherWhere
Greenray Industries
NTLab
TeleOrbit GmbH

RTK
Bynav Technology Co
Carlson Software
CHC Navigation (CHCNAV)
eSurvey GNSS
Geneq
Geodnet
GEOsat GmbH
Geostar Navigation
Gutec AB
NovAtel
Septentrio
SingularXYZ Intelligent Technology
SkyTraq Technology
Suzhou Foif Co
Topcon Positioning Systems
Trimble OEM GNSS
Unicore Communications

Software Receivers
Baseband Technologies
eSurvey GNSS
IP-Solutions Satellite Applications, Japan
Loctronix Corp
Nottingham Scientific
Oscilloquartz
Syntony GNSS
TeleOrbit GmbH

Space
Analog Devices
BAE Systems
Baseband Technologies
Borealis Precision
Collins Aerospace
etherWhere
Greenray Industries
Gutec AB
NovAtel
Rakon Limited
Septentrio
Surrey Satellite Technology
Syntony GNSS

Surveying
Carlson Software
CHC Navigation (CHCNAV)
DT Research
eSurvey GNSS
GEOsat GmbH
NovAtel
Satlab Geosolutions
Septentrio
Suzhou Foif Co
TeleOrbit GmbH
Topcon Positioning Systems
Unicore Communications

Timing
Arbiter Systems
Baseband Technologies
ESE
etherWhere
Greenray Industries
Jackson Labs Technologies
NovAtel
Oscilloquartz
Precise Time and Frequency
Septentrio
Seven Solutions
SigNav Pty
Synergy Systems
TeleOrbit GmbH
Unicore Communications
UrsaNav

Tracking
Advanced Tracking Technologies
Baseband Technologies
etherWhere
Geneq
GEOsat GmbH
Geostar Navigation
L3 Interstate Electronics
NovAtel
Synergy Systems
Syntony GNSS
TeleOrbit GmbH
Topcon Positioning Systems
Unicore Communications

SATELLITE SIGNAL SIMULATORS/ PSEUDOLITES
Global FOXCOM
IFEN GmbH
IP-Solutions Satellite Applications, Japan
Jackson Labs Technologies
LabSat
Loctronix Corp
M3 Systems
Nottingham Scientific
OHB Austria GmbH
Rohde & Schwarz GmbH & Co KG
Safran Federal Systems
Safran Trusted 4D
Spirent Communications
Spirent Federal Systems, Now Part of Keysight
Syntony GNSS
WORK Microwave GmbH

SECURITY CODE DECRYPTION DEVICES
Retail Secure

SEMINARS/TRAINING
Chronos Technology
Institute of Navigation (ION)
NavtechGPS
Space Foundation

SOFTWARE
Advanced Tracking Technologies
ALLSAT GmbH
AutonomouStuff
Azimap
Clark Labs
Effigis Geo Solutions
eSurvey GNSS
Forsberg Services
Fretron Private Limited
Geometer International
GEOsat GmbH
Global Navigation Software
Inertial Labs, a VIAVI Solutions Co
LabSat
Leonardo DRS
LocoNav
M3 Systems
oneNav
PP-Solution
Qascom
Remote GeoSystems
Rokubun SL
Sapcorda Services GmbH
SBG Systems
TDK Trusted Positioning
TerraGo
Topcon Positioning Systems
TowCentric

Coordinate Conversion
ALLSAT GmbH
Azimap
Best-Fit Computing
Effigis Geo Solutions
eSurvey GNSS
Polaris Wireless
Telogis Fleet Mgmt Software
Topcon Positioning Systems

Geodetic Surveying
ALLSAT GmbH
Best-Fit Computing
Effigis Geo Solutions
eSurvey GNSS
Geometer International
Topcon Positioning Systems

Geotagging
ALLSAT GmbH
Azimap
Effigis Geo Solutions
Polaris Wireless
Remote GeoSystems

GIS/LIS
ALLSAT GmbH
Azimap
Clark Labs
eSurvey GNSS
F4 Tech
Geometer International
GEOsat GmbH
Remote GeoSystems
Telogis Fleet Mgmt Software
Topcon Positioning Systems

GPS-Related Internet Applications (Mapping, Navigation, Tracking, etc.)
Advanced Tracking Technologies
ALLSAT GmbH
deCarta
GEOsat GmbH
Geotab
Global Navigation Software
GPS Insight
Polaris Wireless
Position Logic
Remote GeoSystems
Telogis Fleet Mgmt Software
TerraGo
Topcon Positioning Systems
Track Your Truck

Mapping
ALLSAT GmbH
AutonomouStuff
Azimap
deCarta
Geometer International
GEOsat GmbH
Inertial Labs, a VIAVI Solutions Co
PeopleNet
Polaris Wireless
Remote GeoSystems
Telogis Fleet Mgmt Software
TerraGo
Topcon Positioning Systems

Mission Planning
ALLSAT GmbH
AutonomouStuff
Effigis Geo Solutions
Polaris Wireless
Remote GeoSystems
Telogis Fleet Mgmt Software
Topcon Positioning Systems

Navigation/Route Guidance
ALLSAT GmbH
AutonomouStuff
Azimap
deCarta
Geotab
PeopleNet
Polaris Wireless
Telogis Fleet Mgmt Software
TerraGo

Network Adjustment
ALLSAT GmbH
Azimap
Best-Fit Computing
Effigis Geo Solutions
eSurvey GNSS
Polaris Wireless
Topcon Positioning Systems

Orbit Analysis and Simulation
ALLSAT GmbH
M3 Systems
Spirent Federal Systems, Now Part of Keysight

Pre- and Postprocessing
ALLSAT GmbH
AXIO-NET GmbH
Effigis Geo Solutions
eSurvey GNSS
Forsberg Services
Polaris Wireless
Remote GeoSystems
Rokubun SL
SBG Systems
Topcon Positioning Systems

System Performance Analysis
ALLSAT GmbH
Chemring Technology Solutions
LabSat
M3 Systems
Polaris Wireless
Telogis Fleet Mgmt Software
Topcon Positioning Systems

Vehicle/Vessel/Asset Tracking
Advanced Tracking Technologies
ALLSAT GmbH
deCarta
GEOsat GmbH
Geotab
GPS Insight
PeopleNet
Polaris Wireless
Telogis Fleet Mgmt Software
Topcon Positioning Systems

SURVEYING-RELATED EQUIPMENT
ALLSAT GmbH
DT Research
Fredericks Co
Frontier Precision
Spectra Geospatial
Suzhou Foif Co
US Radar

Dataloggers
4P Mobile Data Processing
ALLSAT GmbH
DT Research
Spectra Geospatial

Electronic Fieldbooks
ALLSAT GmbH

Pen-Based Survey/GIS
ALLSAT GmbH

SYSTEM DESIGN/ INTEGRATION
GPS Networking
Inertial Labs, a VIAVI Solutions Co
Meitrack Group
Parker LORD
Parsons
SoftNav Systems
Syncworks
TMYTEK

TIMING
AEVEX Aerospace
Connor-Winfield
EKOSinerji
ELPROMA
EndRun Technologies
etherWhere
Furuno USA
Locata
Masterclock
Microchip Technology
Orca Technologies
Oscilloquartz
Precise Time and Frequency
Rakon Limited
Safran Trusted 4D
SiTime Corporation
Spectrum Instruments
Syncworks
TimeTools

Time-Code Generators
ELPROMA
EndRun Technologies
ESE
Masterclock
Microchip Technology
Orca Technologies
Precise Time and Frequency
Safran Trusted 4D
Spectrum Instruments

Time-Transfer Stations
ELPROMA
EndRun Technologies
Microchip Technology
Precise Time and Frequency
Spectrum Instruments

Timing Clocks
Connor-Winfield
ELPROMA
EndRun Technologies
ESE
etherWhere
Microchip Technology
Orca Technologies
Oscilloquartz
Precise Time and Frequency
Rakon Limited
Safran Trusted 4D
SiTime Corporation
SpectraDynamics
Spectrum Instruments
Syncworks
TimeTools

Timing/Frequency Systems
Connor-Winfield
EKOSinerji
ELPROMA
EndRun Technologies
ESE
etherWhere
Masterclock
Microchip Technology
Orca Technologies
Oscilloquartz
Precise Time and Frequency
Safran Federal Systems
Safran Trusted 4D
SiTime Corporation
SpectraDynamics
Spectrum Instruments
Syncworks
TimeTools

TRACKING SERVICES (MOBILE ASSETS, ROADSIDE ASSISTANCE, E-911, FLEET MANAGEMENT, ETC.)
Back2You
Geotab
LocoNav
Ready Track Pty
Union Leasing

UNMANNED AERIAL VEHICLES (UAVS)
Airobot
Analog Devices
Antcom Corp
CHC Navigation (CHCNAV)
EMCORE Corp
ESSP SAS
Frontier Precision
Hitec Commercial Solutions
Inertial Labs, a VIAVI Solutions Co
Lidar USA
Maxtena
MostaTech
Physical Logic
Sensonor
Wingtra
Yellowscan

Components (including Software)
Airobot
Analog Devices
Antcom Corp
EMCORE Corp
Inertial Labs, a VIAVI Solutions Co
Lidar USA
MostaTech
Physical Logic
Sensonor

Integrated Systems
Analog Devices
CHC Navigation (CHCNAV)
EMCORE Corp
Lidar USA
Physical Logic
Sensonor
Wingtra

VEHICLE LOCATION/ TRACKING WORKSTATIONS AND SYSTEMS (COMPUTER-AIDED DISPATCH)
Fretron Private Limited
Position Logic
Ready Track Pty
TDK Trusted Positioning

MARKET WATCH

Segment Snapshot: Applications, Trends & News

DEFENSE

TopStar Smart Receiver Ready for Deployment

Thales

Thales has launched the TopStar Smart Receiver, a three-in-one ultra-compact solution designed to provide land forces with resilient positioning, navigation and timing (PNT) capabilities, while maintaining radio communications in increasingly contested electronic warfare environments.

The TopStar Smart Receiver can be integrated into land vehicles, drones and munitions.

Key Features

- **Dual-constellation GNSS receiver.** The receiver integrates signals from military constellations, Galileo PRS and civilian GPS, and provides resistance to spoofing with enhanced accuracy and availability.
- **Anti-jamming function.** Its adaptive controlled radiation pattern antenna (CRPA) reduces interference from jammers, and enables operation at distances up to 30 times closer than with a conventional GPS receiver.
- **High-performance clock.** The clock ensures synchronization of tactical radios for up to 48 hours following GNSS signal loss, versus 30 minutes with conventional equipment.

The TopStar Smart Receiver is assembled at Thales' site in Valence, France. The receiver is now available for testing in real-world conditions.

VectorNav Offers High-G in its Tactical Series

VectorNav Technologies has announced 95G and 250G accelerometer and 4000°/sec gyroscope ranges across its Tactical Series inertial measurement unit (IMU) and GNSS/inertial navigation system (INS) product line.

The enhancement directly addresses urgent requirements from defense contractors and platform developers operating in high-G mission profiles, the company said.

Defense modernization priorities are accelerating procurements of interceptors, missiles and hypersonic platforms that must operate through launch, interception and aggressive maneuvering — often in environments where GPS is denied or degraded. In these conditions, navigation performance depends on the IMU's ability to maintain solution integrity without saturating.

The extended-range Tactical Series is designed to meet that requirement, providing the core inertial measurements that enable resilient PNT solutions to operate through mission-critical flight phases where conventional sensors fail.

U.S. Army

The extended-range accelerometer and gyroscope provide navigation solution integrity in high-dynamic environments, such as interceptors, missiles and hypersonic platforms.

AUTONOMOUS SOLUTIONS

Geodash Aims for Map-Free, AI-Driven Precision Spraying

DroneDash Technologies and Geonet are forming Geodash Aerosystems Pte. Ltd. — a Singapore-incorporated joint venture to develop a new class of agricultural spraying drone for large-scale, industrial farming operations. Commercial deployment is set for Q3 2026.

Geodash Aerosystems' platform uses real-time AI vision and centimeter-accurate real-time kinematic (RTK) positioning to perceive, navigate and adapt dynamically during flight. The result is faster deployment, lower operating costs and continuous agronomic intelligence from one system.

Most agricultural spraying drones in operation were adapted from general-purpose UAV platforms. Before each deployment, operators must manually survey and map the field, generate static flight plans, and repeat the entire process whenever terrain, planting patterns, or canopy profiles change. For plantations and large-scale row-crop environments, this overhead mapping limits how many hectares a team can cover and how quickly they can respond to emerging crop conditions.

Geodash Aerosystems' drone architecture removes pre-mapping from the deployment workflow. Using DroneDash's proprietary AI vision system, the aircraft performs real-time perception of plantation structure, canopy height and terrain features during flight.


DroneDash

Geodnet's RTK correction network delivers centimeter-level positional accuracy throughout each mission.

Situational awareness is generated dynamically during flight. Each aircraft maintains geofencing controls, safety constraints, and full operational data logging for regulatory compliance and audit traceability.

Pilot deployments and system validation have been conducted throughout 2025 and into early 2026.

INTERFERENCE CLOCKED BY FAA

The U.S. Federal Aviation Administration (FAA) has updated its "GNSS Interference Resource Guide." The FAA's Flight Technologies and Procedures Division (AFS-400) developed the guide to provide operators and pilots with current information on GPS/GNSS jamming and spoofing. According to the guide, "As the threat of GNSS jamming and spoofing is constantly changing, the FAA will update this resource guide to provide the best guidance in the rapidly changing environments." Download the guide from the FAA website.

UK SCIENTISTS UNITE TO UNCOVER COASTLINE MYSTERIES

The UK Centre for Seabed Mapping (UK CSM) conducted a survey to explore and map the seabed along the United Kingdom's southwest coastline. For four weeks, a team of 26 maritime scientists collected hydrographic, geological and environmental data. According to UK CSM, the survey represents an unprecedented level of collaboration within the maritime sector. The team aimed to collect and share high-quality marine data and make advances in how the seabed is mapped, understood and managed. The findings will support a wide range of applications including offshore energy and infrastructure, marine ecosystem science, safety at sea, marine policy, and defense.

BANGLADESH AT THE TOP

In April,field teams for the Survey department under the Ministry of Defense conducted field work in the remote hill areas of Bangladesh to determine the highest peak. Surveyors used modern geodetic methods and advanced GNSS technology in the Bandarban district, and followed international standards to determine the height of the country's highest peak above mean sea level (MSL) with centimeter-level accuracy, including latitude, longitude and elevation.

TURBULENCE SHRINKS ANTARCTICA'S ROSS ICE SHELF

GNSS observations suggest a major melting event at Antarctica's Ross Ice Shelf was linked to atmospheric turbulence. While the shelf typically melts underneath from warm ocean water, an unusual surface melting episode occurred in January 2016. Researchers from MIT Haystack Observatory used data from existing GNSS stations, with 13 stations installed on the shelf, to examine atmospheric turbulence. Wind, water vapor and temperature variations drawn in by warm and humid air caused the surface to melt, with turbulence four times greater than usual.

PHOTO CREDITS: Map, FAA • Endeavor, Cefas • Bangladesh, MD Maruf ARUF Hassan/E+/Getty Images • Antarctica, gyro/iStock/Getty Images Plus/Getty Images

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Wherever Position Matters, **Unicore Delivers.**

NebulasIV Series High-Precision GNSS Positioning Modules

Product	UM960/UM960E	UM980/UM980C	UM982/UM982C	UM981/UM981C	UM981S	UM1080A
Dimensions(mm)	16.0 × 12.2	22.0 × 17.0	21.0 × 16.0	22.0 × 17.0	22.0 × 17.0	22.0 × 17.0
Antenna	Single antenna	Single antenna	Dual antennas	Single antenna	Single antenna	Single antenna
Features	RTK	RTK / L-Band + CLAS	RTK + Heading / L-Band + CLAS	RTK + Built-in IMU / L-Band + CLAS	RTK + Built-in IMU	RTK + Raw data
Grade	Industrial	Industrial	Industrial	Industrial	Industrial	Automotive
Application	Lawn mower, Drone light show	Surveying & mapping	Industrial UAV, Agricultural machinery	Agricultural machinery	Surveying & mapping	Intelligent driving, P-BOX

UFirebird II Series Dual-Frequency GNSS Positioning Modules / UFirebird IV Series Single-Frequency GNSS Positioning Modules

Product	UM670A	UM671A	UM680A/UM680	UM681A/UM681	UM620A/UM620	UM621A/UM621	UM760A/UM760	UM761A/UM761
Dimensions(mm)	22.0 × 17.0	22.0 × 17.0	22.0 × 17.0	22.0 × 17.0	16.0 × 12.2	16.0 × 12.2	16.0 × 12.2	16.0 × 12.2
Features	SPP + Raw data	SPP + DR + Raw data	RTK + Raw data	RTK + DR + Raw data	SPP	SPP + DR	SPP	SPP + DR
Grade	Automotive	Automotive	Automotive/Industrial	Automotive/Industrial	Automotive/Industrial	Automotive/Industrial	Automotive/Industrial	Automotive/Industrial
Application	Intelligent driving, T-BOX, P-BOX	Intelligent driving, V2X, T-BOX	Intelligent driving, T-BOX, P-BOX, Industrial applications ...	Intelligent driving, T-BOX, V2X, Industrial applications ...	Vehicle navigation, T-BOX, Intelligent cockpit, Industrial applications ...	Vehicle navigation, T-BOX, Intelligent cockpit Industrial applications ...	Vehicle navigation, T-BOX, Vehicle monitoring, Streaming rearview mirror, Industrial applications ...	Vehicle navigation, T-BOX, Vehicle monitoring, Streaming rearview mirror, Industrial applications ...

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Flexible CRPA configuration ideal for aerial platforms
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