GPS WORLD
GNSS POSITION NAVIGATION TIMING
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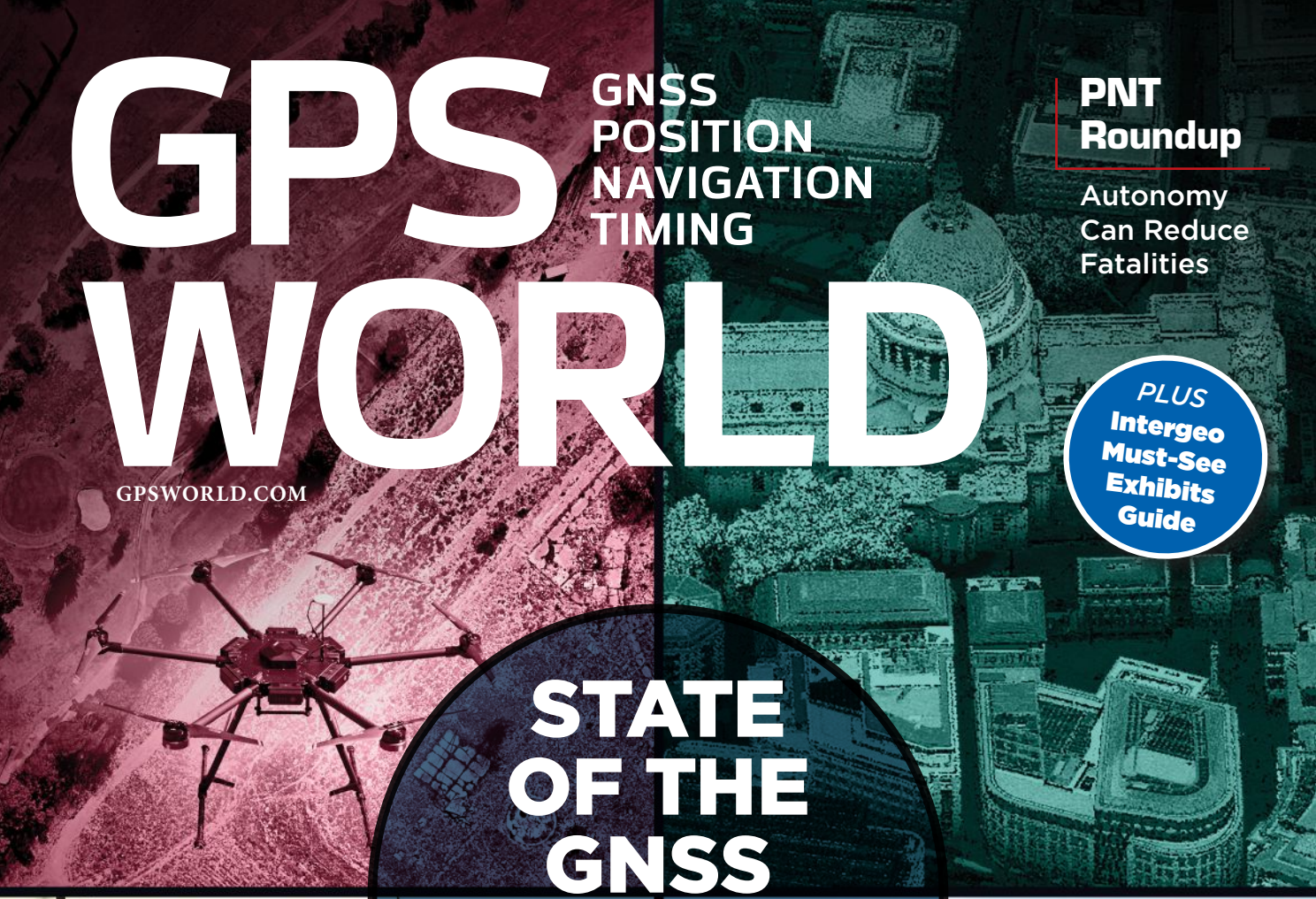
PNT Roundup

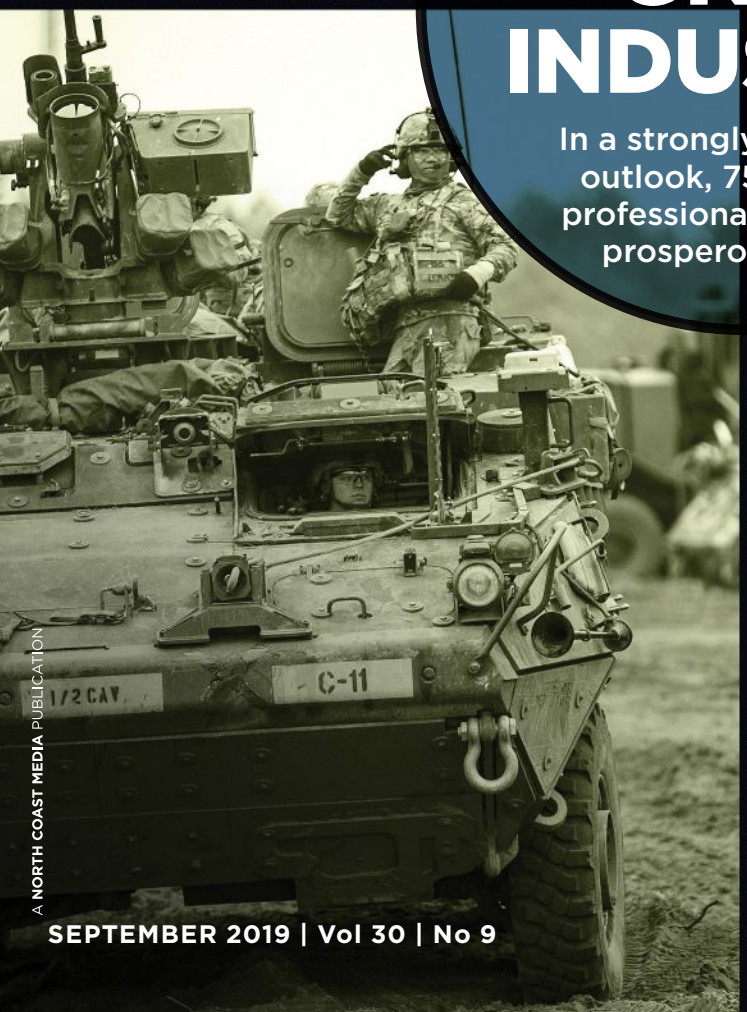
Autonomy Can Reduce Fatalities

PLUS **Intergeo Must-See Exhibits Guide**



STATE OF THE GNSS INDUSTRY

In a strongly optimistic outlook, 75% of PNT professionals predict a prosperous 2020.



Second GPS III Now Orbiting

Galileo Improves Clocks

Great Blue Hole Revealed

A NORTH COAST MEDIA PUBLICATION

SEPTEMBER 2019 | Vol 30 | No 9

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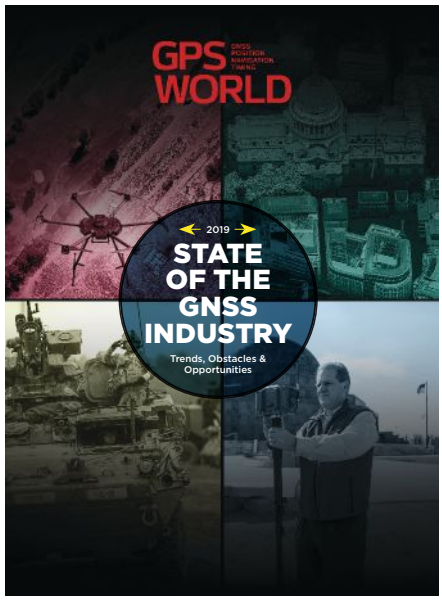
SEPTEMBER 2019

COVER STORY

27 STATE OF THE GNSS INDUSTRY REPORT



Trends, Obstacles & Opportunities

Conducted online in June 2019, the State of the GNSS Industry survey compiled detailed answers to 41 penetrating questions from respondents from all major industry sectors, spread across six continents. Here you'll find top-line statistical insights paired with perspectives from *GPS World's* knowledgable editors.

SPECIAL SECTION

INTERGEO MUST-SEE EXHIBITS GUIDE

(following page 42)

STUTTGART 2019 17 – 19 SEPTEMBER INTERGEO KNOWLEDGE AND ACTION FOR PLANET EARTH

Whether or not you are attending the world's largest trade fair in the field of geodesy, spatial data and land management, you will find the information in our special Must-See Exhibits Guide of great value, as it details the offerings of leading companies that exhibit at the show.

Photo: MicroSurvey Software

LAUNCHPAD

MARKET WATCH

CONTENTS

OPINIONS AND DEPARTMENTS

Photo: ULA

Screenshot: WABI-TV Maine

Photo: Aquatica Submarine

ADDED DEPTH

ONLINE NOW

NEWSLETTER EXCERPT

Using the New Interactive 'GPS on Bench Marks' Map

BY David Zilkoski
CONTRIBUTING EDITOR, SURVEY

The National Geodetic Survey (NGS) is now developing the 2022 transformation model. Once again, the National Geodetic Service (NGS) requests the assistance of the surveying and mapping community. This column provides examples to explain the symbology and use of the new version of the GPS on Bench Marks program for developing the 2022 transformation tool.

The Geoid18 model is still in beta, so hopefully users will continue their support by evaluating the beta hybrid geoid model and reporting their issues to NGS. Saying that, NGS' GPS on Bench Marks program is now in a different phase...

A goal of the transformation tool is to provide a model that will allow users to convert from NAVD 88 to the new North American – Pacific Geopotential Datum of 2022 (NAPGD2022)....

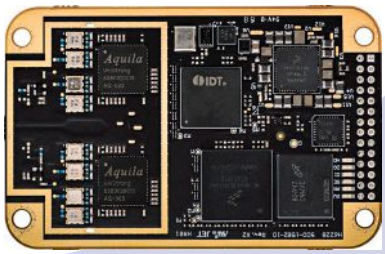
Read the full column at **gpsworld.com/category/opinions/**.

NO SMALL FEAT

Hemisphere GNSS' huge breakthrough is its smallest form factor GNSS positioning and heading board solution ever.

Behind each great product is a remarkably talented team. The employees of Hemisphere GNSS are no exception.

The precise positioning technology company prides itself on being flexible with customers while offering the highest-level technology. President and Chief Executive Officer Farlin Halsey credits the company's success to its passionate and skilled employees. "Our employees really benefit the customers because they are truly interested in making the best systems possible," Halsey says.



VEGA™ 28 GNSS COMPASS BOARD

Users wanted a low-power, low-cost system in a smaller machine. Responding to customer needs, Hemisphere researched and developed for more than three years to create the new Phantom and Vega positioning technology that fits into customer applications to make day-to-day work easier.

"You get a lot more signals, lower power, smaller-sized boards, and excellent performance in an interference environment," says Brad Badke, chief scientist at Hemisphere, adding that smaller board sizes lead to a longer life for handheld devices.

Also, customers can look at the spectrum on a receiver and add filters to block interference.

"The ability to look at the spectrum is highly valuable. You get more for lower power than you've ever gotten in the past," Badke says. "You've got a lot more capability."

Another key focus for the Hemisphere team is to create solutions for today's market and the future.

"Our Phantom and Vega series boards improve on our previous generations of hardware as they are based on our new Lyra II ASIC technology," says Miles Ware, Hemisphere's director of marketing. "Our new ASIC technology platforms allow our GNSS receivers to track all available and forthcoming GNSS signals, giving our users exceptional access to new technology."

The company remains a top-tier GNSS provider as it continues to improve and develop technology with customers in mind.

"It's the dedication our employees have not only to our technology, but actually understanding what the customers do, what the customers are trying to achieve, and," Halsey says, "what problem we are solving for them."

FARLIN HALSEY
PRESIDENT & CEO, HEMISPHERE GNSS

Hemisphere®

Change + Commitment = Progress

BY TRACY COZZENS
SENIOR EDITOR

As George Bernard Shaw said, "Progress is impossible without change." Our industry is a great example of that. We have grown from a single GPS service to multiple GNSS constellations, to today's increasing integration of GNSS solutions with other positioning, navigation and timing (PNT) technologies.

Since its founding 30 years ago, *GPS World* also has been constantly adapting and advancing so we can better report on, and help shape, our brilliant GNSS/PNT industry.

GPS World now includes expanded coverage of PNT solutions and related integration trends. We also dive deeper into GNSS/PNT developments through Q&As with leading industry suppliers, and we deliver more leading-edge application stories in high demand by our readers.

Other recent changes at *GPS World* revolve around our editorial staff. This month, we say goodbye to Alan Cameron, our editor-at-large, who served our media brand for 19 years. We wish Alan well.

Please join us in welcoming Diane Sofranec as *GPS World*'s staff editor.

Diane Sofranec

Matteo Luccio

> "Our commitment to delivering timely, accurate, insightful GNSS/PNT intel has never wavered."

Diane brings with her more than 30 years of experience writing and editing content for business-to-business magazines and digital media.

GPS World also is excited to welcome Matteo Luccio as a regular contributing editor. Luccio possesses almost 20 years of experience as a writer and editor for GNSS and geospatial technology media. Luccio began his career in the industry in 2000, serving as managing editor of *GPS World* and *Galileo's World*, then as editor of *Earth Observation Magazine* and *GIS Monitor*. Luccio earned a master's degree from the Massachusetts Institute of Technology.

In 2020, Luccio will pen *GPS World* cover stories detailing trends and new solutions in receivers, antennas, simulators and PNT technologies, as well as monthly secondary features on wide-ranging topics.

During the evolution of *GPS World* over the past 30 years, one thing has remained constant: Our commitment to delivering timely, accurate, insightful GNSS/PNT intel has never wavered. Our stable of staff editors and regular contributors collectively possesses 200 years of GNSS/PNT experience, and our audited audience reach tops 237,000 across all media platforms.

We're excited to continue to serve you, our family of loyal readers and marketing partners, for decades to come. Together, we remain committed to advancing our knowledge, organizations, profession and world.

You can reach Cozzens at tcozzens@northcoastmedia.net or 541-255-3334.

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Second GPS III Satellite Launched

The U.S. Air Force's second next-generation GPS III satellite responded to commands two hours after its successful launch on Aug. 22. The satellite, nicknamed "Magellan," was launched from Cape Canaveral Air Force at 9:06 a.m. ET.

Air Force and Lockheed Martin engineers at Lockheed Martin's Launch & Checkout Facility near Denver had full control of GPS III Space Vehicle 02 after the satellite's separation from its United Launch Alliance (ULA) Delta IV rocket booster. The satellite is being commanded using elements of the GPS Next Generation Operational Control System (OCX) Block 0.

Once in orbit, the satellite deployed its solar arrays and antennas, and Lockheed began on-orbit checkout and tests. Testing includes extensive signals testing with an advanced navigation payload provided by L3Harris.

Advanced Payload. The first GPS III satellite launched in December 2018 and its navigation payload has performed beyond expectations on orbit during pre-operational testing, according to L3Harris.

The GPS III navigation payload features a mission data unit (MDU) with a unique 70-percent digital design that links atomic clocks, radiation-hardened processors and powerful transmitters — enabling signals three times

See SECOND GPS III PAGE 10. >>

Photo: United Launch Alliance

Russia Passes Law on GLONASS-BeiDou Cooperation

A Russian law approved July 26 sets forth cooperation between Russia and China on using GLONASS and BeiDou for peaceful purposes.

According to the RosCosmos website, the law was approved at a meeting of the Council of Federation of the Federal Assembly of the Russian Federation. The law is officially named, "On ratification of the agreement between the Government of the Russian Federation and the Government of the People's Republic of China on cooperation in the use of GLONASS and Beidou global navigation satellite systems for peaceful purposes."

An intergovernmental agreement was signed on Nov. 7, 2018, in Beijing during the 23rd regular meeting of the heads of government of Russia and China. The agreement creates an institutional and legal framework for cooperation in the development and manufacture of civil navigation equipment using GLONASS and BeiDou systems.

It also establishes cooperation in the development of Russian-Chinese standards for the application of navigation technologies using both systems — in particular, standards for the control and management of traffic flows across the Russian-Chinese border. The border is 4,200 kilometers (2,615.5 miles) long — the world's sixth-longest international border.

Under the agreement, the two countries plan to place in their own countries measuring stations for the other country's GNSS, on a reciprocal basis.

Join us at ION GNSS+, booth 316.

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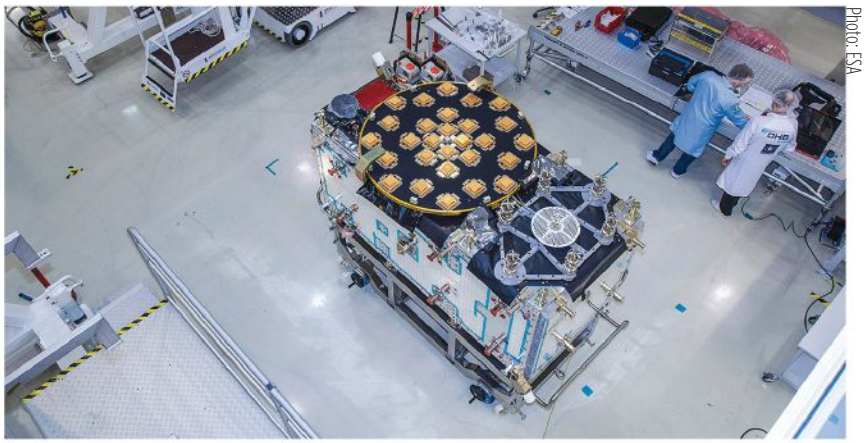

Photo: ESA

SATELLITE PATRICK, the first of Galileo's Batch 3, will eventually travel from OHB to ESA's ESTEC technical centre (shown here) in Noordwijk, the Netherlands, for rigorous testing in simulated space conditions.

Galileo Gets Evolved Clocks with Batch 3 Payloads

Galileo is on the march with a new generation of satellites bearing improved atomic clocks. The first of the Batch 3 navigation payloads was delivered in June by Surrey Satellite Technology (SSTL) in the UK to OHB System AG in Bremen, Germany.

SSTL's payload for Batch 3 is a recurrent build of the existing Full Operational Capability (FOC) payload, with an evolution of the atomic clocks to incorporate advances made under the European GNSS Evolution Programme.

The earlier SSTL Galileo FOC payload comprised different units including European-sourced atomic clocks, navigation signal generators, high power traveling wave tube amplifiers and antennas.

The new payload will be integrated aboard the satellite platform Galileo FOC FM23, with the first satellite of this series named Patrick in honor of the winner of a drawing competition. Payload integration will be followed by a series of comprehensive test activities.

Patrick and its next youngest sibling satellite of this series are scheduled to be ready for launch in autumn 2020.

"We are looking forward to this first 'marriage' of a Batch 3 payload and platform and are ready to start Patrick's test sequence soon," said Lars Peters from OHB System AG. OHB is in charge of Assembly Integration and Test for the satellites at 11 production islands, where one satellite is completed every five weeks.

"The ambitious schedule means that, looking forward, reserve satellites will be available both in orbit and on the ground," said Wolfgang Paetsch, member of the OHB System AG Management Board responsible for navigation, Earth observation and science.

Paetsch received a PNT Leadership Award from *GPS World* magazine in 2017. At that time, Paul Verhoef of ESA, accepting on behalf of Paetsch, stated: "Of course we are waiting a bit to see what the real lifetime of the satellites is going to be. We don't know that yet but we will find out in the next couple of years. Obviously there is a lot of pressure for further innovation, for further improvements.

"The user community over the last couple of years has become more outspoken about what they want and what they expect, which is nice. Obviously we need to take care of the legacy users, and we are having to see what new technology would allow us to do."

OHB System AG has contracted to deliver a further 12 Batch-3 Galileo satellites, bringing to 34 the number of Galileo satellites being supplied by the SSTL-OHB partnership. Of these, 14 are already in orbit.

SECOND GPS III

<< CONTINUED FROM PAGE 8.

more accurate than those on current GPS satellites. The payload also boosts signal power, which increases jamming resistance by eight times and helps extend the satellite's lifespan.

In 2017, L3Harris announced that it completed development of an even more-powerful, fully digital MDU for the Air Force's GPS III Follow On (GPS IIIF) program. The new GPS IIIF payload design will further enhance the satellite's capabilities and performance.

Next Up: GPS III SV03. GPS III SV01's performance exceeded expectations during testing, according to Lockheed Martin. All on-orbit check-out and test activities were completed July 12, and the satellite is expected to be handed over to the Air Force later this year.

On May 27, the Air Force declared the GPS III SV03 Available for Launch (AFL) and had the company place it into storage waiting for a launch date, which is tentatively planned for early fall. GPS III SV04-08 are now in various stages of assembly and test.

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LIDAR

Autonomy Can Reduce Road Fatalities

Mothers Against Drunk Driving (MADD) has partnered with Velodyne Lidar, a provider of real-time 3D perception systems for a range of commercial applications, including autonomous vehicles. The initiative includes a website on the safety benefits of autonomous vehicle technology (see **velodynelidar.com/madd-partnership.html**) and an October conference on autonomous safety.

"We have learned that technology is essential to getting us to our goal of zero deaths caused by drunk driving," said MADD President Helen Witty. "Autonomous vehicle technology holds the incredible promise of helping us eliminate drunk driving."

Marta Hall, Velodyne Lidar's president and chief business development officer, added, "Our goal is to design, develop and mass-produce lower cost lidar sold for every model of car and truck."

The two organizations partnered in 2018 to create the website with information on how autonomous vehicles can help prevent roadway collisions. The site explains the basics of autonomous driving in easy-to-understand language for all audiences. Content modules include "Lidar 101," explaining how lidar sensor technology is an essential component of self-driving vehicles.

"The promise of safe, self-driving cars is very exciting, particularly for those of us who have seen the devastation that impaired driving and human error can bring," said former MADD President Colleen Sheehey-Church.

Image: Velodyne

A 3D LIDAR SENSOR such as the Velodyne Alpha Puck can deliver information to help enable vehicle autonomy and advanced driver-assistance systems.

Puck Sensor. The Velodyne Alpha Puck is a lidar sensor specifically made for autonomous driving and advanced vehicle safety at highway speeds. In a session at July's Automated Vehicle Symposium, company speakers presented "High-Definition 3D Lidars: An Integral Part of Future Autonomous Driving," including use cases that have proven elusive for solutions based on camera and radar; and "State of Solid-State 3D Lidar," a technical presentation on application-specific integrated circuits (ASICs).

"Core lidar electronics are moving from a printed circuit board to an ASIC, which provides advantages such as higher density, lower cost and improved reliability," said UAV and Robotics Business Manager Frank Bertini. "The trend roughly follows Moore's Law, leading to dramatic decreases in size, weight and cost over relatively short time periods."

> "Autonomous vehicle technology holds the incredible promise of helping us eliminate drunk driving."

WORLD SAFETY SUMMIT ON AUTONOMOUS TECHNOLOGY
Levi's Stadium in Santa Clara, California | October 2, 2019
See **velodynelidar.com/safety-summit.html**

The summit is designed to advance understanding of the safety benefits that can be achieved with autonomous vehicle technology. It is designed for business, government, public safety and community leaders. Attendees will have the opportunity to ride in autonomous vehicles.

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1. VEHICLE TRACKER

USES U-BLOX TO DETECT PANIC BREAKING

Arvento's imt.x1 has a six-axis gyro sensor that can sense three-dimensional movement caused by emergency acceleration, panic braking and directional yaw and drift. With connectivity options including dual CANBus and Bluetooth, the system is eCall compatible and captures and provides data for accident analysis and other vehicle tracking functions. The system also uses the next-generation powerful Arm-based microcontroller. The system's high position sensitivity and accuracy are based on integration of u-blox's 2G, 4G and 5G-ready cellular modules as well as GNSS modules.

Arvento, arvento.com; u-blox, u-blox.com

2. DUAL-BAND GNSS MODULE

PROVIDES MASS-MARKET POSITIONING

The compact LC79D module features concurrent multi-constellation GNSS receivers on dual GNSS bands. It uses L1 and L5 for GPS, Galileo and QZSS, L1 band for GLONASS and BeiDou, and L5 band for IRNSS. It can generally increase the number of visible satellites, significantly improve positioning drifting when driving in urban canyons and enhance positioning accuracy. Embedded with a low-noise amplifier (LNA) and multi-tone active interference, the module provides high sensitivity and reliable anti-jamming capability, ensuring exceptional acquisition and tracking even in weak signal areas.

Quectel Wireless Solutions, quectel.com

3. DEVELOPMENT KIT

FOR TESTING AND INTERATING MOSAIC

The mosaic development kit helps integrate mosaic into an existing system. Mosaic is a compact high-precision multi-frequency GPS/GNSS module that brings precision and reliability of high-end multi-frequency GNSS to mass-market applications. Its light weight and low power consumption makes mosaic suitable for robotics, automation, telematics and wearables. The kit supports connectivity through internet, COM ports, USB 2.0 and an SD Card slot. Mosaic provides Advanced Interference Mitigation (AIM+); extensive corrections support for high-accuracy positioning; integrity needed for safety-critical applications such as autonomous vehicles; and a 100-Hz update rate, suitable for robotics and fast-moving vehicles.

Septentrio, www.septentrio.com

4. MICRO INS

FOR DEFENSE, AVIATION, AERONAUTICS

The EN-2000 is the newest addition to the Emcore-Orion series of micro-inertial navigation (MINAV) systems. It is compact and lightweight, weighing less than 7 pounds, with very low power consumption of 10 watts. It can deliver twice the performance of the EN-1000 with the same form factor. With its low size, weight and power (SWaP), the compact EN-2000 is suitable for unmanned aerial vehicles, unmanned underwater vehicles, unmanned ground vehicles, manned aircraft, rotorcraft and dismounted soldier applications. Its three-axis design uses a solid-state optical transceiver with advanced integrated optics, combined with new field programmable gate array (FPGA) electronics to deliver stand-alone aircraft-grade navigator performance at one-third the SWaP of legacy systems.

Emcore, emcore.com

5. M-CODE RECEIVER

SET FOR 2020 PRODUCTION DELIVERIES

The Miniature PLGR Engine – M-Code (MPE-M) GPS receiver is a small Type II form factor ground receiver, and incorporates the company's recently certified Common GPS Module (CGM). As a drop-in replacement for the thousands of customers using Collins' Miniature PLGR Engine-SAASM (MPE-S) GPS receiver, the new MPE-M technology provides 10 times stronger anti-jamming capabilities for the direct acquisition of GPS signals than its predecessor. The MPE-M receives the current military Y-code GPS signal along M-code. It provides warfighters with improved security and assured positioning, and it satisfies the U.S. government's requirement for all military GPS equipment to be M-code capable. It is designed for lightweight, ground-based applications such as radios, blue force trackers, targeting devices, vehicle line-replaceable units (LRUs) and small unmanned aircraft. The MPE-M's security certification makes the receiver eligible for export to U.S. allies through the Foreign Military Sales (FMS) program.

Collins Aerospace, www.utc.com

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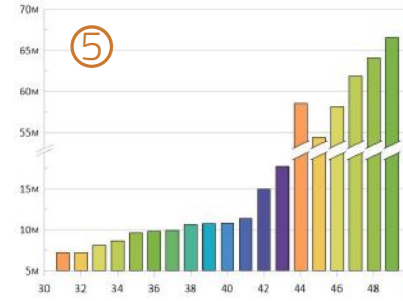


1. SOFTWARE RECEIVER

AVAILABLE WITH USAGE-BASED PLAN

The Catalyst software-defined GNSS receiver for Android phones and tablets is now available with a usage-based service plan: Trimble Catalyst On Demand. The new service plan meets the needs of industries and organizations that need a more flexible payment model. Organizations use Catalyst to record positions, navigate to points, measure relative distance and create digital maps. Trimble Catalyst On Demand provides scalable access to real-time kinematic (RTK)-quality GNSS positioning using a pay-per-use hourly pricing model in addition to the current Catalyst monthly plans. The service also enables automated domain-level email address access, which streamlines license allocation for organizations with a large number of users. (Pictured: Catalyst DA1 antenna).

Trimble, www.trimble.com

2. RUGGED TABLET

3D IMAGING AND BUILT-IN GNSS

The DT301X is designed for 3D mapping. Its Intel RealSense Depth camera provides real-time 3D imaging combined with a dual-frequency GNSS module for real-time mapping and positioning. The digital images are better than high-definition standard, and are suitable for construction building information management (BIM) graphics. The highly durable IP65 and MIL-STD-810G-rated tablet in a slim case can be used in the field, office and vehicles. A bright 10.1-inch touchscreen provides indoor/outdoor viewing. The tablet includes long-range Bluetooth and 4G LTE mobile broadband for the latest in high-speed communications. An Intel 8th-generation Core i5 or i7 processor offers high performance while still being energy efficient.

DT Research, www.dtresearch.com

3. AIRBORNE LIDAR

MAPPER FOR WIDE-AREA, MOUNTAIN, URBAN AND CORRIDOR SURVEYS

The ALTM Galaxy PRIME wide-area lidar sensor offers collection efficiency, a small form factor and high-quality data sets that meet rigorous USGS lidar standards. It has a 6,000-meter above-ground-level (AGL) collection envelope and 1-MHz on-ground collection rate. Galaxy PRIME includes lidar technology enhancements to increase sensor performance and collection efficiency, improve data quality, and simplify the collection process. It can be used either gyro-stabilized or fixed-mounted, one camera or six, and full waveform or discrete. PulseTRAK technology enables a continuous operating envelope by eliminating data coverage gaps and irregular point density. Applications include wide-area mapping, urban mapping, natural resource management, engineering, infrastructure modeling, and powerline and transportation corridors.

Teledyne Optech, teledyneoptech.com

4. IMAGING SENSOR

REAL-TIME 3D REALITY CAPTURE

The Leica BLK247 real-time reality-capture device uses sensor fusion technology to detect and report physical changes within a space. It is designed for continuous 3D reality capture, extending capabilities for safety and security applications. The sensor provides real-time situational awareness through edge computing and lidar-enabled change-detection technology. Using artificial intelligence, the BLK247 can tell the difference between still and moving objects — such as a person walking who leaves a suitcase behind — and identify security threats to provide real-time alerts.

Hexagon, hexagon.com

5. SCIENTIFIC SOFTWARE

BETTER DATA INTERPRETATION

Version 15 of Grapher has new capabilities to improve the ability to model, analyze and interpret data as well as communicate the results. Grapher users can now access new Fit Curve, Axes and Statistical Plotting capabilities. Also, users are provided greater color customization functions in the latest release. Enhancements give Grapher users a more powerful ability to display and communicate the results of their work to others. The software provides 80 different 2D and 3D plot types for analyzing and displaying scientific data.

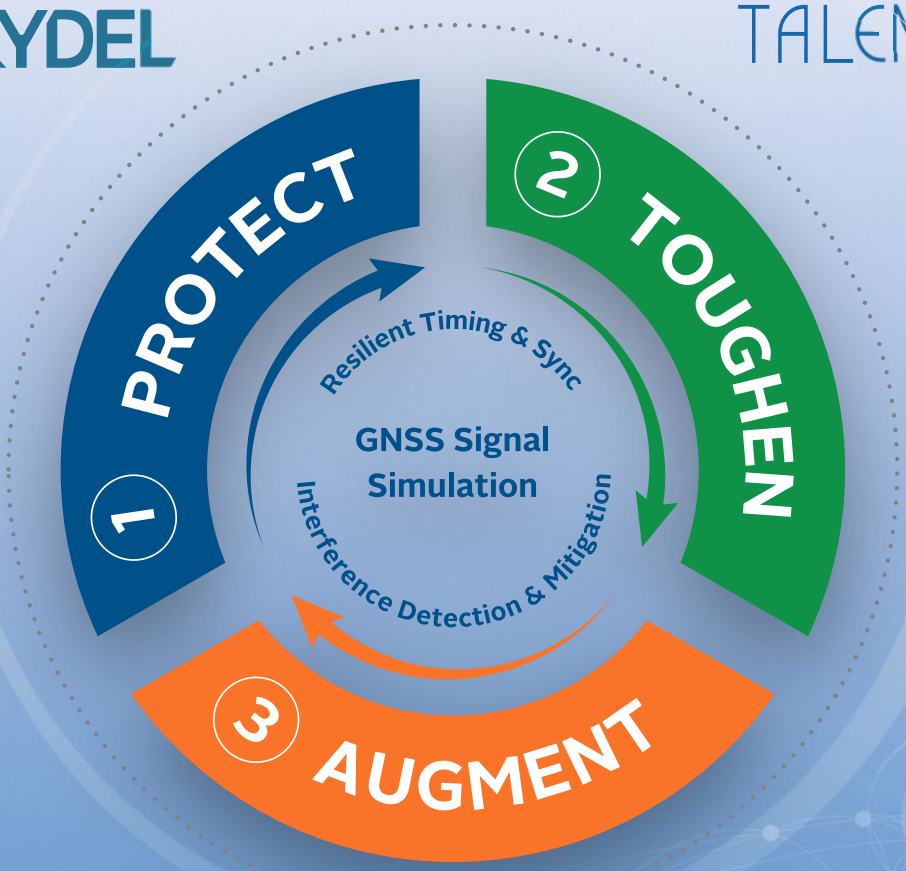
Golden Software, goldensoftware.com

Talen-X and Skydel Join the World Leader in Resilient PNT

- Unparalleled Solutions for GNSS Testing & Simulation
- Global Military & Commercial Applications
- Jamming/Spoofing Threat ID & Mitigation

SKYDEL

TALEN-X



See Live Demos of our full suite of Assured PNT Solutions at

AUSA 2019
October 14-16
Booth 8232

orolia
Time and Location You Can Trust™

Contact us to learn more about our GNSS and PNT solutions for military and commercial applications.

orolia.com
sales@orolia.com

LAUNCHPAD | UAV

1. HEAVY-LIFT SCANNING UAV
READY FOR LONGER FLIGHTS

The Harris Aerial H4/H6 Hybrid multicopter is now offered as an integrated package with any Lidar USA scanning system. The Harris Hybrid can provide longer flights with lidar and industrial-grade cameras. The Harris Hybrids use a small generator running on 95 or higher octane fuel to power the UAV for up to five hours.The H6 can carry an A-series high-definition lidar system of 3 kg for 2.5 hours and a V-series of 5 kg up to 1.5 hours. For the lidar operator, this means most projects will require only one or two flights.
Lidar USA, www.lidarusa.com

2. COMMERCIAL DRONE
LONG DURATION FOR SENSITIVE TASKS

The US-1 was built with sensitive enterprise and government customers in mind. It was designed from the ground up in the United States with a battery-first approach to enable electric aircraft to compete with conventionally fueled incumbents. The US-1 runs on a secure open-source operating system by Auterion. It provides 78 minutes of flight time and high-resolution optical and thermal cameras. US-1 UAVs have been deployed to fight fires, locate pipeline leaks, and track armed suspects.
Impossible Aerospace, impossible.aero
Auterion, auterion.com

3. DRONE RESCUE SYSTEM
MEETS ASTM STANDARDS

The DRS-M600 reusable parachute safety solution, developed for DJI M600 and DJI M600 Pro, meets specifications of the ASTM F3322-18 standard. The successful completion of the ASTM standard test makes it possible for the Federal Aviation Administration to issue permits for its use on drones over crowds. The ASTM F3322-18 standard is the first standard for parachute systems designed specifically for small UAVs.
Drone Rescue Systems, www.dronerescue.com

LAUNCHPAD | TRANSPORTATION

1. GPS/COMM RADIO
WAAS/SBAS WITH LPV APPROACHES

The GNS 355 GPS navigator with localizer performance with vertical (LPV) approach guidance gives pilots the benefits of WAAS/SBAS GPS guidance with a modern communications radio. Intended for Class I/II aircraft that weigh 6,000 lbs./2,721 kg. or less, the GNC 355 is certified for more than 700 aircraft makes and models. Aircraft owners can incorporate the GNC 355 into an existing avionics stack because of its standard 6.25-inch wide by 2-inch tall design. The responsive touchscreen display allows pilots to quickly access direct-to functionality, moving map, flight plan, nearest, procedures, waypoint and terrain pages and create customizable data fields and shortcuts for quick, one-touch access to important information. Fully WAAS/SBAS IFR-approach-capable, the GNC 355 gives pilots the benefit of flying LPV, as well as Area Navigation (RNAV) approaches. Many approaches offer vertical approach guidance as low as 200-feet above ground level (AGL).
Garmin, Garmin.com

2. RTK INS PLATFORM
FOR AUTONOMOUS VEHICLES UNDER DEMANDING CONDITIONS

The Allystar INS Platform is a dual-antenna, multi-frequency, multi-GNSS inertial navigation system (INS) that delivers accurate and reliable position, velocity and orientation. It combines high-grade, six-axis, temperature-calibrated accelerometers and gyroscopes with a multi-frequency, multi-GNSS engine, the HD9300 series. The HD9300 is a dual-antenna chip-grade real-time kinematic (RTK) GNSS receiver for accurate positioning and heading. The Allystar INS platform contains an on-board sensor-fusion filter, plus navigation and calibration algorithms for different dynamic motions of land vehicles. The Allystar OBD Data Adapter (v1.0) enables users to read and monitor various sensors built into cars, obtaining real-time vehicle speed and gear signals from the on-board diagnostics (OBD) interface, and then output AT (attention) commands by serial port or serial peripheral interface (SPI).
Allystar, www.allystar.com

GNSS Spoofers, don't mess with me!

There are more spoofing reports in international waters!

Tracked • Used • Faked

Spoofed • Replaced • Blocked/Jammed

See details inside >>>

JAVAD

www.javad.com

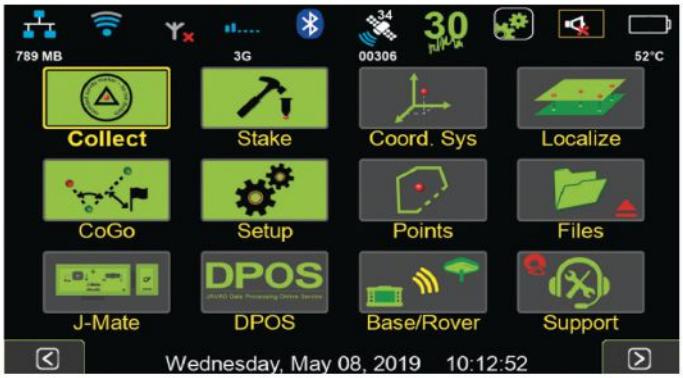
Introduction to J-Mate

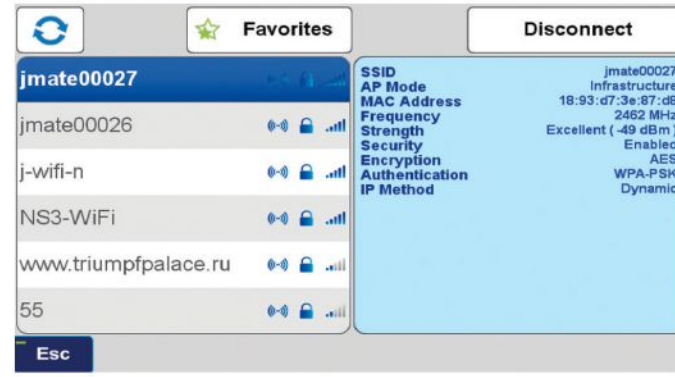
Let's set the record straight: J-Mate is not a total-station. **J-Mate and TRIUMPH-LS together** make the **"Total Solution"** which is a combination of GNSS, encoder and laser range measurements that **together do a lot more than a total station**. For long distances you use GNSS and for short distances (maximum of 100 meters) you use the J-Mate along with the TRIUMPH-LS. Together they provide RTK level accuracy (few centimeters) in ranges **from zero to infinity**.

As with the TRIUMPH-LS, with the J-Mate we also provide software improvement updates regularly and free of charge. Download the J-Mate update in your TRIUMPH-LS and then inject it to the J-Mate. The J-Mate SSID will be in this format JMatexxx, where xxx is your J-Mate's serial number. After a Wi-Fi connection is established, click the J-Mate icon and then click Setup. When you are prompted to connect to the J-Mate, click yes and then follow the remaining prompts.

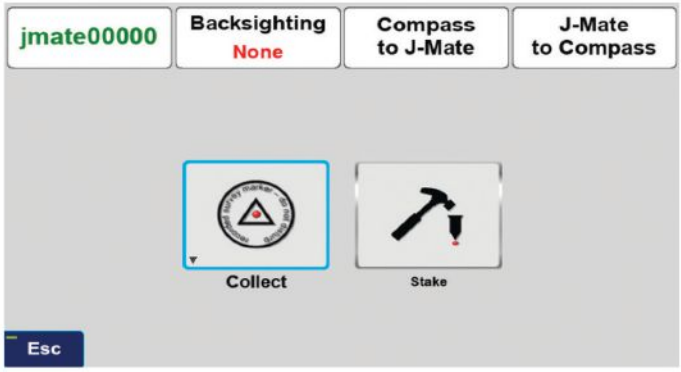
Connecting the TRIUMPH-LS to the J-Mate

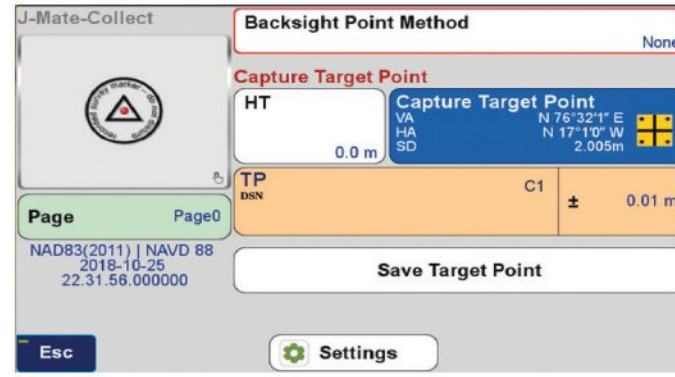
TRIUMPH-LS communicates with the J-Mate through Wi-Fi. Turn on both the TRIUMPH-LS and the J-Mate. Click the Wi-Fi icon on the TRIUMPH-LS Home screen to connect to the J-Mate, much the same way as you connect TRIUMPH-LS to your Wi-Fi access point.





After connection, click the J-Mate icon on the TRIUMPH-LS Home screen and then J-Mate/ J-Mate Collect/Capture Target Point to get familiar with the Main J-Mate screen.





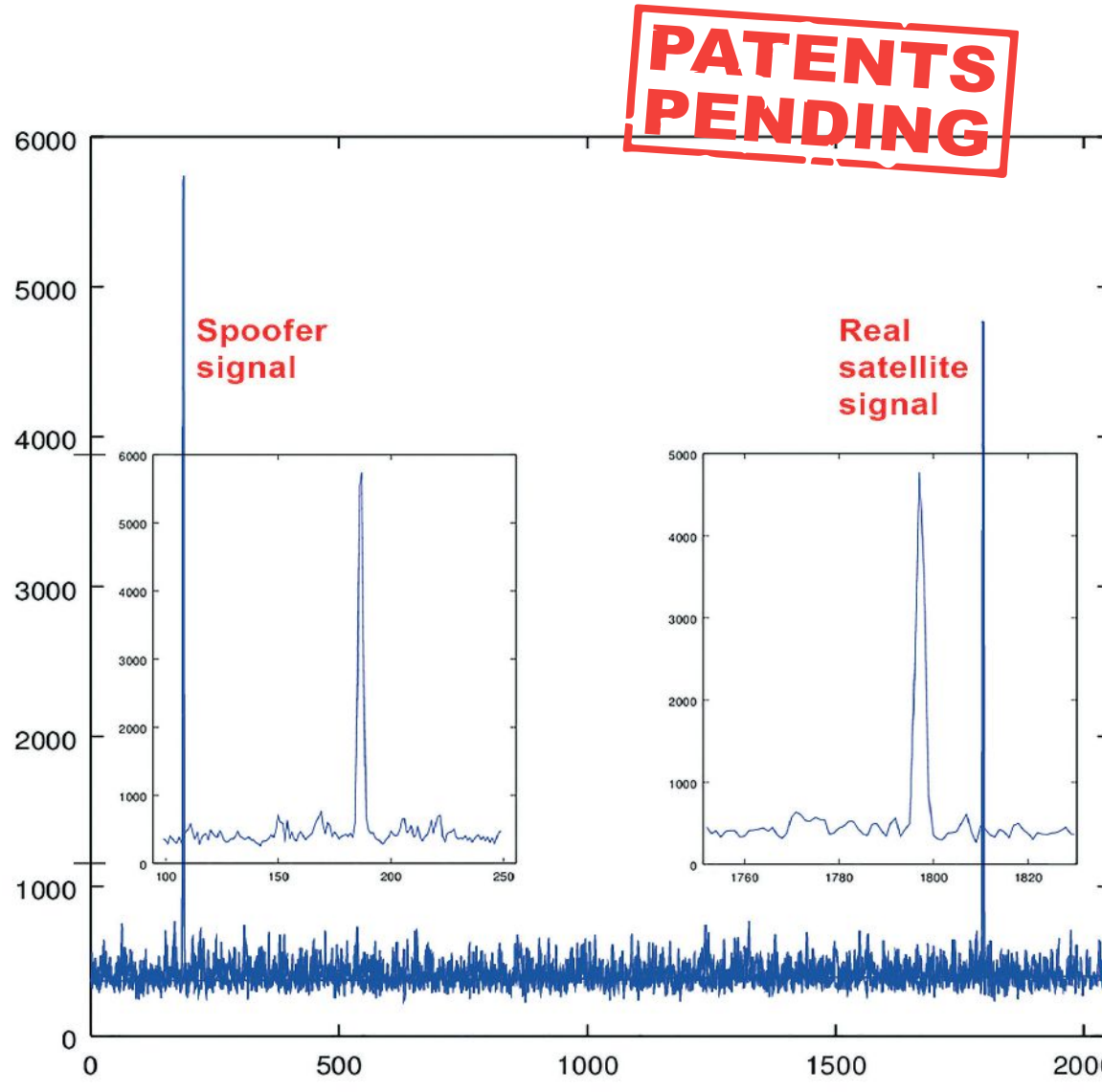
Spoofer Detection

With 864 channels and about 130,000 quick acquisition correlators in our TRIUMPH chip, we have resources to assign more than one channel to each satellite to find ALL signals that are transmitted with that GNSS satellite PRN code.

If we detect more than one reasonable and consistent correlation peak for any PRN code, we know that we are being spoofed and can identify the spoofed signals.

When we detect that spoofing is in effect, we use the position solution provided by all other clean signals (L1, L2, L5, etc... GPS, GLONASS, Galileo, Beidou, etc...) to identify the spoofer signal and use the real satellite measurement. If all GNSS signals are spoofed or jammed, then we alarm you to ignore GNSS and use other sensors in your integrated system.

Figure below shows an example of a spoofer signal and a real satellite signal received at GNSS receiver.



Satellite and Spoofer Peaks

The screenshots below are from a real spoofer in a large city. The bold numbers are for the detected peaks. The gray numbers represent highest noise, not a consistent peak. "*" symbol next to the CNT numbers indicate that signal is used in position calculation. Each CNT count represent about 5 seconds of continuous peak tracking.

SAT	EL	S...	Range 1	Dopp...	CNT 1	S...	Range 2	Dopp...	CNT 2	dRng	dDop	N
GPS5	33	**16**	**61.14**	**1382**	**184***	4	25.95	181	1	29.32	1201	29
GPS7	51	**21**	**14.39**	**1146**	**184***	4	18.21	-453	1	2.80	1599	29
GPS8	30	**18**	**65.10**	**-918**	**184***	4	4.26	-1318	1	3.68	400	29
GPS9	12	**14**	**40.46**	**2966**	**184***	4	2.08	3765	1	26.13	-799	29
GPS13	40	**16**	**46.92**	**-3525**	**184***	4	8.21	-4325	1	25.80	800	29
GPS15	12	**14**	**12.46**	**-4336**	**30***	5	33.00	-1536	1	19.52	-2800	28
GPS20	24	**12**	**13.19**	**-1707**	**107***	4	29.32	-3307	1	15.11	1600	29
GPS27	16	**11**	**10.26**	**1264**	**184***	4	43.55	63	1	31.22	1201	29
GPS28	53	**19**	**9.41**	**-2724**	**184***	4	7.93	-4724	1	0.46	2000	29
GPS30	81	**22**	**13.79**	**-332**	**184***	5	34.16	1266	1	19.35	-1598	28
GLN-4	54	**20**	**62.08**	**1498**	**1158***	5	21.72	2697	1	24.16	-1199	25
GLN5	46	**20**	**18.04**	**-2897**	**524***	4	26.26	-3697	1	7.20	800	25
GLN0	37	**18**	**30.37**	**2355**	**1469***	4	38.37	1554	1	6.98	801	25
GLN-1	82	**18**	**34.92**	**-776**	**189***	4	12.54	-1576	1	21.35	800	25
GLN-2	26	**12**	**30.96**	**-4358**	**229***	4	11.80	-3158	1	18.13	-1200	25
GLN2	21	**10**	**59.73**	**288**	**551***	4	47.55	1087	1	11.16	-799	25
GLN4	22	**15**	**30.59**	**-3361**	**208***	4	11.74	-5361	1	17.83	2000	25
GLN-5	21	**14**	**20.17**	**276**	**187+**	3	25.45	2275	1	4.26	-1999	25

Esc Sat: 10 7 6 4 4 0 dPos: 19.0m Age: <1s

No spoofer. Only one reasonable peak for each satellite.

PATENTS PENDING

Elevation Angle | Signal above noise level | Range mod 1 ms | Doppler | 5 sec count | Signal above noise level | Range mod 1 ms | Doppler | 5 sec count

Satellite Name | First Peak | Second Peak | Delta range | Delta Doppler | Noise level

SAT	EL	S...	Range 1	Dopp...	CNT 1	S...	Range 2	Dopp...	CNT 2	dRng	dDop	N
GPS1	**14**	**14**	**231.08**	**-2627**	**140***	**9**	**155.13**	**-2627**	**60**	74.93	0	28
GPS10	9	**12**	**267.44**	**-2078**	**74***	4	238.41	-3278	1	28.01	1200	28
GPS11	22	**13**	**297.36**	**-847**	**301***	3	6.45	1151	1	289.89	-1998	29
GPS13	**55**	**21**	**136.95**	**1154**	**301***	**9**	**21.70**	**1153**	**73**	114.23	1	28
GPS15	**49**	**20**	**278.00**	**-453**	**301***	**9**	**168.03**	**-453**	**73**	108.95	0	29
GPS17	**41**	**22**	**83.28**	**-3212**	**301***	**10**	**277.41**	**-3212**	**69**	193.11	0	28
GPS19	**23**	**14**	**133.13**	**-4590**	**164***	**7**	**19.06**	**-4590**	**69**	113.05	0	29
GPS20	5	**8**	**170.96**	**2215**	**36***	3	50.73	614	1	119.21	1601	29
GPS24	**22**	**15**	**54.25**	**-4022**	**177***	**9**	**250.43**	**-4022**	**82**	195.16	0	29
GPS28	58	**18**	**50.14**	**1040**	**301***	3	268.62	1439	1	217.46	-399	29
GPS30	23	**17**	**290.02**	**2593**	**301***	3	214.66	4592	1	74.34	-1999	28
GLN-7	30	**22**	**159.09**	**2505**	**213***	7	274.16	2104	1	114.05	401	28
GLN-4	39	**18**	**72.21**	**-450**	**282***	7	220.15	-3250	1	146.92	2800	28
GLN-1	34	**18**	**92.17**	**-3838**	**259***	6	299.41	-1838	1	206.22	-2000	28
GLN0	72	**23**	**271.81**	**147**	**283***	7	78.08	2146	1	192.71	-1999	28
GLN1	23	**15**	**297.65**	**3244**	**129***	6	8.21	2443	1	288.42	801	28
GLN2	42	**18**	**200.78**	**-742**	**282***	6	234.83	2056	1	33.03	-2798	28
GLN3	17	**18**	**158.51**	**2584**	**282***	6	44.03	4583	1	113.46	-1999	28

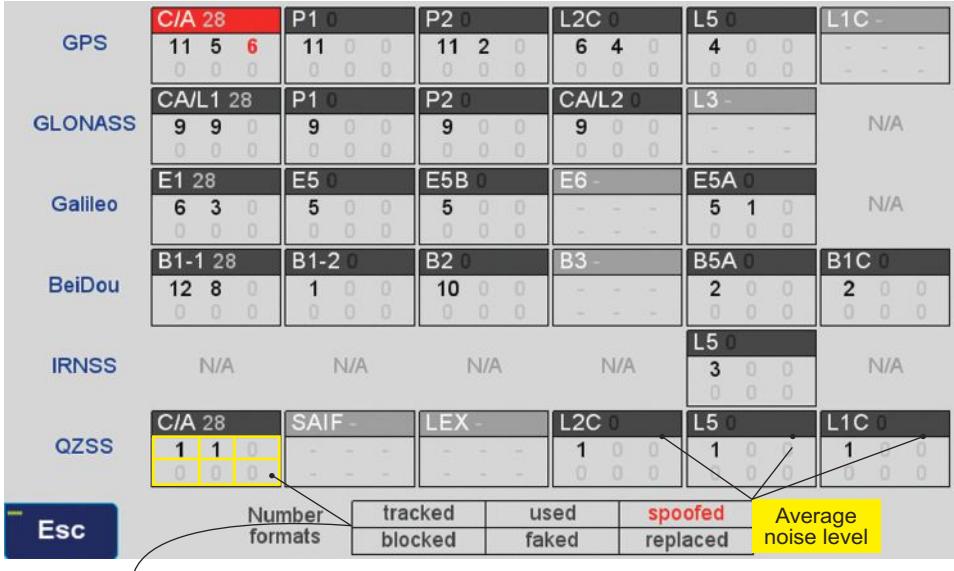
Esc Used: 11+9+4+8+0+1=33 1 2 dPos: 21.2m Age: <1s

GPS GLN GAL BDU IRN QZ ◂ Number of satellites used in position calculation

In the above screenshot all GPS satellites have two peaks and all are spoofed. We were able to distinguish the spoofer signal and use the real satellite signals in correct position calculation as indicated by the "*" next to the CNT numbers.

GNSS Overall View

The screenshot below shows the status of all GNSS signals. The format and the signal definitions are explained below.



GPS L2C: L+M
GLN L3: I+Q
GAL E1: B+C
GAL E5: alboc
GAL E5B: I+Q
GAL E5A: I+Q
BeiDou B2: B5B
QZSS L2C: L+M
QZSS L1C: I+Q

Figure 4
The screenshot shows the status of all GNSS signals.

Definitions for the number of signals:

Tracked: Tracked by the tracking channels and has one valid peak only.

Used: Used in position calculation.

Spoofed: Has two peaks. Good peak is isolated, if existed.

Blocked: Blocked by buildings or by jamming. If jammed, shows higher noise level.

Faked: Satellite should not be visible, or such PRN does not exist.

Replaced: Real signal is jammed and a spoofed signal put on top of it. Because of jammer, it shows higher noise level.

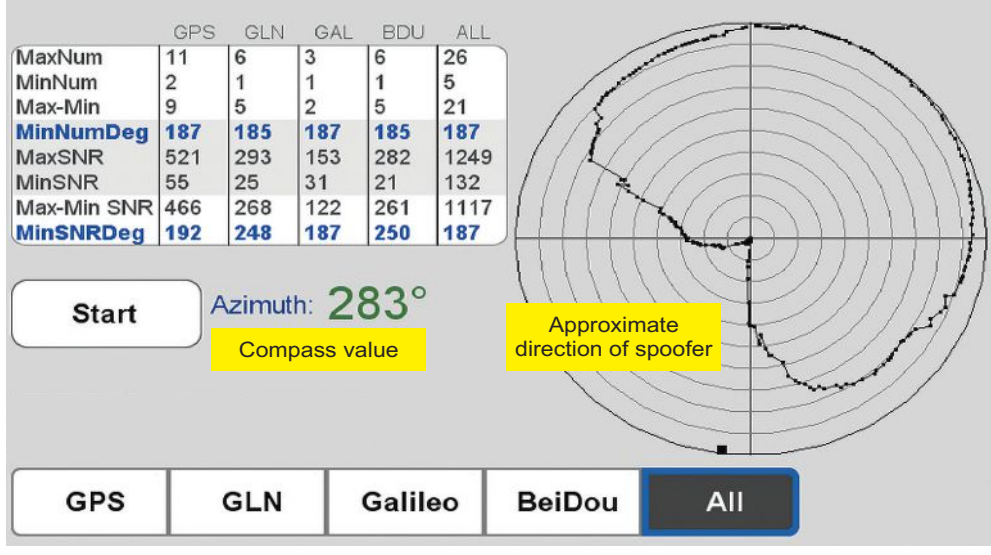
Spoofer detection available in all of our OEM boards too.

See details in GPS World expert opinions section “What is the biggest challenge facing designers of multi-constellation GNSS receivers today?” with Javad Ashjaee and at www.javad.com

Spoofer Orientation

When you detect that spoofers exist, you can also try to find the direction that the spoofing signals are coming from. For this, hold your receiver antenna (e.g. TRIUMPH-LS) horizontally and rotate it slowly (one rotation about 30 seconds) as shown in the picture and find the direction that the satellite energies become minimum. This is the orientation that the spoofer is behind the null point of the antenna reception pattern.

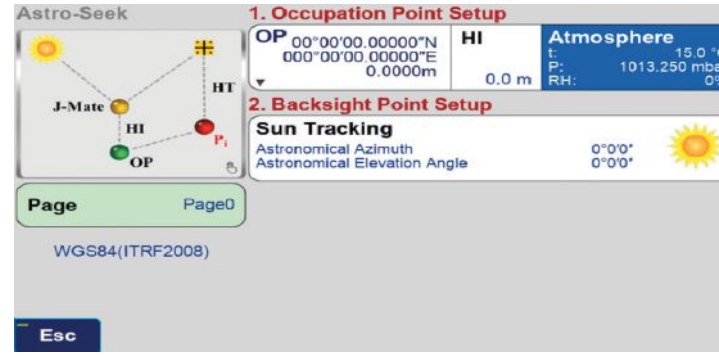
After one or more full rotations observe the resulting graph that shows approximate orientation of the spoofer as shown in figure below.



This screenshot is from the experiment within an anechoic chamber. That is why the picture is clean and smooth.

Backsight point and the Sun

Similar to using conventional total station, to use the J-Mate you need to first establish its accurate position and calibrate its vertical and horizontal encoders. Then proceed to shoot the unknown points. This is similar to using any total station, but we have improved and automated the process.



With J-Mate you can do these in three different ways as shown in the J-Mate screen of the TRIUMPH-LS. Via the J-Mate-Backsight; J-Mate-Resect and J-Mate-Astro-Seek icons.

If GNSS signals are available at the site, click the J-Mate-Backsight icon.

This screen appears which guides you to determine the accurate positions of the Occupation Point and a Backsight Point to establish an azimuth and calibrate the J-Mate angular encoders.

The tripod is setup at the “Occupation Point” (OP). The J-Mate is secured on top of the tripod.

Next, TRIUMPH-LS is put on top of the J-Mate with its legs registered to the matching features on the J-Mate.

Next Use the RTK Survey feature of the TRIUMPH-LS to quickly determine the accurate location of the Occupation Point. You can use your own base station or any public RTN.

Next, slide the J-Target on top of the TRIUMPH-LS, lift it from the J-Mate and move to the “Backsight Point” (BP). The camera of the J-Mate will search the J-Target. The camera’s view is visible from the TRIUMPH-LS screen, which mostly focuses on this J-Target. When at the Backsight Point, its accurate position is determined by the TRIUMPH-LS, and the Azimuth from the Operation Point to the Backsight Point is determined, and the J-Mate is calibrated and ready for use.

After this calibration is complete, if the tripod is disturbed, the red LED on the front of the J-Mate will blink to show that re-calibration is required.

We can now replace the TRIUMPH-LS on top of the J-Mate at the Occupation Point and proceed to shooting as many “Target Points” as the job requires. From now on TRIUMPH-LS is used as a controller and you can hold in your hand too, but it is more convenient to put it on its place to have free hands.

If GNSS signals are not available at the Occupation Point, click the “J-Mate-Resect” icon to shoot two known points to establish its accurate position and calibrate its encoders. Then continue to shoot the unknown points.

Astro-Seek feature: Sun as the Backsight point!

We have added a new innovative feature to the J-Mate that it can automatically calibrate itself via its automatic Sun Seeking feature.

Attach the Sun filter to the camera of the J-Mate, click the “J-Mate-Astro-Seek” icon and click the “Sun” icon in the screen which appears and J-Mate will automatically find the Sun, and use its position to calibrate the angular encoders automatically.

TRIUMPH-3

The new TRIUMPH-3 receiver inherits the best features of our famous TRIUMPH-1M.

Based on our new third generation TRIUMPH chip enclosed in a rugged magnesium alloy housing.

The TRIUMPH-3 receiver can operate as a portable base station for Real-time Kinematic (RTK) applications or as a receiver for post-processing, and as a scientific station collecting information for individual studies, such as ionosphere monitoring and the like.

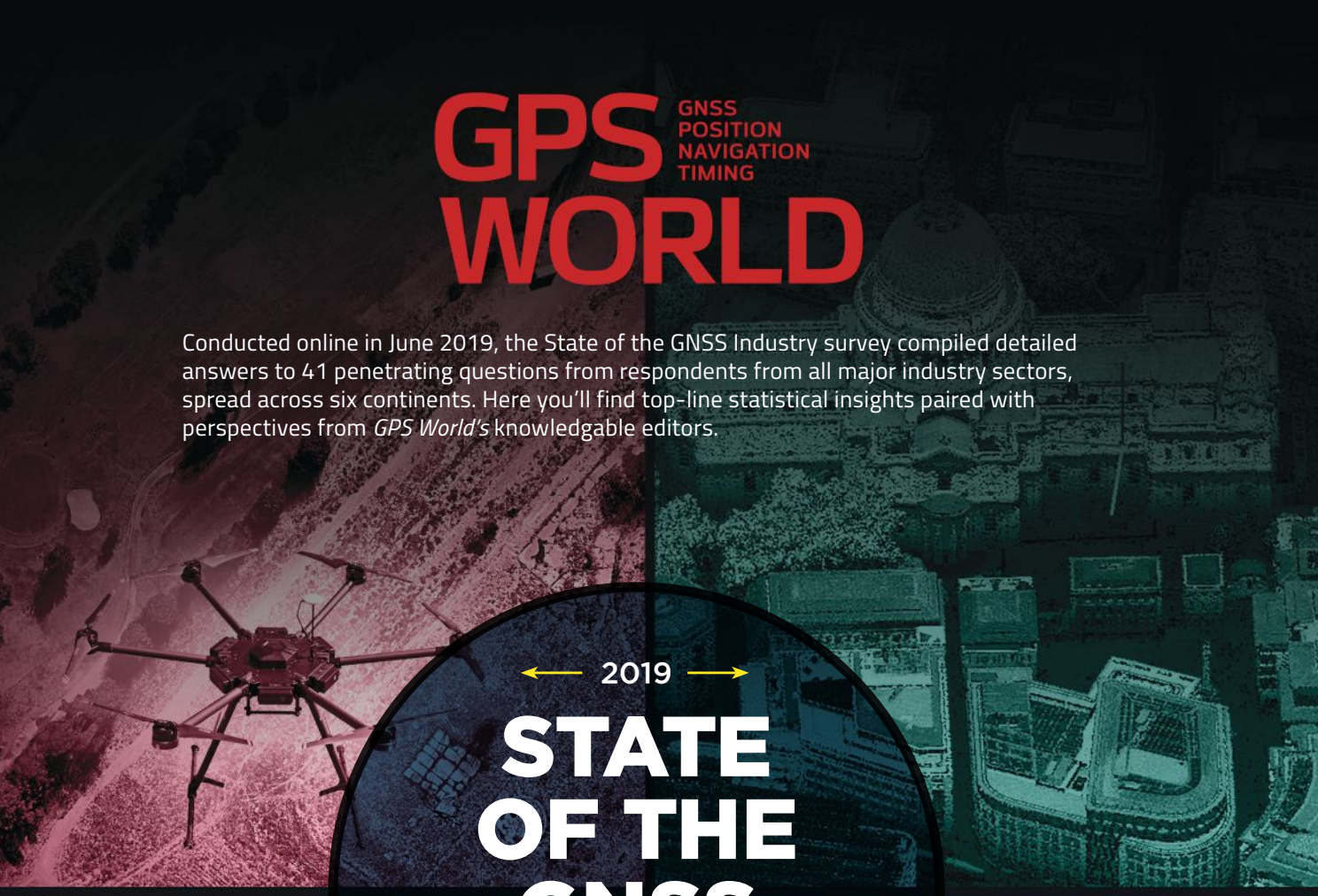
It includes options for all of the software and hardware features required to perform a wide variety of tasks.

- UHF/Spread Spectrum Radio
- 4G/LTE module
- Wi-Fi 5 GHz and 2.4 GHz (802.11 a, b, g, n, d, e, i)
- Dual-mode Bluetooth and Bluetooth LE
- Full-duplex 10BASE-T/100Base-TX Ethernet port
- High Speed USB 2.0 Host (480 Mbps)
- High Speed USB 2.0 Device (480 Mbps)
- High Capacity microSD Card (microSDHC) up to 128GB Class 10;
- “Lift & Tilt”
- J-Mobile interface

Ideal as a base station

GPS WORLD
GNSS POSITION NAVIGATION TIMING

Conducted online in June 2019, the State of the GNSS Industry survey compiled detailed answers to 41 penetrating questions from respondents from all major industry sectors, spread across six continents. Here you'll find top-line statistical insights paired with perspectives from *GPS World's* knowledgable editors.



2019

STATE OF THE GNSS INDUSTRY

Trends, Obstacles & Opportunities

Nearmap

Photo: Nearmap

3D REALITY CAPTURE of the HNTB headquarters in Kansas City, Missouri, in June 2018.

Elevating 3D Visualization

HNTB Corp. is an employee-owned infrastructure firm serving public and private owners and contractors in architecture, construction and engineering. Their clients' projects require high-resolution aerial imagery to ensure accuracy and life-like modeling.

Timeliness is also a factor as the team needs to create in-depth renderings in a relatively short amount of time.

Using high-quality 2D aerial imagery and photo-realistic 3D cityscapes from Nearmap, HNTB has upped its game and is serving its customers even better.

With the implementation of Nearmap 5.8–7.5-centimeter ground sample distance (GSD) aerial imagery, HNTB was able to implement an improved workflow. GSD aerial imagery is many times sharper than free satellite imagery.

For instance, oblique images are imported into a program such as 3ds Max to create a 3D point cloud. The point cloud can then be used to create a 3D mesh.

The imagery can be aligned to origin, trace and texture terrain, curbs, sidewalks and buildings. Lighting and shadows are matched to the exact time of day to create the most realistic rendering possible. When finished, the visualization technician can export it into AutoCAD for other engineering teams.

With photo-realistic, high-resolution visuals and models, HNTB now impresses its clients with accuracy and beauty, and can clearly showcase the overall impact of a project.

HNTB's use of Nearmap imagery allows them to:

- **Locate.** Using vertical imagery, team members become acquainted with the project site. This is especially useful when the project is out of state, minimizing the need for site visits.
- **Process.** Because the team has access to the same accurate, georeferenced data through Nearmap's MapBrowser, they are able to view and compare historical with current imagery, see timestamps, and export the imagery with gridded tiles for better integration into 3ds Max.
- **Integrate.** By generating a digital surface model from the aerial imagery, HNTB professionals can detect variation in terrain, which helps them provide more precise estimates for the client.

Nearmap serves more than 8,200 organizations and businesses globally using small aircraft for image capture. The aerial mapping company provides high-quality imagery as a subscription service delivered through the cloud. In most areas, its photo maps are captured at least twice a year, with leaves both on and off the trees, to provide different views of locations in different seasons.

Nearmap
10897 S. River Front Parkway
Suite 150
South Jordan, UT 84095

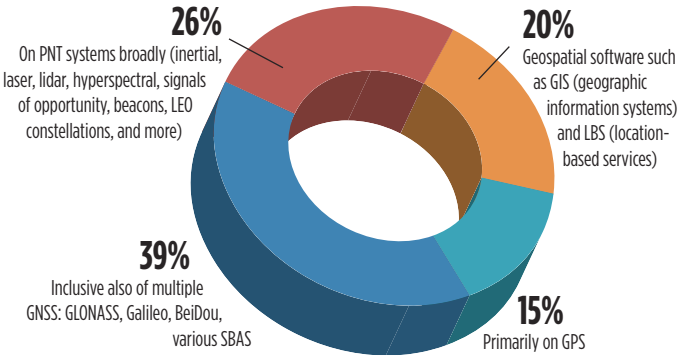
Phone:
1-844-463-2762

Web:
www.nearmap.com

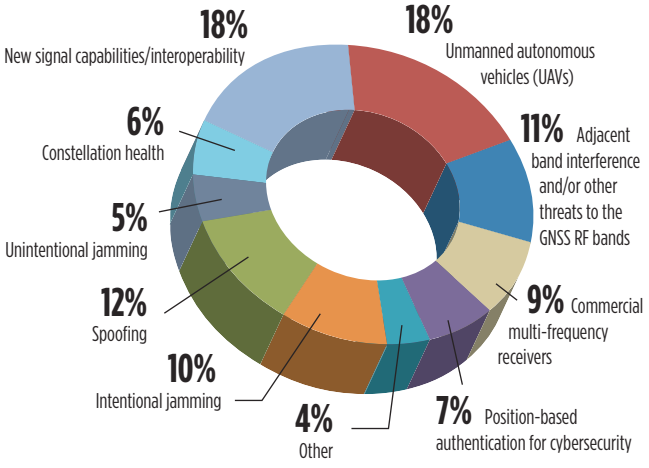
Where the GNSS Industry is Heading

INSIGHT PROVIDED BY ALL REGIONS, SECTORS AND JOB TITLES

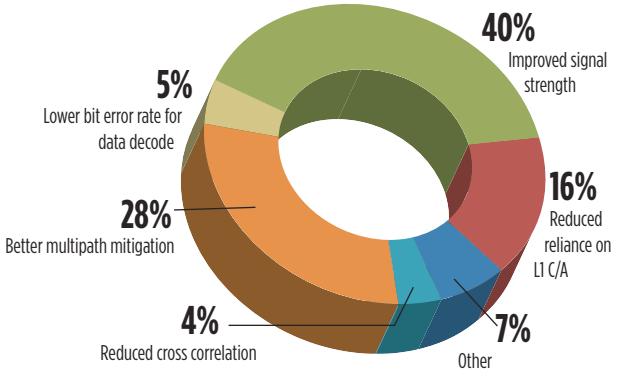
Where do you see your efforts focusing primarily over the next decade?



What is the industry "Issue of the Year?"



Among the many benefits of modernized signals, which is the most important in your field of work?



ALAN CAMERON
EDITOR-AT-LARGE
GPS WORLD

We bring you a full global perspective with this year's State of the GNSS Industry Survey. Just over half our respondents work for companies or organizations headquartered in North America; 15% are from Asia-based operations; roughly 10% each for enterprises in Europe and Latin America; slightly less for the Pacific region; and the rest of the replies scattered across Africa, the Middle East and Russia. Truly an international sampling!

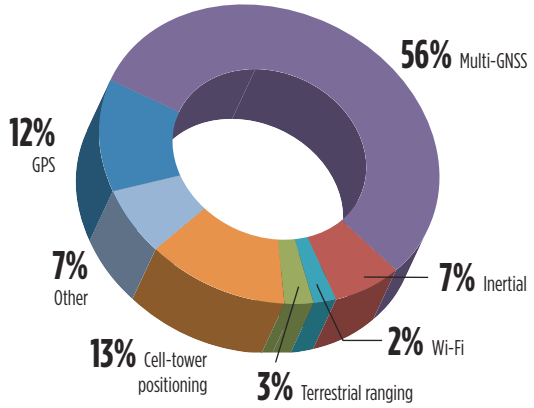
Demographics. For job titles, we drew in-depth data from:

- owner/president/CEO, 21%
- engineer, 20%
- general, product or program manager, 19%
- other, mostly surveyors or GIS analysts, 18%
- researcher, 10%
- vice president, CTO, COO, CFO or similar, 6%
- sales and marketing, 5%

Sector. The intelligence in the following pages accumulated from these industry verticals:

- survey and high precision, 29%
- defense, security, government, 19%
- mapping, data acquisition/processing, GIS, 14%
- satellites, signals and simulation, 9%
- machine control, precision agriculture, or transportation (non-autonomous), 6%
- autonomous vehicles (air, ground or water), 5%
- wireless and consumer, 4%
- other, 13%

What will be the core PNT technology 10 years from now, in 2029?



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- Threat and degraded environment simulation
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Economic Outlook: GNSS on the Rise

TRADE WARS MAY BE THE ONLY SERIOUS LIMITING FACTOR

ALAN CAMERON
EDITOR-AT-LARGE
GPS WORLD

The GNSS chip market worldwide is projected to grow by US$2.7 billion, guided by a compounded growth of 8%, to 2025, according to ResearchandMarkets. Other market reports cite "huge growth" and "strong development" in GNSS-related markets such as simulators, aviation and defense. We can count ourselves lucky — or remarkably prescient — to be part of such a robust industry, in such uncertain times.

The world conquest by smartphones, smart cities and the internet of things (IoT) will strongly support this market growth. Also on the horizon is the rising tide of GPS-enabled vehicles, putting automotive telematics on the road to assisted-driver and ultimately autonomous driving.

M&A. Meanwhile, the fast pace of mergers and acquisitions among manufacturers and integrators will strengthen the GNSS economy and propel it even higher. Such interactivity will bring higher revenue shares to key players as well as support overall profitability increases to come.

Accurate monitoring of operations and assets; the astonishing rise of drones to active roles in many industries; and the constant innovation and imagination churning out new products, solutions and augmented services — all will consolidate the strength of our remarkable economy. The much-heralded arrivals of BeiDou and Galileo fully upon the scene will only make the immediate future stronger for our industry.

PNT Broadly. Where GPS, GNSS, and multi-GNSS go, they carry other positioning technologies along on their coat tails: inertial, signals of opportunity, Wi-Fi, ultra-wideband and more. The growing pie is certainly big enough for all to get a large share.

That's not to say there are no barriers to growth, no clouds on the horizon. Licensing, laws and regulations will, as ever, constrict growth. This is not always a bad thing. Controlled growth and wise use benefit us all, and prevent runaway bubbles that can burst for lack of proper internal support.

Mapping. Meanwhile, a host of well-established businesses and nascent enterprises exploit the increased interest in location-based information as an enabler for many consumer, organizational and governmental services. This means that mapping and all manner of technologies associated with it — laser, lidar, infrared and more — may grow at even faster rates.

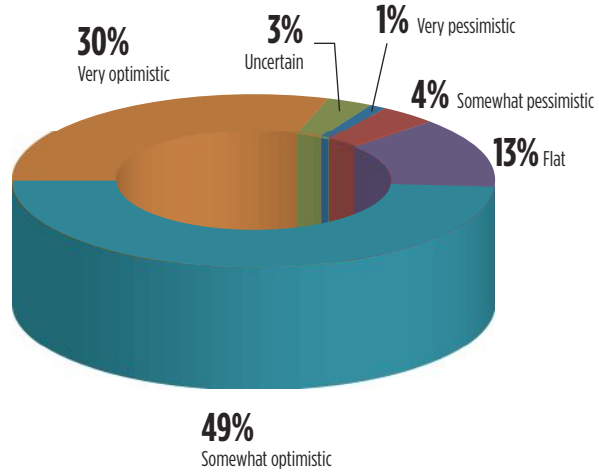
A brave new world awaits. Once GNSS is integrated with artificial intelligence, there's no telling where we're headed.

Of the many uncertainties across the globe, economic warfare poses a greater risk to GNSS than does military conflict. The latter, cynically enough, will actually benefit the industry in the short run, though its effect may chill in the long run.

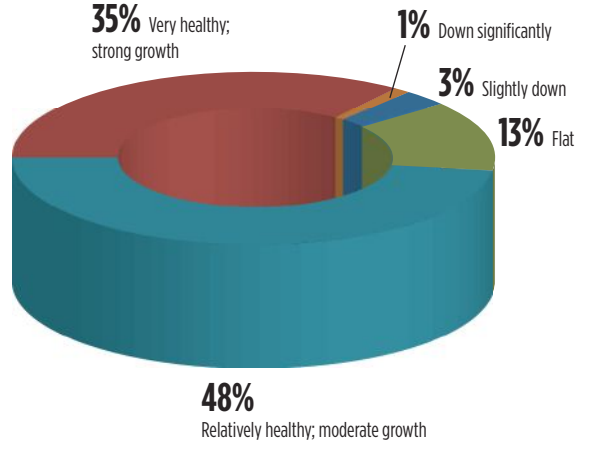
Trade. One of the biggest questions confronting the industry now is whether the trade and tariff war between the U.S. and China will continue, and what effect it will have. Experts disagree widely on both questions, though almost all of them, except the leaders who are supposed to listen to them, agree that it's generally a bad thing.

As was stated in these pages at this time last year, if business confidence falls as a result, global output could also drop.

What is your business outlook for 2019?



Describe the market for GNSS products/services in your industry sector as of today.



Opportunities Outweigh Obstacles

INDUSTRY LEADERS CONFRONT SPECTRUM ISSUES, JAMMING

ALAN CAMERON
EDITOR-AT-LARGE
GPS WORLD

In contrast to the rosy forecast on the previous page, serious issues confront the GNSS market. None of them are more serious, thornier or difficult to resolve (despite the many solutions offered) than spoofing and jamming.

Like a tragic hero, GNSS carries a potentially fatal weakness within its strength. To be ubiquitous and highly precise, the signals come from space. Coming from space, they are weak and susceptible to malicious meddling.

Other political and technological obstacles put pressure on the GNSS industry, and therefore upon the whole PNT industry. GNSS always will be the backbone, the center core holding together various adjunct positioning, navigation and timing technologies.

These issues, following closely on the heels of spoofing and jamming, include but are not limited to: spectrum competition and spectrum management; cybersecurity; privacy; net neutrality; national security export controls; product liability; and failure, however temporary, of GNSS systems.

We've seen this last most recently with Galileo, but all the GNSS have suffered such setbacks, and surely will again. The nature of the response to each occurrence is the most critical factor.

Keep on the Sunny Side. However, the opportunities far outweigh the obstacles. The greatest opportunities always arise from the greatest asset that the industry possesses: intellectual capital. Many of the opportunities are cited on the previous page. While high precision will continue to lead the innovation charge and provide the highest profit margins, the smartphone and the automobile will increasingly take up the MVP (most valuable positioner) role within the industry.

Market Intelligence. All these factors make unprecedented demands on management attention and agility. Executives need good market intelligence to keep abreast and ahead of fast-developing research and development trends, market shifts, developments in neighboring or competing technologies, and protectionist tariffs and import/export controls.

Survey Advances on Almost Daily Basis

REAL-TIME NETWORK AVAILABILITY GROWS IN APPEAL, EXTENT

TIM BURCH
CONTRIBUTING EDITOR, SURVEY
GPS WORLD

State of the GNSS Industry respondents who identified themselves as being from the survey sector constituted 28% of the total, roughly corresponding to the percentage of the magazine's readership.

Multi-GNSS for Accuracy. In similar results to 2018's study, the most promising and practical way to gain the increased accuracy that survey and other high-precision applications demands, the choice was "dual-frequency, dual- or multi-constellation GNSS," followed by "real-time kinematic." The newest application in the survey, "real-time network (RTN) availability," came in a close third. GNSS receivers with inertial correction devices or remote sensing capability, while increasing in product exposure and advertising, continue to remain low on the respondent's agenda.

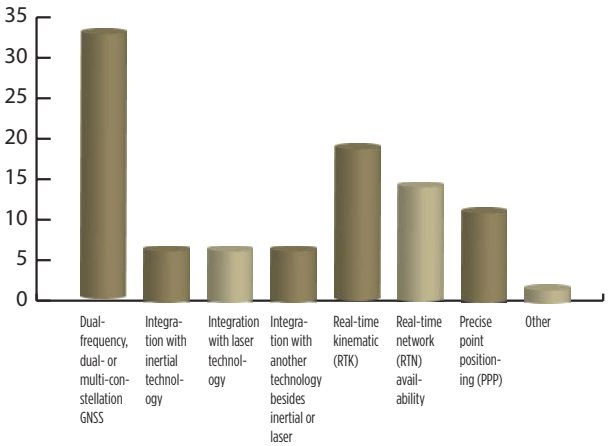
While not surprising that dual-frequency, dual- or multi-constellation GNSS would remain on top of the list with RTK capability coming in second, what is surprising is how RTN availability is a primary choice of many of those answering the poll questions. Coverage of RTN networks is expanding, so many surveyors must be taking advantage of them, seeing the value of not relying on a base station RTK setup. With the advancements in 5G cellphone coverage, it would not be startling to see this category increase significantly in the coming years. I also foresee an increase in precise point positioning (PPP) usage with UAV implementation because the cost of entry is quite reasonable.

The Role of Drones. This year's question on what role drones (UAVs) will play in the next three years for the survey sector was expanded to include the broad range of remote-sensing modules being added to the aerial vehicles — and based upon the responses, rightly so. More than 32% of the poll-takers replied that UAVs with remote-sensor capability will perform up to 50% of our field survey tasks. Those who feel that drone technology will only perform one-tenth of the survey tasks fell to 35%, down from 42% in 2018. However, those who felt UAVs will perform up to half of survey tasks rose significantly, from 9% last year to 23% this year. Bringing up the bottom were those who felt drones will perform 80% of field tasks along with gradually phasing out field surveyors, coming in at 5% each.

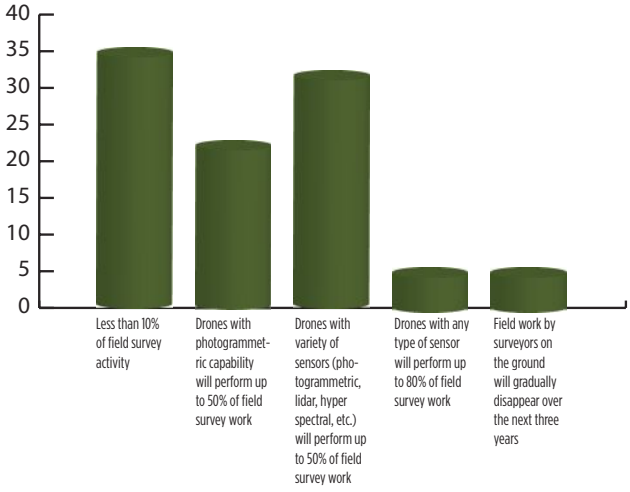
The expansion of remote-sensing methods (photogrammetric, lidar, hyperspectral, etc.) now available on UAVs has increased the viability for more data collection by autonomous and pilot-controlled methods. Increases in software capability, ease-of-use and storage capacity is leading to more surveying and mapping implementation in everyday tasks.

The overall increase in those who see UAVs becoming more prevalent in a surveying department's service offerings should not be surprising as more firms adopt the newer technology to maintain a competitive edge. We will continue to watch this trend, noting how the surveying profession both adapts to emerging technology and how that will affect the workforce. The rise from 1.3% to 5% of those who feel traditional tasks by

What is the most promising and practical way to gain the increased accuracy that survey and other high-precision applications continue to demand?



What role will drones (UAVs) play during the next three years in the survey sector?



field surveyors will begin to disappear is not troublesome, but may be a sign of changes in our near future.

The surveying industry continues to embrace GNSS and UAV technology along with the advancements happening on nearly a daily basis. More professionals are upgrading to remain current with the market trends, so staying in tune with the technological advancements is a major key to success.

TIM BURCH is a professional land surveyor and secretary on the board of directors, National Society of Professional Surveyors.

OPPORTUNITY:
NEW TECH

OBSTACLE:
KEEPING UP-TO-DATE WITH NEW TECH

UAVs Active Across All Sectors

DIFFERENT PLATFORM CONFIGURATIONS RAPIDLY EMERGE

TONY MURFIN
CONTRIBUTING EDITOR
PROFESSIONAL OEM & UAV
GPS WORLD

Drones continue to move further into everyday life and activity as they become more involved in applications that touch almost everyone. Previously a curious novelty, now unmanned aircraft are almost commonplace.

Real Estate. Suppose you are buying a new house. Almost all the exterior home pictures and video on real-estate websites come from dones. The high-definition photo capability of any commercially available drone is well up to providing great panoramic aerial shots — now virtually required to market homes.

See UAVs page 36. >>

Personnel no longer have to crawl through extensive, potentially toxic environments, such as the containment vessels at Fukushima Daiichi.

UAVs

« CONTINUED FROM PAGE 35.

Suitable UAVs and their operators are either readily available, or real-estate agents are taking on the job, buying and flying the equipment and managing the video-processing software themselves. Approvals for regular real-estate operations using drones now can be more readily obtained The objective is near real-time approval using the U.S. FAA's Low Altitude Authorization and Notification Capability (LAANC) system, with drone operations provided by an expanding list of independent UAS Service Supplier companies, cleared and qualified by the FAA to provide commercial drone operations.

Crop Monitoring. In agriculture, it is virtually expected that a large farm operation will be on a crop monitoring/maintenance program that entails regular drone data-collection flights and automated processing of geo-tagged photographic, thermal and laser crop images. An initial baseline set of images establishes the starting point for the program, and then analysis identifies crop weaknesses. A fertilizer/treatment "prescription" is then drawn up to address deficiencies. After applications throughout the growing areas, follow-up drone monitoring checks whether growth rates have improved or if more remedial action is necessary.

The cycle continues throughout the growing season. A number of large and small companies offer turnkey services to farmers, or farms themesleves run subsets of this UAS-based operation.

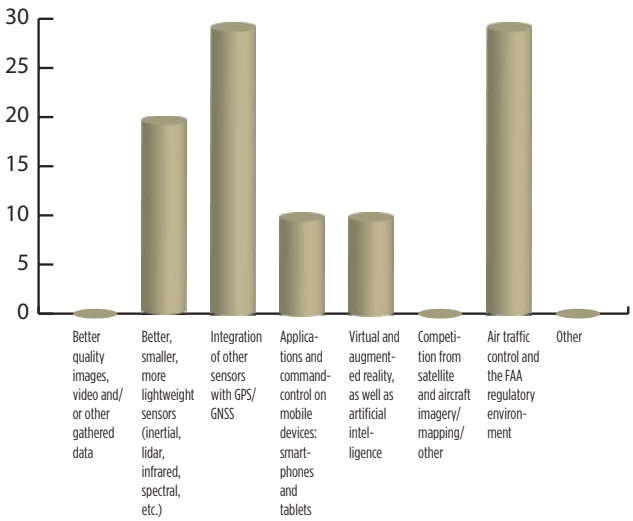
Construction and Inspection. Mining and construction now also have drone services that gather and process image data to automate significant parts of the process, as does surveying and geospatial information services (GIS).

Facility inspection using drones follows the agriculture model, with initial overflights establishing a baseline status record against which subsequent image data is compared.

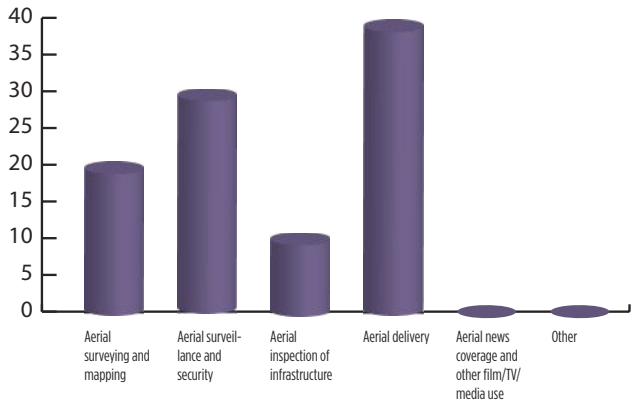
Indoor automation with drones also has enabled a huge reduction in time spent in frequent physical inspection of tanks, pressure vessels, holds and more. It also has greatly improved safety for inspection personnel who no longer have to crawl through extensive, potentially toxic environments, such as the containment vessels at Fukushima Daiichi.

News and Events. News gathering has been enhanced by the use of drones. Aerial videos capture the news quickly and inexpensively compared to helicopters, and provide overview situational awareness for the news audience. In the same vein, we can add crowd surveillance at large events, where higher levels of security are required, such as the 2019 FIFA

What is the biggest challenge for the UAV industry?



What is the killer app for drones? What professional UAV market sector will most powerfully drive adoption and influence new regulations for unmanned aerial vehicles?



Women's World Cup in Paris.

Package Delivery. One classic drone application — package delivery — still hasn't arrived fully, but many trials have been underway for several years, particularly for the delivery of medical supplies. It seems now that UPS is making a significant effort to qualify a UAS system that meets existing manned delivery standards (FAA Part 137 operations) by the end of this year. Wish them luck: there are many elements to prove and demonstrate for an unmanned delivery system, particularly in populated areas.

Security and Defense. Extensive use of drones in local and national policing and security operations has become almost commonplace, too. Cost-effective and easy-to-fly UAV systems have begun to replace manned surveillance helicopters, with police forces discovering significant improvements in reaction speed and affordability.

And, of course, the use of drones by defense forces worldwide has expanded greatly. Most people can picture the familiar silhouette of the General Atomics Reaper as their image of what a military drone looks like. Many people might even now know where the Straight of Hormuz is located, following the world-wide reports of an apparent Iranian attack that brought down a Northrop Grumman RQ-4 Global Hawk, followed by the takedown of one or two Iranian drones by the USS Boxer in the same area. Drones would now seem to be predominantly associated by Joe Public with a level of military aerial presence — perhaps more so than in any civilian applications.

New and different configurations of UAS continue to rapidly emerge for any and all applications in both the civil and military sectors. Now that we have operating regulations for small UAS in the U.S. and elsewhere around the world, cost-effective commercial uses abound and support new and existing tasks, and the military is rapidly creating new variations to assist or replace manned ground, navy and airborne forces. Large and small investments in artificial Intelligence for drone automation seem to be announced almost daily – so we can expect some independent drone capability to emerge over time.

There is only much, much more to come.

TONY MURFIN is a GNSS aerospace consultant with several decades experience at leading companies in the GPS/aviation and OEM sectors.

OPPORTUNITY:
APPLICATIONS

OBSTACLE:
KEEPING THEM SAFE

Autonomy Relies on GNSS/INS

IN TRANSPORTATION AND MACHINE CONTROL

TRACY COZZENS
SENIOR EDITOR
GPS WORLD

It's hard to overstate the importance of inertial sensors in the transportation and machine control markets.

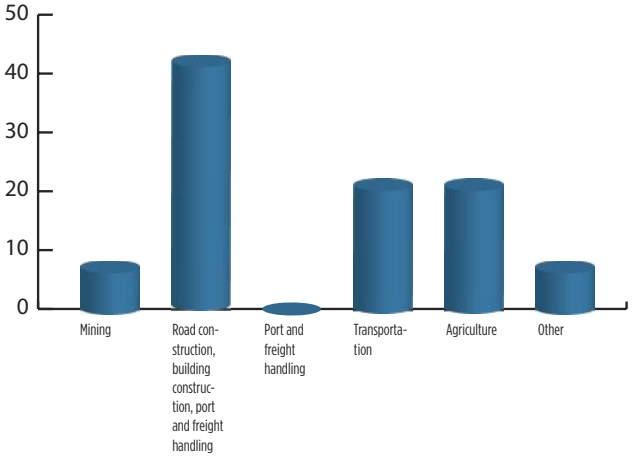
For the second year, using inertial navigation systems (INS) to augment positioning was selected by the most respondents (43%) as the best additional solution for positioning in GPS/GNSS-challenged environments.

Inertial measurement units are based on multi-axis combinations of precision gyroscopes, accelerometers and magnetometers using algorithms to determine location, direction and position. Other tech used to increase positioning accuracy includes signals of opportunity (cellular, radio, TV), visual indicators (such as lidar) and ultra-wideband.

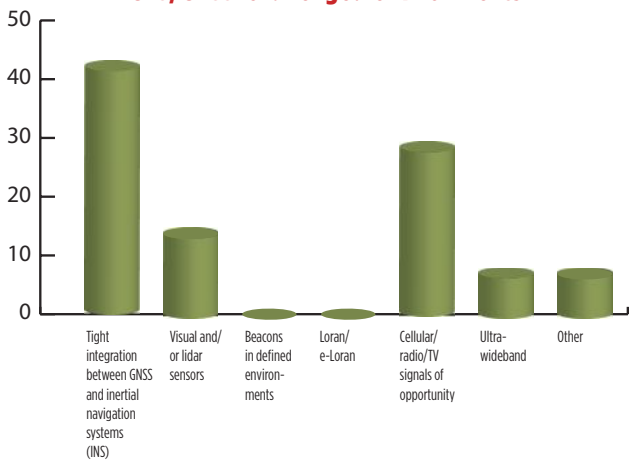
Automakers are pushing hard to get autonomous vehicles on our roads and highways. Nissan and Renault (with Microsoft) plan to have 10 vehicles on sale by 2020 with "significant autonomous functionality." Ford plans to roll out autonomous vehicles by 2021, and Hyundai is targeting them for the highway by 2020 and urban driving by 2030. While industry experts debate the time frame, it's clear autonomous vehicles are coming.

Every Tier 1 automaker has an autonomous navigation program, along with heavyweights such as Google, Apple an Amazon. Many automakers are teaming with tech companies on R&D, such as GM with Lyft, and BMW with Intel and Mobileye. Others are teaming with each other —Volkswagen and Ford partnered to acquire AI startup Argo. Daimler has joined Volvo to invest in the platooning concept, connecting trucks through wireless signals.

What best describes your sector of machine control technology?



What is the best additional solution for positioning in GPS/GNSS-challenged environments?



Stages of Autonomy. The move to autonomous won't be a sudden jump, but will take place in incremental steps. Formerly only offered on luxury autos such as the Tesla or Mercedes, Honda has introduced semi-autonomous advanced-driver assistance systems (ADAS) options on its entry-level Civic, offering lane-keeping, automatic braking, and adaptive cruise control functionality for the mass market.

Automakers rely on SAE International's J3016 standard, which defines six levels of automation from Level 0 (no automation) to Level 5 (full vehicle autonomy). The pivotal change occurs between Levels 2 and 3, when responsibility for monitoring the driving environment shifts from the driver to the system.

At Level 1 (driver assistance) is cruise control. Level 2 (partial automation) includes Audi Traffic Jam Assist, Cadillac Super Cruise, Mercedes-Benz Driver Assistance Systems, Tesla Autopilot and Volvo Pilot Assist. Level 3 (conditional automation) puts the car in the driver's seat, but prompts the driver to intervene in a difficult encounter (Audi Traffic Jam Pilot).

At Level 4 (high automation), the car operates without human input, but only under select conditions (road type, geographic area). For instance, the driver might manage all driving duties on surface streets then become a passenger as the car enters a highway. At Level 5 (full automation), the driverless car can operate on any road and in any conditions a human driver could negotiate. There are no Level 5 autos yet, but Waymo is using a fleet of 600 Chrysler Pacifica hybrids to develop Level 5 tech for production.

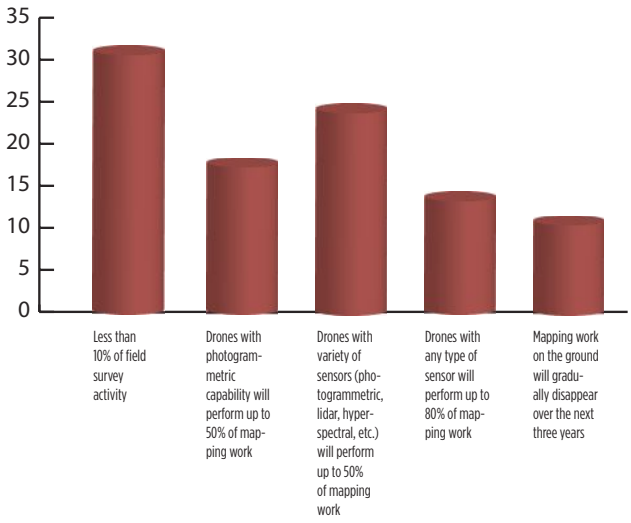
Machine Control. Not having to deal as much with traffic, except to navigate to the work site, machines in agriculture and construction are much more autonomous than the family car. For liability reasons, fully autonomous machines have yet to be approved for field work in the U.S. Nevertheless, manufacturers

See Transportation page 40. >>

Delivering the World through Maps

GIS READY TO MEET DEMANDS OF IOT, SMART CITIES

What role will UAVs play in the mapping industry over the next three years?



TRACY COZZENS
SENIOR EDITOR
GPS WORLD & GEOSPATIAL SOLUTIONS

The mapping industry has taken to UAVs — sort of. Put it this way: UAVs are only one tool in the GIS (geographic information system) toolbox.

A third of our respondents (32%) say that UAVs will be used for less than 10% of field survey activity in the next three years. In contrast, a quarter of our respondents say that drones with variety of sensors (photogrammetric, lidar, hyperspectral, etc.) will perform up to half of mapping work.

The response is similar to replies in 2018. While UAVs are an exciting new technology for mapping, most respondents to our survey recognize the continued value of hands-on, in-the-field data collection. In fact, only 11% of respondents expect that mapping work on the ground will gradually disappear over the next three years.

Sensors Aboard. When on board a UAV, 43% say the best sensor to use in conjunction with GPS/GNSS for mapping and

See Mapping page 40. >>

TRANSPORTATION

<< Continued from page 38.

such as Case IH, New Holland, John Deere and Komatsu are continuing to push the tech, and most tractors sold in the U.S. today include auto-steering systems.

At construction sites, GNSS technology installed in bulldozers, excavators, graders and pavers increase productivity and provide situational awareness to operators. GNSS increases the efficiency and accuracy of these machines, with the input used in task management, data management and theft-detection applications. Operators rely on GNSS information to position the cutting edge of a bulldozer blade or an excavator bucket. GNSS enables comparison of the position against a 3D digital design to compute cut and fill amounts. Display systems provide the operator with the visual information to manually move the machine's blade or bucket for highest accuracy.

OPPORTUNITY:
INCREASING INVESTMENT IN R&D

OBSTACLE:
LIABILITY AND REGULATIONS

MAPPING

<< Continued from page 39.

data collection is a high-resolution still-image camera, which is highly preferred over video cameras. Today's high-resolution cameras can capture details down to a few centimeters on the ground, even from an aircraft hundreds of feet in the air (see our August issue for more on aerial mapping).

Other top sensor choices for our readers include lidar (light detection and ranging) at 32% and multispectral imaging cameras at 14%. Lidar (light detection and ranging) uses a pulsed laser to measure distances and generate precise, three-dimensional information.

Rather than UAVs, airplanes and helicopters are the most commonly used platforms for acquiring lidar data over broad areas. Topographic lidar uses a near-infrared laser to map the land, while bathymetric lidar uses water-penetrating green light to measure seafloor and riverbed elevations. Lidar is used to create more accurate maps, make digital elevation models, assist in emergency response operations, to name a few applications. GNSS and INS systems translate the collected sensor data into static points for GIS.

Multispectral and hyperspectral cameras capture images in infrared (IR) and ultraviolet (UV) as well as traditional RGB (red, blue, green). The main difference between multispectral

and hyperspectral is the number of bands and how narrow the bands are — from 3 to 10 bands for multispectral to hundreds for hyperspectral. Practically speaking, multispectral imagery can be used to map forested areas, while hyperspectral imagery can be used to map tree species within the forest.

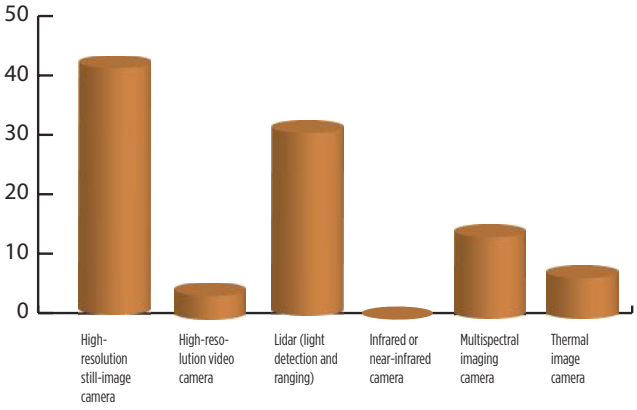
Both types of cameras are used in agriculture, ecology, oil and gas, oceanography and atmospheric studies. They can map invasive species, monitor crop health, and help in mineral exploration. For building inspections, a multispectral camera can see water penetration, plumbing leaks, overloaded electrical circuits and malfunctioning mechanical systems.

Cloudy, Chance of Maps. Anywhere, anytime access to geospatial data is increasingly important, fueled in part by both the internet of things (IoT) and smart-city initiatives. Geospatial technology enables effective and integrated planning by providing real-time location data and analytics.

Most mapping providers have developed cloud software and storage, which helps organizations access data to meet their specific requirements. Along with the cloud, advances in mobile computing are enabling organizations to take GIS to the field, interacting with the information needed to view, capture, update and synchronize changes between the field and office. The field workforce can use maps to add validity to data, record observations, and respond to events.

GIS software is also assisting connected cars and autonomous vehicles, an area expected to grow significantly (see page 38). The mobile GIS software market is expected to reach a CAGR of 18% by 2024, according to Global Market Insights.

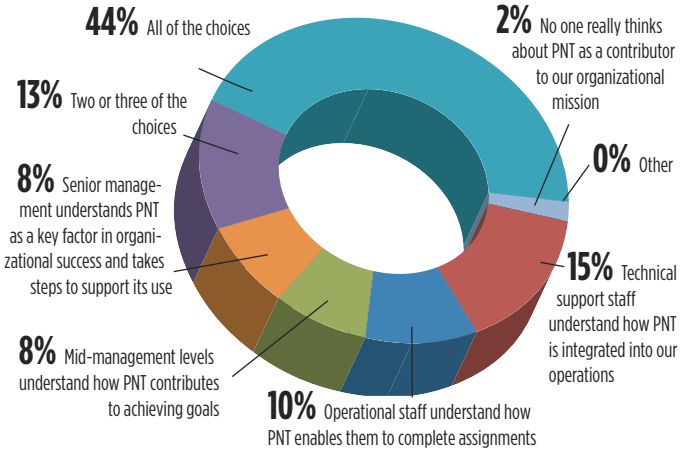
What is the most valuable and productive sensor to use in conjunction with GPS/GNSS aboard a UAV for mapping and data collection purposes?



Defense Sector Sustains Anti-Jam

REVERSING NORM, CEDES INITIATIVE TO CIVIL SIDE

At what management level do the people in your organization understand the role that positioning, navigation and timing (PNT) data from GNSS plays in enabling your organization to achieve its goals?



ALAN CAMERON
EDITOR-AT-LARGE
GPS WORLD

Nowhere is the interest in anti-jamming and anti-spoofing technology higher and more urgent than in the defense and security sectors. Overall, the anti-jamming market is about a tenth the size of the full GNSS market, but that still amounts to a considerable number. It is projected to grow at a slower rate than the overall market, according to one market report, or about 40% of the total GNSS industry pace from 2018 to 2023.

Major growth opportunities stem from high demand for robustness and resistance to enemy technology in military applications. This demand is primarily for unmanned aerial vehicles (UAVs) to conduct surveillance, reconnaissance and actual combat. Other demands are for munitions and guided implementations, and low-cost GPS anti-jamming solutions.

While the military market has fueled growth in civil GPS products and services, this trend is being turned on its head. For instance, U.S. Army light tanks were equipped in quick succession with new iterations of civil anti-jam units.

ADVERTISER INDEX: COMPANIES FEATURED IN THIS ISSUE

Editor's Note: This ad/edit index is for reader convenience only. Publisher accepts no responsibility for errors or omissions.

SUPPLEMENT TO
GPS WORLD
GNSS POSITION NAVIGATION TIMING

STUTTGART 2019
17 – 19 SEPTEMBER
INTERGEO
KNOWLEDGE AND ACTION FOR PLANET EARTH

MUST-SEE EXHIBITS GUIDE

MUST-SEE EXHIBITS AT INTERGEO

Whether or not you are attending the world's largest trade fair in the field of geodesy, spatial data and land management — takiing place Sept. 17–19 in Stuttgart, Germany — you will find valuable information in these pages detailing the offerings of leading GNSS/PNT companies that exhibit there.

TALLYSMAN
Hall 3, Booth F3.082

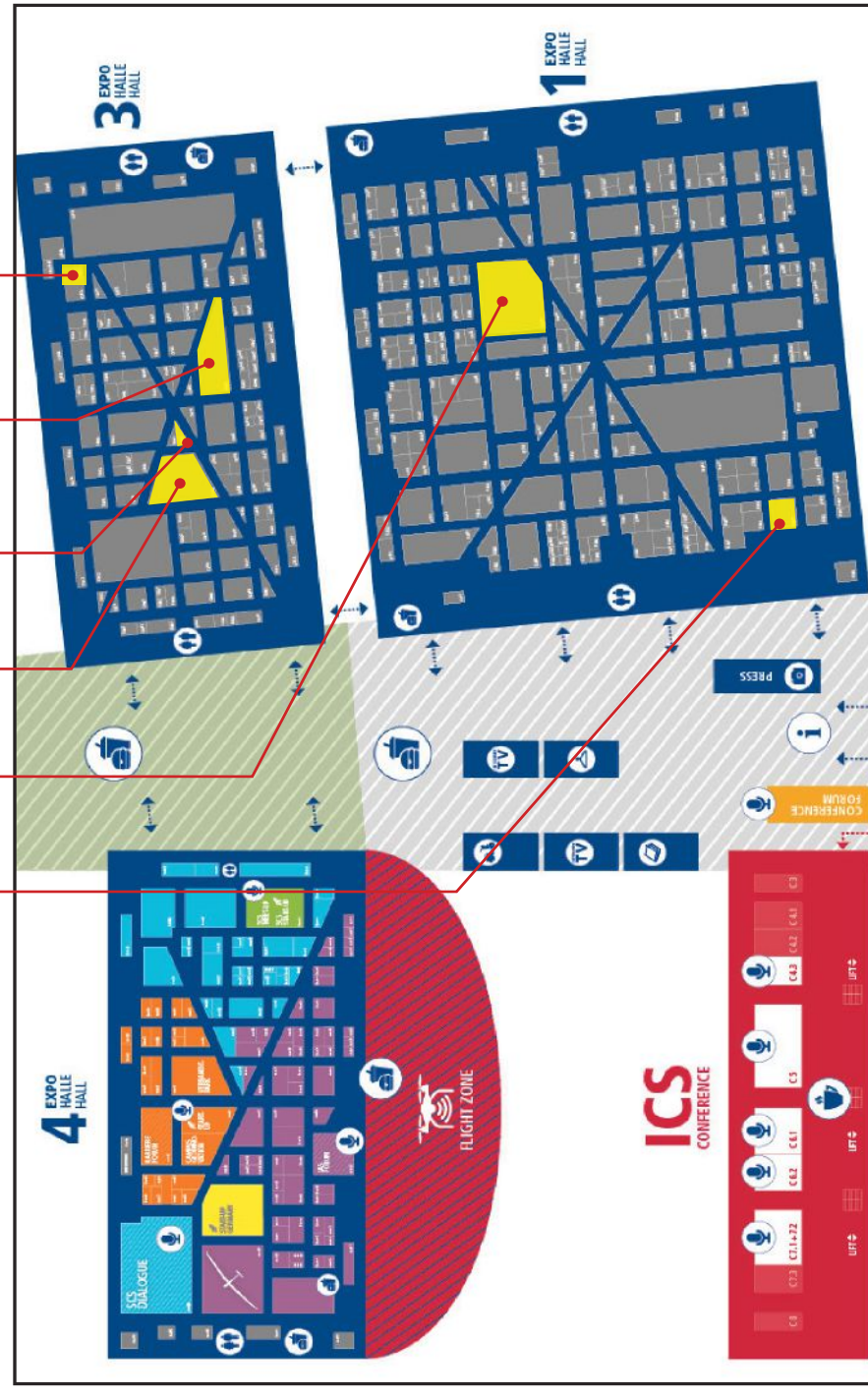
CHC NAVIGATION
Hall 3, Booth B3.052

LIDAR USA
Hall 3, Booth B3.042

HEMISPHERE GNSS
Hall 3, Booth C3.030

JAVAD GNSS
Hall1, Booth G1.050

TERSUS GNSS
Hall 1, Booth B1.006



Cover: Greens87/Shutterstock.com

CHC NAVIGATION

Hall: 3
Booth: B3.052

Founded in 2003, CHC Navigation (CHCNAV) is a publicly listed company creating Innovative GNSS navigation and positioning solutions. With a global presence across the world and distributors in more than 100 countries and more than 1,300 employees, CHC Navigation is today recognized as one of the fastest-growing companies in geomatics technologies.

i90 IMU-RTK GNSS

The i90 GNSS receiver offers integrated IMU tilt compensation to provide robust and accurate GNSS positioning, in any circumstances. The i90 GNSS makes your work more efficient by adjusting automatically for pole-tilt up to 30 degrees and improving surveying and stakeout measurement speed up to 20%. The embedded interference-free inertial sensor initializes after a few meters' walk to enable accurate tilt compensation.

ALPHA3D

The Alpha3D mobile mapping solution combines a state-of-the-art long-range, ultra-high-speed, precise laser scanner and a high-resolution HDR panoramic camera with an advanced GNSS receiver and high-precision IMU in one compact, lightweight and rugged instrument design. With Alpha3D, users can collect more data faster and reduce field survey time by more than 40% compared to traditional surveying instruments.

APACHE 3

Featuring a triple-hulled and shallow draught design, the APACHE 3 is a portable USV for bathymetric surveys of lakes, inland rivers and coastal areas. Its compact size allows one person to operate the system easily. The APACHE3 USV solution embeds CHCNAV's absolute straight-line technology, which enables fully automated courses in all current and flow conditions.

P2 GNSS SENSOR

P2 GNSS sensors are designed for a wide variety of applications such as marine survey, industrial automation, robotics, machine control and reference stations. The P2 series integrates the latest GNSS positioning and heading technology in an extremely rugged IP67 enclosure matching the toughest protection standards to ensure uninterrupted performance.

CHCNAV

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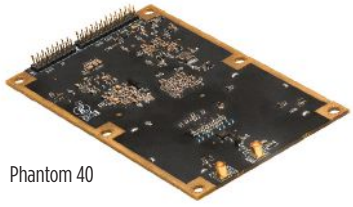
Hall: 3
Booth: C3.030

HEMISPHERE GNSS


Phantom 40


Vega 28


Vega 40

Hemisphere GNSS has released its next-generation digital and RF application-specific integrated circuit (ASIC) platforms, as well as new positioning and heading OEM boards — the first products to incorporate these technological advancements.

Hemisphere's new (Lyra II™) digital and (Aquila™) wideband RF ASIC designs optimize performance and provide the ability to track and process more than 1,100 channels from all GNSS constellations and signals including GPS, GLONASS, Galileo, BeiDou, QZSS, IRNSS, SBAS, and L-Band (Atlas®). Signal support and tracking for AltBOC and BS-ACEBOC, BeiDou Phase 2 and 3, L5, and QZSS/L6 (L6-D and L6-E) are also available.

This new ASIC technology offers scalable access to every modern GNSS signal available. Also, the Lyra II and Aquila ASIC technology provide the foundation for a new GNSS receiver chipset architecture that significantly reduces the number of board components required, thereby reducing complexity, improving reliability, and lowering power consumption.

The powerful technology platform also includes Hemisphere's new Cygnus™ interference mitigation technology with built-in digital filtering capabilities and spectrum analysis. The new Cygnus technology provides enhanced anti-jamming, interference detection and mitigation.

The Phantom 40 positioning board is the first Lyra-based offering in a line of low-power, high-precision OEM boards. Its multi-frequency, multi-GNSS receiver processes 800+ channels with access to Hemisphere's Atlas GNSS global corrections network. The 60 x 100 mm module with 24-pin and 16-pin headers is a significant upgrade for existing designs using this industry-standard form factor.

The Vega 40 and Vega 28 are the first introductions in a new line of low-power, high-precision positioning and heading OEM boards. The multi-frequency, multi-GNSS receivers offer access to 1,100+ channels and also include access to Atlas. The Vega 40 is a 60 x 100 mm module with 24-pin and 16-pin headers, also an upgrade for existing designs. The Vega 28 is a 45 x 71 mm positioning and heading module, the smallest GNSS OEM heading module Hemisphere has ever offered to the geospatial market.

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JAVAD GNSS

Hall: 1
Booth: G1.050

Inseparably uniting the two continents of America and Europe, JAVAD GNSS Inc. represents a dynamic and respected brand in the industry. The creative potential of two great countries has found its manifestation in JAVAD products. Since its inception, JAVAD GNSS has been focused on developing and manufacturing the newest generation of GNSS receivers for high-precision/high-performance applications. The primary products marketed under this brand name are GNSS receivers and OEM boards based on its Triumph technology. The unmistakable lime-green JAVAD GNSS receivers are known to surveyors the world over. With its J-Shield technology, JAVAD GNSS currently has protection against interferences. J-Shield is a robust filter in the antenna that blocks out-of-band interference. It also provides GNSS receivers with built-in detailed interference awareness features and with a Spoofing Detection option: there is absolutely no way that JAVAD GNSS receivers can be spoofed or jammed without the user's knowledge. JAVAD GNSS receivers will immediately recognize spoofers and jammers and take corrective action.

One recent and revolutionary innovation from JAVAD GNSS is the J-Mate "Total Solution" coupled with the TRIUMPH-LS RTK receiver that is a combination of GNSS, encoder, digital camera and laser range measurements that together do a lot more than a total station. At long distances, you use GNSS RTK measurements, and at short distances (maximum of 100 meters), you use the J-Mate along with the TRIUMPH-LS. Together they provide RTK-level accuracy (a few centimeters) in ranges from zero to infinity.

JAVAD GNSS has its own manufacturing facilities in San Jose, California. Four continuous-flow SMT lines are highly flexible, allowing for diverse and complex products utilizing the latest in component packaging technologies to be assembled and with quick changeover between products, enabling high-mix, low- to medium-volume production.

The company's online store allows the customer to calculate project costs and place orders on the same day a purchasing decision is made. Highly qualified staff members operate from two hemispheres via more than a hundred international dealers to provide high-performance GNSS devices, components, technology and software for professional end-users in the navigation, survey, GIS, agricultural and OEM-board markets. As a manufacturer, JAVAD GNSS can afford to maintain attractive prices for its customers thanks to complete control of the manufacturing process managed by experts with more than twenty years' experience in the industry. As the sun goes down in San Jose, day is breaking over Moscow; a 24/7 free technical support system provides support by phone, email and interactively online to customers no matter where are they are located on the globe.

The JAVAD GNSS mission is to continue to be at the cutting edge of GNSS technology. The last word is left to Marc Cheves, editor of *The American Surveyor*: "By creating affordable, portable GPS devices for the past nearly thirty years, surveyors all over the world have benefited from JAVAD's passion for precise positioning. The company is in it for the long run. It's hard to even imagine how far the GNSS envelope may be pushed in the future, but wherever it is, no doubt JAVAD will be there."

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LIDAR USA

Celebrating more than 20 years in business, Fagerman Technologies Inc., dba. LiDAR USA, has been revolutionizing the geospatial arena from aerial triangulation, photogrammetry and 360 imagery to lidar. LiDAR USA systems can be deployed on any platform that meets the payload and physical requirements to attach the system. They have no communication with the platform, ensuring portability between vehicles.

LiDAR USA's ScanLook software is included with each system. This includes the data capture software and the desktop processing software. The ScanLookPC desktop software performs all of the data fusion and geo-referencing in virtually any coordinate system and includes a powerful control-point correction and strip alignment tool built on proprietary algorithms. Its systems are extremely versatile, suitable for backpack, rail, car, UAV, fixed-wing, helicopter, boat and robot to name a few uses.

LiDAR USA Partners with Teledyne Optech on UAV Sensor Integration

The summer of 2019 is an exciting time as the integration with the new Teledyne Optech **CL-90** is completed, bringing a much needed long-range, high-accuracy, multiple-return lidar system purpose-built for heavy-lift UAVs.

With a 90-degree field of view (FOV), multiple returns, 500-kHz data rate, and several-hundred-meter range combined with 1-cm accuracy, the CL-90 will rapidly become the sensor of choice for a growing market of topography, corridor, highway and all forms of mapping.

The CL-90 sensor features exceptional canopy penetration for excellent ground coverage, long-range performance for maximum productivity at UAS ceilings, and best-in-class data precision for tight tolerance.

Additional sensors and UAVs will also be available in the fall of 2019.

Let us help you complete your project faster and more accurately. Chat with us today at **https://bit.ly/2vspqfW**

LiDAR USA will be at Intergeo Sept. 17–19 at ICS Foyer Stand 2, featuring the fully integrated CL-90 solution.

Teledyne Optech will be at Intergeo Sept. 17–19 at Booth B3.042, featuring its new Compact Lidar (CL) suite of products.

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TALLYSMAN

Hall: 3
Booth: F3.082

Today's users rely on GNSS antennas to enable accurate and precise positioning, while also requiring lightweight, waterproof and compact design.

New Product Announcements

The Tallysman VeroStar™
Tallysman is proud to introduce its latest innovative GNSS antenna, the VeroStar. Designed to receive all GNSS signals as well as L-band, the VeroStar supports survey, marine, aviation, agriculture, machine control and other demanding applications.

VeroStar features:
- A unique patent-pending full GNSS bandwidth crossed-dipole antenna element with:
  - excellent radiating pattern with low roll off for improved low-elevation tracking
  - high radiating efficiency for optimised signal-to-noise ratio
  - super stable phase centre
  - excellent axial ratio for improved multipath rejection.
- An innovative low noise amplifier (LNA) with superior out-of-band filtering
- Waterproof with IP69K compliance
- Available in housed and embedded versions that cover single, dual, triple and full GNSS band coverage (with and without L-band correction support)
- A compact design

Expansion of Tallysman's Helicals
The Tallysman Helical family of antennas, released earlier this year, provides unprecedented performance in a lightweight, compact form factor. The line now extends beyond dual-band GNSS and Iridium support to also include single and triple GNSS frequency bands. Tallysman Helical antennas are designed for applications that require high performance and versatility with an absolute minimum of weight, such as unmanned aerial vehicles (UAVs).

Features of the expanded Helical antenna family:
- Extreme lightweight, ranging from 5 g to 37 g
- A novel helical antenna element
  - Excellent axial ratio and multipath rejection
- Broad GNSS frequency coverage, including single, dual and triple GNSS bands, including L-band
- Robust, military-grade plastic enclosure with IP69K compliance
- An extremely low noise amplifier (LNA) combined with a pre-filter
- Ideal design and performance for real-time kinematic (RTK) applications
- A certified Iridium model
- A choice of housed and embedded models

TALLYSMAN®

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Hall: 1
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TERSUS GNSS

Tersus David

Oscar GNSS Receiver

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Tersus is a leading GNSS RTK solution provider. We are pioneers in the flexible design of GNSS products to support high-precision positioning applications.

Tersus products range from GNSS RTK and PPK OEM boards and receivers to integrated solutions such as the David GNSS receiver, Oscar GNSS receiver, MatrixRTK and GNSS-aided Inertial Navigation System.

One newest generation of the Tersus family is the Oscar GNSS Receiver. It supports a calibration-free tilt-compensation function that is immune to magnetic disturbances — keeping the survey pole upright is not required any more. Easy configuration with an 1.54-inch interactive screen is provided on the Ultimate and Advanced versions. With an internal high-performance multi-constellation and multi-frequency GNSS board, the Oscar GNSS receiver provides quick fix and centimeter accuracy without exception.

The Tersus David is a cost-efficient, palm-sized GNSS receiver designed for surveying, UAVs, AGVs and agricultural applications. Working with an external GNSS antenna, along with the easy-to-use Tersus Survey App and post-processing software, the David GNSS receiver is a low-cost solution for all survey applications including real-time RTK positioning and data collection for PPK.

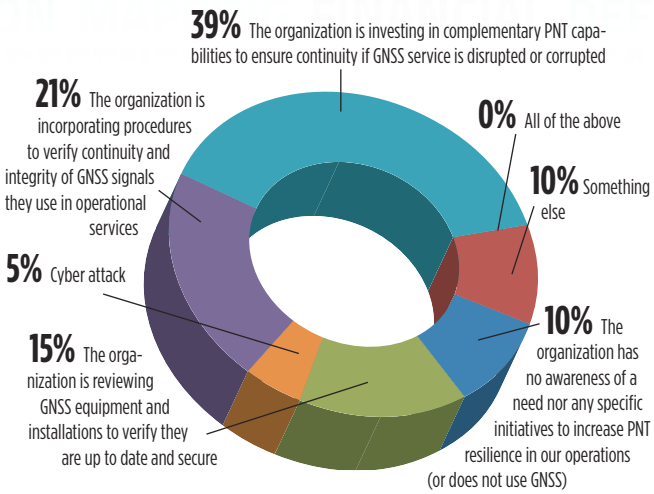
Both Tersus David and Tersus Oscar have native support from mainstream field data-collection software such as FieldGenius. We also have a spectrum of controller hardware options. Please come to our stand to see if Tersus can offer a bespoke solution for your company.

Mr. Xiaohua Wen
Founder & CEO

"Tersus has been providing high-quality, affordable, and centimeter-accurate GNSS RTK modules and systems that solve positioning and navigation challenges. With three support offices, 50+ employees worldwide and an expansive domestic and international dealer network, Tersus is dedicated to more valuable GNSS solutions for integrators, equipment manufacturers and end-users. At Tersus, addressing their wants and needs is our first priority in this constantly changing world."

Tersus values industry solutions as well as innovations. Accurate, reliable, state-of-the-art hardware is not where we stop. We support you with the most straightforward workflow, from the site to the office. We often hear "digital twin," "VR," "IoT," all these buzzwords — but one day they won't be merely words. In preparing ourselves for tomorrow's changes, we need your expertise. Come to our stand and share your thoughts and your needs with Tersus GNSS RTK Architect and CAD/GIS/BIM Coders.

Is your organization taking steps to ensure continuity of PNT availability in the event of a disruption in GNSS service?



"[We] asked for exactly what we wanted and industry built exactly to that. We don't know exactly what we want. Tell us how we should do this the best, and then we'll test that," said the acquisition officer in charge. This PNT program may set the mold for future U.S. military development — leaving requirements broad and open to change with the knowledge that technology develops quickly, and can just as quickly be shown to be vulnerable.

Go Small, Go Modernized. Two other key trends exert control over the defense market: the reduction in size, weight and requisite power (SWaP) of hundreds — if not more — of GNSS-dominated navigation and positioning devices installed aboard myriad different military platforms, and the coming need to retrofit all such platforms, not only for SWaP but for the new signals, prime among them M-code, coming with modernized and multi-GNSS.

Commercial activity in this sector is constrained to a degree by International Traffic in Arms Regulations (ITAR) and Export Administration Regulations (EAR), administered by different U.S. government departments to ensure that defense-related technology does not fall into adversarial or mischievous hands. Nevertheless, all those involved in defense and security will be very, very busy for several years to come.

OPPORTUNITY: MULTI-GNSS
OBSTACLE: JAMMING

OEM

Racelogic Releases Galileo Update for SatGen

Racelogic Ltd. has released the latest update to its SatGen GNSS simulation software for PC, which now incorporates Galileo RF simulation.

Designed to create a GNSS RF I&Q or IF data file based on a user-generated trajectory file, the updated software can now accurately simulate the European Galileo GNSS satellite constellation alongside existing GPS, GLONASS and BeiDou RF signal generation.

The full range of Galileo frequencies that SatGen can simulate are Galileo E1 B/C, E5a, E5b and E6 B/C. Other changes to the software include various user interface tweaks, performance optimization and fixes.

Image: Racelogic

Septentrio Offers GNSS/INS Single-Antenna Receiver

Septentrio's GPS/INS receiver is now available with a single-antenna option. By offering both single- and dual-antenna options, Septentrio can better accommodate specific needs of their customers, the company said.

The single-antenna receiver provides robust centimeter positioning and 3D attitude (heading, roll, pitch), while keeping weight and power consumption to a minimum. For Septentrio customers, this means simplified integration as well as increased operation time and productivity.

Septentrio centimeter-level positioning is based on multi-frequency, multi-constellation GNSS (GPS, GLONASS, Galileo, BeiDou, QZSS) technology. AsteRx-i S combines GNSS and an industry-grade inertial measurement unit (IMU) to deliver precise positioning together with 3D attitude and coasting functionality.

Septentrio's unique GNSS/IMU integration algorithm enables continuous positioning in difficult environments such as near high structures, under foliage or during short GNSS outages (this is referred to as coasting or dead reckoning).

Photo: Septentrio

High-precision GPS/INS receiver is now available with a single-antenna option for faster integration, lighter weight and lower power consumption.

This makes AsteRx-i S a suitable positioning solution for robotics, autonomous vehicles and logistics. Previously available only as a dual-antenna product, AsteRx-i S is now available with either a single- or a dual-antenna option.

Robotics. The single-antenna AsteRx-i S requires minimal space, which makes it suitable for robotic devices that need small and light precise-positioning solutions. Because only one antenna is required, there is less weight and lower power consumption, resulting in extended battery life. The dual-antenna AsteRx-i S, on the other hand, is suitable for devices requiring quick heading initialization and devices with prolonged static operation.

Advanced Interference Mitigation. AsteRx-i S comes with built-in Advanced Interference Mitigation (AIM+) technology. In robotic devices, neighboring electronics can emit electromagnetic radiation that interfere with GNSS signals. AIM+ offers protection against such interference, resulting in faster set-up times and robust continuous operation. A built-in power spectrum plot allows users to analyze interference, helping locate its source and mitigating it.

SURVEY

MicroSurvey Releases FieldGenius for Android

MicroSurvey Software, part of Hexagon, has released its new field data-collection software platform for Android users.

FieldGenius for Android, version 1.0, is the first release of the company's new multi-platform field software built on the Android platform. It supports most popular GNSS sensors on the market today.

Brand Neutral. FieldGenius is third-party, brand-neutral data-collection software used by many surveyors. The new release builds on decades of innovation MicroSurvey has invested into the original FieldGenius software, providing users with an easy-to-use and intuitive mobile data-collection software package.

New features include dynamic data panels synchronized with map views. A fresh user interface provides familiarity for existing FieldGenius users while offering new tools, simplified workflows and readily available data that surveyors require at the point of work to make informed decisions in the field.

Whether using the original software or the Android app, Field Genius's designers aim to provide a consistent user experience across a wide cross-section of data collection devices.

MicroSurvey said in a press release that it plans to continue its hardware neutrality strategy, offering support for almost every brand of popular and upcoming GNSS receiver on the market.

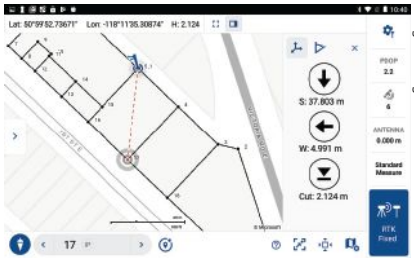


Image: Hexagon

FieldGenius for Android, version 1.

Early adopters of FieldGenius for Android will receive additional benefits and participate in the newly created MicroSurvey Technology Innovation Group (MTIG). Users interested in taking part can contact a MicroSurvey representative

UAV

Terra Drone Completes 3D Model for Shell Oil

Terra Drone Europe, a group company of Terra Drone Corp., has completed an aerial 3D survey and produced a 3D model of an offshore oil rig platform in the North Sea for Shell.

The platform complex surveyed was positioned years ago when GNSS survey techniques were neither very advanced nor common. Several coordinates were known and as-build drawings were available, but Shell wanted to know the position of each and every element on the platform to facilitate accurate drill-rig positioning.

Precision positioning is indispensable in offshore exploration. Errors can pose significant worker safety and commercial implications.

Terra Drone Europe captured the as-is conditions through a high-precision survey. The survey was divided into two parts: one part dedicated to creating a 3D point cloud and the second to accurately check the position of the platform using GNSS readings.

Image: Terra Drone

3D MODEL of an offshore oil-rig platform in the North Sea.

Two GNSS receivers were installed at different locations and used to log raw data, which was later processed. When the data was combined with the 3D point cloud created by Terra Drone Europe, the coordinates of each asset on the platform structure was determined.

Terra Drone Corp. has established new branches focusing on the oil and gas sector in Argentina, Angola, Kazakhstan and the United Arab Emirates. The company also formed a new branch to provide advanced non-destructive testing and inspection services to the oil and gas industry.

TRANSPORTATION

Swift Expands Skylark Network for Autonomous Vehicles

Swift Navigation's network-connected Skylark precise positioning service is now available throughout the United States. Full contiguous U.S. (CONUS) coverage reduces initialization times to seconds, ensuring high-accuracy, high-integrity positioning is available when customers need it.

Swift Navigation is a San Francisco-based tech firm providing centimeter-accurate GNSS positioning technology for autonomous vehicles, and the maker of the Piksi Multi and Duro GNSS receivers.

Skylark is built for autonomy at scale and delivers lane-level precision with safety-of-life integrity — required by mass-market automotive and autonomous applications. Skylark is a scalable network delivering a continuous stream via the cloud of robust, reliable, multi-constellation, multi-frequency corrections, with the latency, security, precision and reliability required for safety and autonomy.

Since Skylark was introduced in 2018, the Swift network team has been deploying infrastructure across the country.

Skylark is designed to address the needs of automotive original equipment manufacturers (OEMs) by supporting ASIL (Automotive Safety Integrity Level)-rated systems and Ntrip2 (Networked transport of RTCM via internet protocol) connections in cloud reference station mode. It is state-space-representation ready — an emerging industry format.

Skylark is hardware-independent, and OEMs are able to use a host of third-party receivers in addition to Swift's Piksi Multi and Duro receivers.

Skylark is a high-performance hybrid nationwide U.S. network that delivers initialization times in seconds, better than 10 centimeters of accuracy and integrity required by the most demanding safety-of-life critical applications.

Skylark offers a subscription service for ease of deployment for large-scale autonomous vehicle fleets.

DEFENSE

Raytheon M-Code Receivers Certified by US Air Force

Raytheon has received security certification for new GPS modules and receivers from the GPS Directorate at the U.S. Air Force Space and Missile Systems Center.

The new modules and receivers will give military aircraft, ships, ground vehicles and weapon systems secure and reliable access to modernized GPS with M-code. Because the tech is platform agnostic, it will work on a wide-range of platforms for air, ground or sea. Raytheon's M-code common GPS module was certified, along with its ground-based GPS receiver, or GB-GRAM, and the avionics GPS receiver, or GRAM-S/M. GB-GRAM and GRAM S/M are jointly developed with Trimble, while General Dynamics provides cryptographic capabilities for the modules. These GPS systems have a common security architecture, meaning Raytheon can get the new capability to operators faster and eliminate the need for additional security certifications.

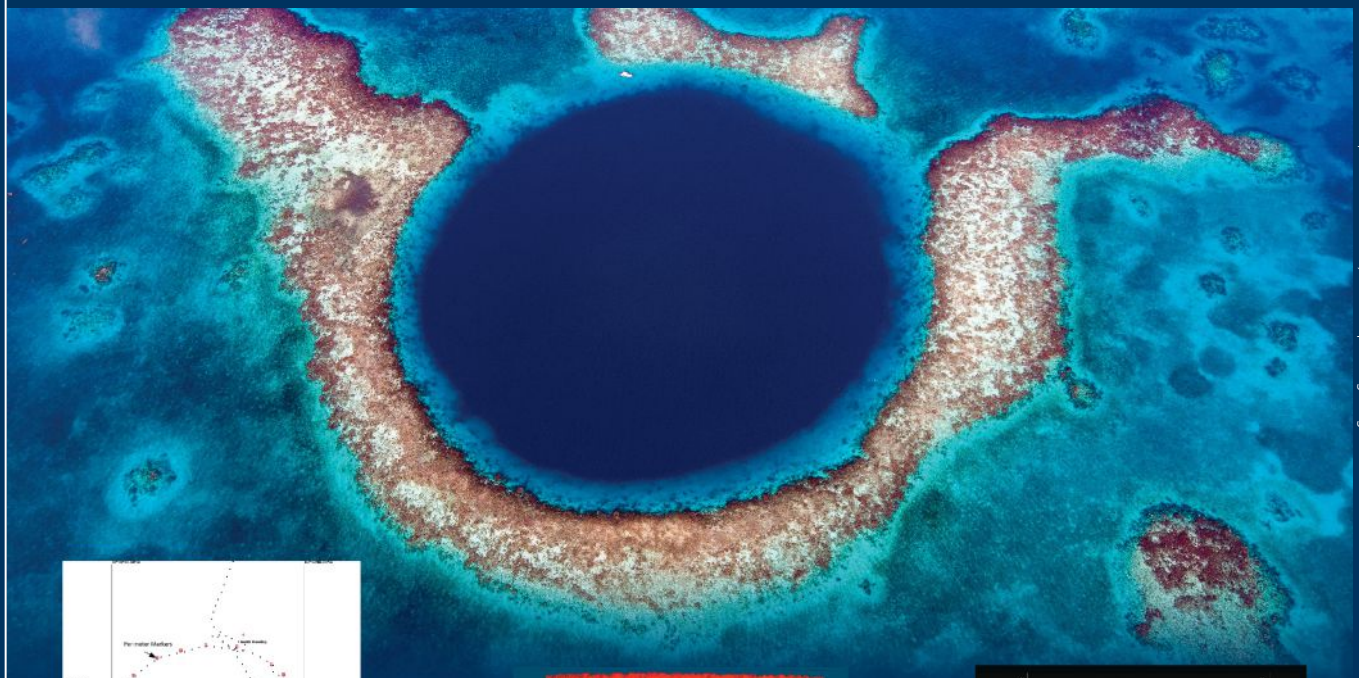
Iran Suspected of Jamming

Ships sailing through the Strait of Hormuz and the Persian Gulf have been experiencing GPS interference that U.S. officials suspect is the work of the Iranians..

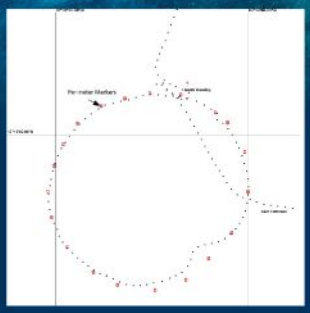
The U.S. Department of Transportation's Maritime Administration issued an advisory on Aug. 7 to commercial ships traveling in the region. Ships have reported GPS interference, bridge-to-bridge communications spoofing and jamming, and other problems.

Iran's goal is for ships and aircraft to wander into Iranian waters or airspace, justifying a seizure, a U.S. defense official said. He said Iran has placed GPS jammers on Iran-controlled Abu Musa Island, which lies in the Persian Gulf close to the entrance of the Strait of Hormuz.

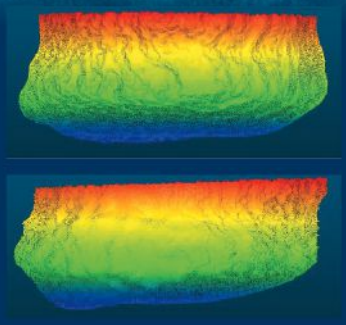
"Heightened military activity and increased political tensions in this region continue to pose serious threats to commercial vessels," reads the advisory. "Associated with these threats is a potential for miscalculation or misidentification that could lead to aggressive actions."



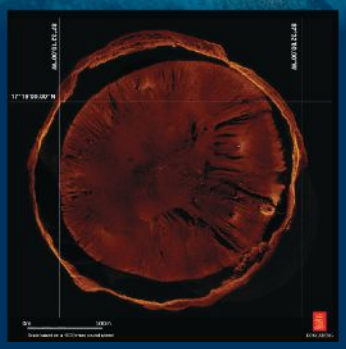
Blue Hole: JamieB333/Shutterstock.com; sonar maps: Kongsberg



Perimeter Markers: Using an SBG Systems Ellipse receiver positioned directly over suspended tripods, positions were locked in the MS1000 processing software the instant each tripod touched bottom. With no current within the Blue Hole and the tripod and sonar weighing 21.7 kg, there was no issue with offset position differences between the vessel and the tripod hanging plumb during deployment.



Processed Scan Data: A dual-axis sonar (DAS) system collected point-cloud data to create a 3D representation of the Blue Hole. The unit was pole-mounted on the survey vessel with the GPS and motion reference unit directly over the scanner's head.



Mosaic: GPS tripod position and target matching on overlapping scans were used to align the 50-, 75- and 100-meter-range data collected at 21 drop locations. This mosaic is a very close approximation of the bottom of the Blue Hole.

Great Blue Hole Revealed

A sonar survey, camera and sensor data of the world's largest marine sinkhole is shining light on sea level and climate change over 100,000 years. From Nov. 27 to Dec. 13, 2018, the Blue Hole Belize Expedition mapped the sinkhole. Led by Aquatica Submarines, the team of scientists, explorers and film makers included Sir Richard Branson and Fabien Cousteau.

Sonar expert Mark Atherton from Kongsberg's Canadian subsidiary Kongsberg Mesotech was a key member of the science-based sonar and scientific data collection team. Atherton operated both surface and submarine-mounted sonar equipment from aboard the Research Vessel *Brooks McCall*, contributing to an invaluable high-resolution map of the entire sinkhole. "By understanding the geological history and geometric structure at the Blue Hole, we can contribute new data to the global scientific community studying sinkholes and cenotes," he said.

Aquatica Submarine's Stingray 500 submarine was used for sonar surveying, filming and dives. A key outcome of the expedition is creation of a complete 3D sonar map of the Blue Hole. The sonar map is enhanced with other passive submarine-collected environmental data.

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SEEN & HEARD

BATMAN ONLY WISHES HE HAD ONE

New miniature GPS "backpacks" are making it possible to track tiny desert bats, providing insight into their lives. Tiny 1-g GPS tags showed University of Helsinki researchers that Africa's yellow-winged bats struggle during dry periods. The species is one of the few desert bats large enough to carry the tag. Researchers placed GPS trackers on 29 bats, 15 in the rainy season and 14 in the dry season, for one week each, and recorded their positions every 30 to 60 minutes each night.

THE WHEELS ON THE BUS NEED GPS

All New York City public school buses will provide GPS tracking by the first day of class this fall. The city has teamed up with Via to install the equipment and provide an app for real-time tracking of the nearly 10,000 buses. The city council approved the tracking program after a sudden snowstorm in November 2018 left buses stranded in traffic for hours, and parents couldn't reach their kids.

KEEP ON TRUCKIN'

Shipping company UPS is investing in autonomous deliveries, specifically in TuSimple, a robot-trucking startup. UPS is testing self-driving tractor trailers on a route between Phoenix and Tucson, Arizona, to help it understand requirements for Level 4 autonomous trucking. TuSimple completed a two-week pilot with the U.S. Postal Service in May, hauling mail between Phoenix and Dallas. All TuSimple trucks operate with two technicians in the cab, with the aim to operate without drivers within two years.

A+ FOR GPS COWS

High-school students interested in agricultural professions can now learn about the use of GPS for monitoring livestock, and even make their own GPS collars. The collaborative GPS Cows program brings together industry researchers, professionals and educators from the U.S. and Australia. GPS Cows is fighting the misperception that ag-focused students don't need digital literacy, and is engaging them in agri-tech, specifically tools and systems that provide animal location and behavior data.

PHOTO CREDITS: Yellow-winged bat/Adrià López-Baucells; New York City school buses/iStock/ MBPROJEKT_Maciej_Bledowski; truck/TuSimple; cow with GPS collar/Dave Ganskopp, USDA

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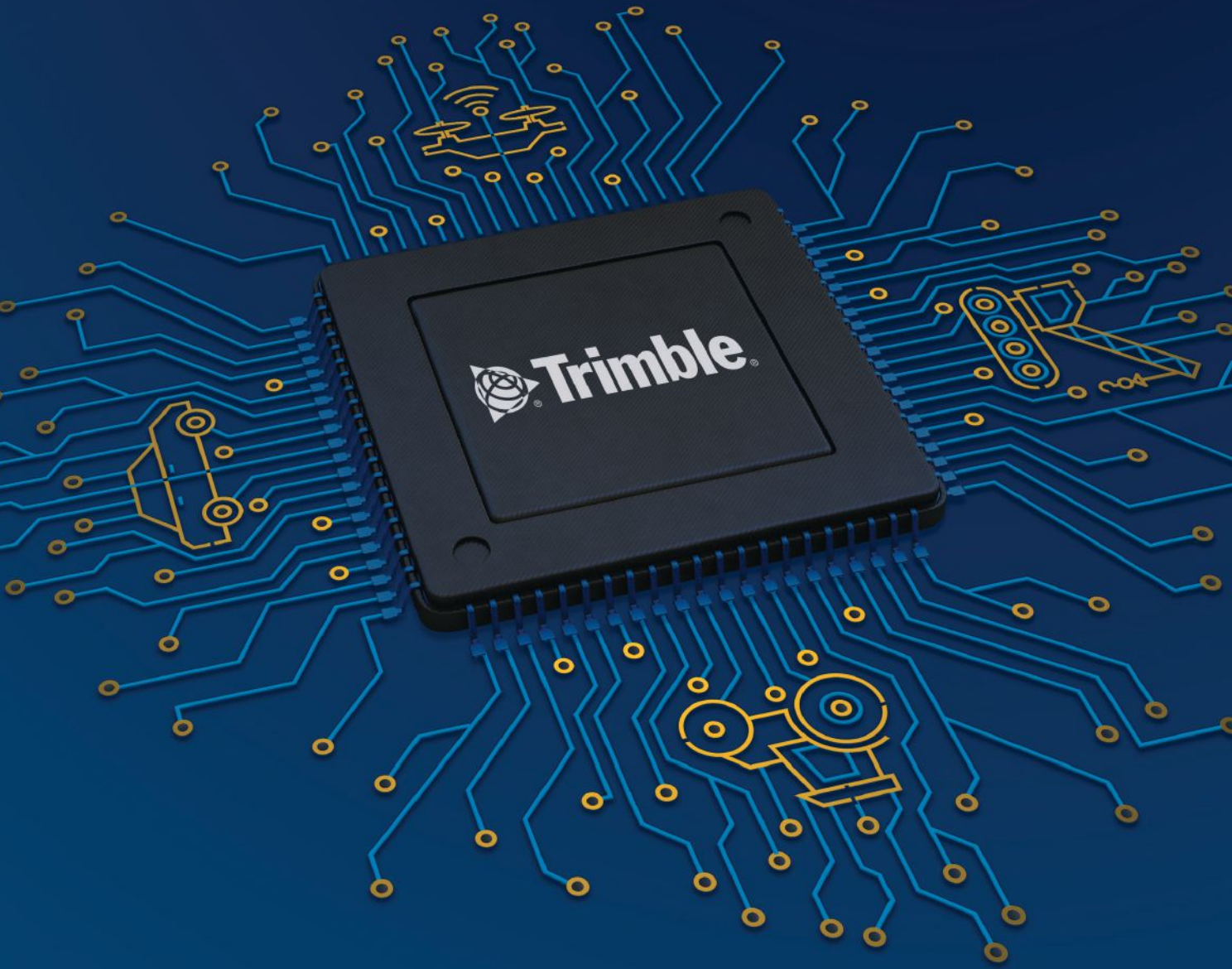

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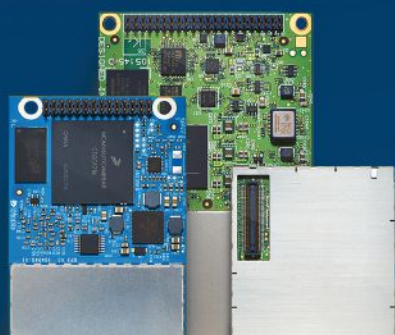

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