Defeating ‘Death by GPS’

Park rangers in Death Valley National Park have begun calling it “death by GPS.” Visitors faithfully following their navigation devices turn down the wrong road or hike away from help and die before rangers can reach them.

But it really isn’t the GPS, it’s the maps in the navigation database.

“People are blindly following this GIS [geographic information system] data,” Rick Hamilton, a member of the Civil GPS Service Interface Committee Executive Secretariat told a Tuesday session of the CGSIC.

Drivers have died stuck on remote mountain roads or in deserts. Others have driven onto closed bridges, down animal trails, or into lakes — sometimes with disastrous results.

Part of the problem is out-of-date maps and users who don’t know to update the maps. But many times critical information was never entered into mapping databases in the first place.

“It is not enough to just enter GIS data into GIS databases anymore. We need to attribute this data,” said Hamilton, who asked audience members for their ideas on how to tackle the problem.

No formal mechanism set up yet for submitting ideas but Hamilton said people could contact him at <rick.hamilton@uscg.mil>.

GNSS Program Status Panel

GNSS World Adds Satellites, Services

With several years yet before completion of their satellite constellations several of the world’s satellite navigation providers are moving to expand service and engage potential users, speakers at the GNSS Program Status panel told their ION GNSS+ 2016 audience on Wednesday.

The Galileo program is poised to offer initial service capability for its open service, search and rescue, and public regulated service (PRS) this year while initial service for Galileo’s commercial service is scheduled to start in 2018. The full constellation should be complete by 2020 with the contract for the last tranche of satellites to be issued this year.

To make its schedule, the Galileo program hopes to begin launching satellites at an accelerated pace. Two were launched successfully in May and there will be three launches using the Ariane 5 rocket — each car-

Military GPS User Equipment

MGUE Program Nears Milestone B Decision

The program to develop M-code capable GPS receiver cards to swap in for the older cards now in military equipment is poised to enter a new phase as the GPS Directorate seeks approval to start the engineering activities leading, ultimately, to full production.

“The milestone marks the end of the technology maturation phase of the program,” explained Col. Edward Hospodar of the GPS Directorate’s User Equipment Division. “You enter into the next phase of the program, which is the formalization of an acquisition program. That’s what Milestone B accomplishes.”

Kendall was on a DAB that assessed MGUE in January, deciding at the time to have the Air Force further refine its Acquisition Program Baseline.

“At a DAB one of the things that gets approved is the Acquisition Program Baseline.

PROGRAM UPDATES continued on page 2

Members of the panel on the “Status of GPS, GLONASS, Galileo, BeiDou, and QZSS” (from left) Yoshiyuki Murai, Quasi-Zenith Satellite System Services Inc.; Sergey Karutin, Central Research Institute for Machine Building; Eric Chatre and Marco Falcone, European Space Agency; Jun Shen, UniStrong Science & Technology Co.; and Haitao Wu, Chinese Academy of Sciences National Time Service Center.
rying four satellites — going up in rapid succession. If all goes well, one will launch this November, another in 2017, and a final one in 2018.

Putting so many spacecraft up at one time is nerve-racking, admitted Eric Chatre of the European Space Agency. “Our fingernails are getting shorter,” he said.

The Chinese are also keeping their launch pads busy, having put up seven BeiDou satellites since 2015. Five of these are the new generation BeiDou spacecraft while two, which are serving as on-orbit spares, are of an older model.

Acknowledging a desire for standards to help develop applications the Chinese have released version 1.0 of their “BeiDou Navigation Satellite Standard System” as well as 17 BeiDou standards and, on June 16, a white paper laying out the goals and plans for system development, services, and application development for the program.

Jun Shen, the deputy director of the International Cooperation Center of the China Satellite Navigation Office, also said China is developing a national integrated PNT system. That system starts with BeiDou but adds capability to reach indoors, into obscured spaces such as urban canyons, and even provide service underwater.

Both China and Japan are also developing satellite-based augmentation system or SBAS — in both cases, regional services that are to be complete by 2020.

To do this the Japanese Quasi-Zenither Satellite System (QZSS) program, which complements the GPS system across Asia, will launch three satellites by the end of 2018, with three more expected by 2023. Russian plans to launch seven satellites for its GLONASS constellation by the first quarter of 2018. These will be the older GLONASS-M spacecraft, said Sergey Karutin, deputy director general of the Central Research Institute for Machine Building. Russia has one GLONASS K that is operational and another undergoing flight testing. The design of the new K2 satellite, which will have improved clocks, is to be finalized by the end of this year.

The United States continues to modernize its constellation, finally retiring the last of the IIA satellites and launching eight satellites in just 24 months — the most aggressive launch schedule since 1990, said Col. Steve Whitney, the director of the GPS directorate.

GPS achieved its best performance ever this year reaching an accuracy of 45.3 centimeters during the week of April 14. On its best day the constellation produced an accuracy of 36.5 centimeters.
Whitney acknowledged difficulties with the next-generation GPS operational control segment, problems that stem in part from trying to prepare for the next generation of cyber security threats. All of the services, in fact, are wrestling with the issues.

“It’s a very difficult and complex situation,” he said, but it’s a question “that we absolutely have to answer.”

“Obviously we are creating infrastructure that is quite significant in terms of the users and the applications — so we are, by definition, highly exposed infrastructures,” said Chatre. “It’s known, I think, by everyone that we take this very seriously.”

China is actively working the problem said Professor Yuanxi Yang, of the China National Administration of GNSS and Applications, and is working to make its control systems more robust.
SYNTONY Awarded ONEWEB Contract
SYNTONY has been awarded a major contract by ONEWEB Company for the delivery of more than 15 GNSS Simulators. ONEWEB is a US company which is building the largest satellite constellation ever, with 900 satellite launched. In that frame, SYNTONY will deliver his new released CONSTELLATOR product, capable of Hardware-in-the-loop testing for LEO trajectory.

Sensonor STIM300 Provides Inertial Data for INS Unit
The STIM300 inertial measurement unit from Sensonor (Booth 317) now provides inertial data for iMAR’s iNAT-M200 inertial navigation system (INS) and for the iATTHEMO-C high-precision heading, attitude, position, and velocity reference, the Horten, Norway-based company says. The multiband GNSS systems, after extensive testing, are in production and used by several international customers, according to Sensonor.

Weighing 750 grams, the compact unit provides high accuracy with STIM300 features three gyros, accelerometers, inclinometers, and a data update rate up to 500 hertz. The unit is already incorporated in unmanned aerial vehicles (UAVs), satellites, man- and vehicle-portable target acquisition systems, land navigation products, and other systems, the company said.

Champion Instruments Rolls Out Choke-Ring Antenna
Champion Instruments (Booth 416) will be displaying its new choke-ring antenna at ION GNSS. The unit has an integrated GSM/GRPS modem and features a stable antenna phase center (APC) that is tailored for continuously operating reference station (CORS) base stations, the company said. The company’s Champion Pro GNSS receiver is able to track the following signals simultaneously: GPS: L1 C/A, L2E, L2C, L5 GLONASS: L1 C/A, L1 P, L2, L2C/A, L2P, L3 GALILEO: E1, E5A, E5B SBAS: WAAS, EGNOS, MSAS BDS: B1, B2. The Norcross, Georgia-based Champion Instruments, which was founded in 2011, offers GNSS receivers, choke-ring antennas, and rugged data collectors.

Septentrio Signs Deal with JPL, Rolls Out New GNSS Receiver
Septentrio (Booth 216) has received a contract from the Jet Propulsion Laboratory (JPL) for 35 PolaRx5 GNSS receivers, the company said. The receivers, which consist of 25 reference stations and 10 timing instruments, will be used in the NASA Global GNSS Network (GGN).

In other company news, Septentrio rolled out its new PolaRx5TR GNSS receiver. The unit has 544 hardware channels, features a calibration circuit, and supports all major constellations including GPS, GLONASS, Galileo, BeiDou, QZSS, and IRNSS, the company said.

Borden Named TAG Vice-President and COO
Technology Advancement Group (TAG) (Booth 315) has named John Borden as its new executive vice-president and chief operating officer (COO). Borden previously was product director, GNSS systems and vice-president, programs and technology, for the company. Borden, who oversees TAG’s day-to-day operations, joined the company when it was awarded a U.S. Army contract to provide program of record (POR) precise positioning service — GPS survey (PPS GPS-S).

NavTech GPS Hosts Open Mic Night on Thursday
NavTech GPS (Booth 214) will convene its 15th annual open mic event on Thursday, September 15, at the Crystal Ballroom in Portland (1332 W. Burnside Street). The event features raffling of $50 Amazon gift cards, photo booth, music, dancing, and karaoke. This year’s theme is Bohemian Rhapsody. The event, sponsored in part by Inside GNSS and Inside Unmanned Systems, starts at 8 p.m. and ends at midnight. For more information, stop by the NavTech GPS booth.

NovAtel Announces IMUs, Family of GNSS Antennas
NovAtel Inc. (Booth B) introduced its new VEXXIS series of GNSS antennas as well as two new inertial measurement unit (IMU) products for its SPAN technology portfolio at ION GNSS+ 2016.

The VEXXIS series includes two lines of multi-constellation and multi-frequency antennas, the new GNSS-800 series and the GNSS-500 series, introduced earlier this year. As for the IMUs, SPAN tightly couples NovAtel’s GNSS precise positioning technology with inertial navigation systems (INS) to provide continuous 3D position, velocity, and attitude solutions. The compact Litef- µIMU-IC is now part of NovA-
GPS timing performance for the nation’s electric power grids has been poor, and with new technology being rolled out, will continue to be until resolved, said an official at the Civil GPS Service Interface Committee (CGSIC) meeting in Portland, Oregon, on Monday.

“In terms of grid operations, [GPS timing] has to be much better. The signal coming out of the satellites or clocks, down to all of the systems that use it, is where we are having problems,” said Alison Silverstein, North American SynchroPhasor Initiative (NASPI) project manager. “The data is not good enough and the timing is not yet trustworthy. If we lose GPS today, it will complicate, but not kill grid operations. It will take longer and cost more to get stuff done, but it won’t kill the grid.”

She cited numerous factors that account for the poor GPS timing performance, including low-quality mass-market GPS receivers, software bugs, lack of firmware updates, local jamming or spoofing, sunspots, geomagnetic disturbances, and such events as leap seconds.

The importance of timing is evident as most the grid’s relays are synchronized by GPS, Silverstein said. “On the grid, relays turn everything off and on,” she said.

The need for better timing capability, as new grid technology is rolled out, is critical, Silverstein said. Some grid-related applications that require PNT include fleet direction, mobile crew management, customer information systems, physical utility poles detection, LIDAR and 3D modeling for vegetation management, substation siting, and line construction.

To find solutions to problems and to share information, Silverstein said that NASPI had formed a time synchronization task force. “Most members of [the grid] industry are not timing experts. We are getting them tools, best practices, and solutions to keep everyone up to speed on timing problem detection,” she said. “This includes equipment interoperability and standards updates.”

She also said there need to be GPS-independent networks, back-up systems, a telecom network that is capable of time transfer, and GNSS timing receivers capable of processing signals on multiple frequencies.

Not everything is GPS’ fault. After the 2003 blackout on the U.S. East Coast, Silverstein led an investigation of what happened and found out that people operating the local grid had insufficient situational awareness. She said her organization is educating operators to identify when things go wrong, baselining to develop operating decision support tools, and relay records across the grid.

In the future, new smart grid technologies will also make it more important to have accurate PNT, Silverstein said. “The smart grid is a hodge-podge of stuff. Today, we are only working primarily on a transmission level,” she said. “This includes new technologies such as wind farms, hydrogen storage facilities, combinations of heat and power, and others. Right now, it’s just in Popular Mechanics articles; so, don’t expect uniformity across the grid.”
People call it the APB,” said Hospodar. “The APB is fundamentally the agreement between the service and the defense acquisition executive about the milestones and budget requirements that are in the program. Essentially the Air Force took an action to refine the APB and return to the DAB.”

The goal was to improve schedule fidelity, the Air Force said in a written response to a question from Inside GNSS about what refinements were being sought.

“MGUE is a very complex activity that synchronizes five designs from three contractors delivering to government testing at two locations and integrating into four lead platforms identified by the Services: B-2 bomber, Arleigh Burke destroyer, Stryker, and Joint Light Tactical Vehicle,” the service said. “The Acquisition Program Baseline incorporates the most recent data from the contractors, more refined plans for government conducted developmental test, and updates from the lead platforms based on receipt of proposals.”

The overall approach to the program, however, has not changed over the last 18 months, the Air Force noted. The program is proceeding with three contractors — L-3 Interstate Electronics Corporation, Raytheon, and Rockwell Collins — who are in the process of delivering hardware and incremental software builds for that hardware. Additionally, the program is preparing for government developmental test while continuing early integration of test articles into Service-nominated lead platforms.

Other basic elements of the program — security, performance requirements, and a focus on developmental testing — remain unchanged,” the Air Force said.

The program office and Office of the Secretary of Defense (OSD) staff “captured the current developmental test activities in the Developmental Evaluation Framework [DEF] in parallel with the coordination cycle for the GPS Enterprise Test and Evaluation Master Plan,” the service added.

Additional testing is planned, said Hospodar, “to better characterize multiple aspects of the performance such as the power usage.” The Enterprise Test and Evaluation Master Plan has been

The expanded MGUE testing may help address concerns raised last year about the program’s schedule.
updated to contain that DEF and is in the coordination process, he added.

The expanded testing may help address concerns raised last year about the program’s schedule. The Air Force determined in 2014 that its previous experience with the Selective Availability Anti-spoofing Module (SAASM) receiver cards would enable it to condense the usual development and manufacturing process.

The Government Accountability Office, however, raised questions about the accelerated approach in a September 2015 report, mentioning, among other things, plans to skip a critical design review and concerns that the Army had about power limits on the new cards. As a result, one of the purposes of the DAB originally scheduled for the fall of 2015 was to decide if the stepped-up program should be slowed.

The Milestone B review coming up later this year, however, reflects the accelerated program, said Col. Steve Whitney, the director of the GPS Directorate. “It’s all about setting the baseline,” he told the audience at the Tuesday morning session of the Civil GPS Service Interface Committee.

Innovations in Increment 2

Although delays in the program and in other elements of the GPS modernization effort might offer a window for integrating the latest advances, “there are no plans to implement new technology into contractors’ current designs in the MGUE Increment 1 program,” the service said. “Introducing any potential new technologies at this time would impact delivery schedules to the government test program and to the Service lead platforms for integration.”

“However,” the Air Force added, “MGUE Increment 2 will offer opportunities to include new technologies.”

In fact, the second increment is already on the mind of the Acquisition Board, which wants to address the acquisition approach during its upcoming meeting. Increment 2, the Air Force said, “includes requirements for handheld devices, space receivers, and precision-guided munitions which go beyond the Increment 1 ground-embedded and aviation/maritime form factors to support an expanded set of users.”

Form factors are the standardized physical models of the receivers created so that they fit into existing equipment no matter who makes the receiver, in much the same way that batteries from different manufacturers fit into existing cars.

“The MGUE form factors, the two that were selected — the Standard Electronics Module Format E, we call it SEM-E for the aviation and maritime users; and the small serial interface, we call it the SSI, for the ground imbedded users — those were specifically chosen to accommodate replacement of the most common of the currently fielded SAASM receiver cards,” according to the Air Force spokesperson. “So, there are many different kinds of SAASMs, but the two form factors that were picked for MGUE replaced what would be the most common physical ones.”

The SEM-E will be used for the GRAM S/M and the SSI will be used by the GB-GRAM-M.

The GPS Directorate is also working with the Air Force Research Lab and Mayflower Communications Company to design, develop, and demonstrate a small size, weight, and power (SWaP), navigation warfare-compatible, M-code device for resource-limited applications. This Phase III Small GPS User Equipment (SGUE) effort, which is being conducted as a Small Business Innovation Research (SBIR) activity, aims to support both low-to-medium dynamic and high dynamics platforms.

“The same SGUE chip could be packaged into different form factors tailored for the specific platform application to include different software loads that customizes tracking loop filters, navigation filters, and integration with other sensors,” the Air Force said.

The GPS Directorate is also researching a government furnished cryptography reference design for SGUE. The MGUE program implements cryptography designs developed by the three MGUE contractors.

GPS seems to have come out of nowhere.

There was no progression like eight-track tape to cassette to CD to MP3 player. One day we were driving around clueless of where we were, struggling with road maps bought at gas stations that couldn’t be folded back neatly once opened, and — suddenly — there was an amiable female voice coming out of the dashboard offering directions to our destinations and showing no signs of impatience when we made wrong turns.

Actually, GPS is based on simple ideas that have been around for centuries, but their implementation had to wait until the required technologies matured and came together. This book discusses these principles, technologies, and how GPS came to be developed. The only prerequisite for this book is curiosity about a technology that has insinuated itself into our lives in a way that we can’t imagine how we ever lived without it. To get a copy, go to www.gpsforeveryone.com/
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