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The Institute of Navigation
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STAN HONEY, ION GNSS+ 2017 PLENARY SPEAKER

Navigation Adventures Meet Navigation Technology

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What makes Broome’s comment remarkable is not that it was written in the last 10 or so years when GNSS, Wi-Fi, Google, smartphones, and navigation apps have made such exercises routine, but rather in 1985 when GPS was a decade away from becoming fully operational.

At the time, Broome was the senior vice-president of marketing for Etak, Inc., co-founded by Stan Honey, the inventor of the Etak Navigator. The system employed a cathode ray tube display, electronic compass, motion sensors, digital maps stored on cassette tapes, and map-

ION JNC 2017 RECAP

Record Turnout for JNC 2017

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his year’s Joint Navigation Conference (JNC) hosted a record 648 attendees from across the military services, industry, and academia, with 36 companies and organizations participating in the commercial exhibit.

Sponsored by the Institute of Navigation’s Military Division, the JNC is the largest Department of Defense (DoD) and Department of Homeland Security (DHS) Positioning, Navigation, and Timing (PNT) symposium of the year.

This year’s four-day, for official use only

JNC Recap continued on page 8

Thank you to JNC 2017 Plenary Panel members: (from left) Michael Emerson, U.S. Coast Guard, Marine Transportation Systems; Neeraj Pujara, AFRL Sensors Directorate; and Kevin Cogains, Senior Executive Service (SES), Direct Reporting Program Manager Positioning, Navigation, and Timing.
Successful Meeting Programs: Past, Present and Future

I believe that hosting meetings is the most important activity that the ION does, because these meetings provide a forum where the entire international navigation community can gather, share ideas, catch up on what is happening, and jointly look to the future.

In this column, I would like to focus on some of these key meetings — past, present, and future.

Past
We recently concluded two successful ION meetings. First, Pacific PNT 2017 took place in Honolulu, Hawaii, May 1–4. This was our third Pacific PNT meeting, and this continues to be a popular venue and program from which we serve the ever-growing PNT community in the Asia-Pacific region.

The meeting hosted more than 170 attendees, 61 percent of whom were from outside the USA and 45 percent of whom were from Asia/Pacific Rim nations. This meeting attracts new audiences and meets the original purpose for which it was organized. I was able to attend and appreciated the international flavor of the meeting and heard some very good talks on the BeiDou satellite navigation system (among others). Thank you to its leadership (See page 3 for more coverage of this year’s meeting).

Next, the ION’s Military Division hosted a record number of attendees at this year’s Joint Navigation Conference (JNC) June 5–8 where 648 DoD personnel and related contractors convened in Dayton, Ohio. For myself, as Director of the Autonomy and Navigation Technology (ANT) Center at the Air Force Institute of Technology (AFIT), the JNC has become a “must-attend” conference, because almost everyone we work with in the DoD navigation community is there. I know there are many others that feel the same way.

The technical program (including the classified session) was excellent, and the exhibit hall was buzzing, with many opportunities for attendees to experience all the new technologies available to the DoD user community. It was also a valuable opportunity for having sidebar meetings with our sponsors, partners, and customers. Looking around the meeting venue, I could see that I was by no means the only person doing this.

I would like to express a big “thank you” to the Military Division for putting on such a strong show at JNC this year. See pages 1, 8-10 for more detailed information and photos from the event.

Present
I look forward to seeing you all at the ION Satellite Division’s ION GNSS+ 2017 meeting September 25–29 in Portland, Oregon. New this year are Monday’s short courses that will be provided free of charge to all paid ION GNSS+ attendees with the compliments of the Satellite Division and the ION Master Instructors.

Our Master Instructors are internationally recognized GNSS experts and educators who have generously donated their time and talents to this effort, as a service to the GNSS community, to provide lectures in their various fields of expertise. The listing of courses and instructors is impressive, and I encourage you to plan to arrive early to attend Monday’s lectures. Please see the online program <https://www.ion.org/gnss/program.cfm> for a complete list of courses and Master Instructors.

Future
The ION’s co-located International Technical Meeting (ITM) and Precise Time and Timing Interval (PTTI) Systems and Applications meetings will be rotating to the East Coast this January. ITM and PTTI are being held January 29–February 1 in Reston, Virginia and are now accepting abstracts. See <www.ion.org/itm> and <www.ion.org/ptti> for a list of technical sessions and abstract submission instructions. The ION’s Annual Awards will be presented during this event and the 2018 ION Fellows will be named.

Award Nomination Reminder
I encourage you to acknowledge the contributions of your professional associates and nominate one or more of them for an ION award that recognizes individuals making significant contributions or demonstrating outstanding performance relating to the art and science of positioning, navigation, and timing. Nominations for ION’s Fellows and Annual Awards can be made at <www.ion.org/awards> until October 15.
Meeting on a small island, the third Biennial Pacific PNT Conference exceeded expectations by providing 170 global attendees with a unique opportunity to hear and meet with GNSS leaders from Australia, China, Europe, Japan, South Korea, Taiwan, and the United States.

In sessions held at the Marriott Waikiki Beach Hotel in Honolulu, Hawaii, these leaders presented and discussed the latest technical and economic details associated with their countries’ development and use of GNSS. They emphasized the wide range of GNSS activities taking place in the Pacific region and beyond, thus giving conference attendees the latest news about GNSS technologies and related major PNT undertakings in real time. In addition to the international GNSS updates, Pacific PNT attendees were among the first in the world to hear from Dr. David Chapman who presented the United States Air Force Research Laboratory’s vision for space-based PNT and the next generation of GPS — a vision which has the goal of producing extremely robust and resilient capabilities.

Professor Jade Morton, Pacific PNT program co-chair, was especially pleased with the three new special sessions focused on BeiDou (China), QZSS (Japan), and COSMIC/FORMOSAT (U.S.-Taiwan).

“These special topics sessions provided me and my colleagues with a tremendous opportunity to hear firsthand from the researchers and developers directly responsible for the latest technical advancements in their systems and communities,” she said. “In addition to the global Sat-Nav consumers who are benefiting from the huge selection of GNSS signals for PNT, researchers such as myself, who are trying to understand space weather and our environment, are benefiting from these diverse signals and their ability to provide insight into ionospheric disturbances and severe weather, such as hurricanes.”

In addition to the wealth of information shared regarding GNSS-related technologies, Pacific PNT 2017 highlighted Alternative PNT technologies, especially those associated with the increased activity the world is seeing in piloted, unpiloted, and autonomous systems — especially regarding operations in GNSS-challenged environments.

Program Co-Chair Professor Frank van Graas, who has mentored several Ohio University student teams that have successfully competed in autonomous system challenges noted that “with the increased emphasis by the consumer market for direct and autonomous delivery of products and services by unmanned systems — reliable, robust, resilient, and trusted PNT is a must! To see the latest research efforts from my international colleagues related to PNT and autonomy was a huge benefit to me, my students, and my research colleagues.”

Mark your calendar now for Pacific PNT 2019. With our International Advisory Board from eight countries, we plan on continuing this very successful conference with its focus on the current PNT-related technology and consumer topics of greatest importance to the Pacific communities.
Luggage continued from page 4

Misdirected luggage is among the leading complaints of commercial air travelers.

Although such events reached an all-time low — a rate of 2.70 per 1,000 passengers in 2016, according to the U.S. Department of Transportation (DoT), the consequences can often be more than annoying.

For frequent flyers, a day will almost inevitably arrive when they leave the airport empty-handed.

Even keeping track of a suitcase in transit through ever-more-crowded airports has become a challenge to travelers. Until recently, our only recourse was a somber trip to the airline’s service counter. Now, however, a growing number of manufacturers — primarily start-ups angling to “disrupt” the travel industry (in a good way) — have introduced features that enable travelers to track their luggage using GNSS, smart phones, and other positioning/proximity sensors.

The innovations fall under a category that is being called “smart luggage,” which also covers such features as battery charging technology, electronic baggage tags, and built-in scales to ensure that one doesn’t overpack a suitcase. A new product, the Modobag, even offers a suitcase that can be ridden through the airport.

But tracking technology is turning out to be one of the popular features.

For example, in June Bluesmart Luggage, which started with an Indiegogo campaign in 2014, introduced its Series 2 line with products offering GPS+3G global location tracking that reportedly enables travelers to track the location of their bags anywhere in the world with a cellular connection or alert them if they have left an item behind.

FUGU luggage has a similar GPS/smartphone-based “companion app” for locating bags.

Raden’s Bluetooth-based location tracking technology and built-in proximity sensors can alert a traveler when his or her luggage is coming down the carousel or track a bag from up to 100 feet away.

San Francisco, California–based Travelmate Robotics has developed what it describes as a fully autonomous suitcase with artificial intelligence that can talk and follow its owner around.

The Travelmate bag, scheduled for release in September, includes Bluetooth, GPS, an accelerometer, and gyroscope to help orient the suitcase and a Find Me function to locate it. A Follow Me function tracks the location of its owner’s smartphone and exploits obstacle detection and collision avoidance sensors to create a hands-free luggage companion.

The company has invited early developer access for programmers interested in developing applications for Travelmate, allowing access to the full robot application programming interface that enables use of its sensors, motors and other features.

Modobag, developed by Chicago entrepreneur Kevin O’Donnell, is a motorized suitcase that can be ridden on. The company has raised more than half a million dollars on Indiegogo and expects its product to be available this year.

GSM-GPRS technology provides the positioning/navigation/proximity functions. Specifications indicate that Modobag’s belt-driven, 150-watt electric motor will provide an eight-mile range at speeds up to 8 mph for a 180-pound rider. The maximum rider weight is 260 pounds and allows a reduced range.

We’ve undoubtedly not seen the end of progress in the smart luggage field. Imagine a merger between Travelmate and Modobag technologies that produce a driverless suitcase that can move a traveler between airport gates automatically.
Nominate a Colleague for ION Fellows and Annual Awards

Nominations for The Institute of Navigation’s (ION) Fellows and Annual Awards Program are now being accepted. The ION Annual Awards Program is sponsored by The Institute of Navigation and recognizes individuals making significant contributions or demonstrating outstanding performance relating to the art and science of navigation.

The Institute accepts nominations for the following annual awards:

- **Early Achievement Award**
  recognizing an individual early in his or her career who has made an outstanding achievement in the art and science of navigation.

- **Superior Achievement Award**
  recognizing individuals who are practicing navigators and have made outstanding contributions to the advancement of navigation.

- **Distinguished PTTI Service Award**
  recognizing outstanding contributions related to the management of PTTI systems.

- **Captain P.V.H. Weems Award**
  recognizing contributions to the art and science of navigation.

- **Tycho Brahe Award**
  recognizing outstanding contributions to the science of space navigation.

- **Norman P. Hays Award**
  recognizing outstanding encouragement, inspiration and support contributing to the advancement of navigation.

- **Colonel Thomas L. Thurlow Award**
  recognizing outstanding contributions to the science of navigation.

**Election to Fellow membership**
recognizes the distinguished contribution of ION members to the advancement of the technology, management, practice and teaching of the arts and sciences of navigation, and/or for lifetime contributions to the Institute.

Submit your nominations today for ION’s Fellows and Annual Awards at www.ion.org/awards. All nominations must conform to ION nomination guidelines. Details of the nomination process and forms are available at www.ion.org/awards. **Nominations must be received in proper form by October 15th to be considered.**
UPDATE ON THE AFRICAN OUTREACH PROGRAM

Workshop on Space Weather Effects on GNSS Operations

Patricia Doherty
Boston College

The Institute of Navigation’s Satellite Division once again sponsored and participated in an outreach workshop to promote the use of GNSS in developing nations. The latest workshop was held from May 22 to June 2 at the International Centre for Theoretical Physics (ICTP) in Trieste, Italy.

The outreach program was formally initiated in 2009 to provide GNSS education at the university level for scientists, engineers, and students in Africa. The goals were to build a knowledgeable GNSS African workshop, encourage the use of GNSS for societal and economic benefits, build GNSS infrastructure, establish research studies using GNSS in Africa, and establish international scientific collaborations.

Held annually, the series of workshops together with supporting activities have demonstrated progress in attaining these goals. Our measure of success has been the number of papers published by African scientists in peer-reviewed journals that have included the use of GNSS for space science exploration together with the number of new Ph.D. degrees granted to African scientists who used GNSS in their research efforts. The workshop series was designed, and continues to be convened, by Patricia Doherty, ION past president and Boston College staff member, and Sandro Radicella and Bruno Nava of the Abdus Salam International Centre for Theoretical Physics in Trieste, Italy.

Although the outreach program originally focused on scientists, engineers, and students from the developing countries of Africa, the most recent workshop branched out farther to developing nations around the world — but still with a concentrated focus on African nations. The 2017 workshop supported approximately 40 participants from 24 countries, including Argentina, Bosnia and Herzegovina, Brazil, Cote d’Ivoire, Egypt, Ethiopia, India, Indonesia, Malaysia, Nigeria, Peoples Republic of China, Peru, Republic of Cameroon, Rwanda, Uganda, and Ukraine.

A very interesting aspect of the participants this year was the large number of women attendees, a figure that has increased every year. This year, nearly half of the participants were women.

ION Members’ Participation

One reason for the success of the outreach program is the lecturers who generously share their time, their knowledge, and their zeal for GNSS to teach at the workshop. Since the inception of the program, The Institute of Navigation has sponsored the cost of travel for a number of ION experts to participate in the workshop. Because each workshop has a specific focus, various ION experts are asked to support the workshop based on their background and availability.

ION experts who have supported the GNSS workshop include Dr. John Raquet, Dr. Jade Morton, Dr. Anthea Coster, Dr. Keith Groves, Dr. Endawoke Yizengaw and Patricia Doherty. Other GNSS experts from Europe and Africa have joined the ION members to carry out the full program. Together with the international participants, this group contributed to a successful international event supporting scientific exploration using GNSS and social understanding with far-reaching benefits.

The focus for this year’s workshop was Space Weather Effects on GNSS Operations. The lectures were designed to give both theoretical and practical training on the physics of space weather and its effects on GNSS. Topics addressed in the workshop included general Introductions to GNSS, GNSS Errors, Differential GNSS, Ionospheric Calculations Using GNSS, Introduction to GNSS Receivers, Ionospheric and Space Weather Monitoring Using GNSS and other Sensors, Space Weather, Space Weather Effects on GNSS and on SBAS and GBAS Systems, and Equatorial Electrodynamics, Scintillation, and Other Ionospheric Irregularities. The students also worked on group projects in which various space weather events were studied using GNSS.

By all accounts this workshop was a great success! Class presentations were dynamic and easily understood by the students while lecturers and students shared many open discussions. Lecturers commented that this group of students was very attentive and learned quickly, as became apparent when the students presented the results of their group projects on the last day of the workshop. At least a couple of their presentations were worthy of the beginnings of a scientific paper.

From a scientific point of view, we are seeing this as a growing interest in the acceptance and use of GNSS in academic and research programs on space environment studies and applications in Africa and other developing nations.

The convenors gratefully thank our sponsors including the Institute of Navigation’s Satellite Division and our Italian government sponsors, the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy, and the University of Trieste.
What Does the Future Hold?
The conveners have planned another workshop to be held from April 23 to May 4, 2018 — once again at the ICTP in Trieste. Given the level of interest in the 2017 workshop, we will continue the theme of Space Weather Effects on GNSS Operations at Low Latitudes.

The conveners also intend to invite participation from additional agencies for financial support. For the 2017 workshop, we had nearly 200 applications but were limited to financial support for 40 participants. There is apparent interest from around the world to learn more about GNSS, and this workshop series is both contributing and responding to this demand.

The 2018 workshop will also be the 10th workshop held in support of this outreach program. As we celebrate a decade of successful workshops, we intend to make this a larger and more successful event featuring some of the success stories and research of our early participants.
The ION extends our thanks to all the JNC Meeting Organizers!

Front Row: John Langer, Jan Anszperger, Robert Greenlee, Eddy Emile, Sharon Donald, Greg Graham, Neeraj Pujara, Capt Russell Holmes, Kevin Coggins and Joe Schnecker

Back Row: Dr. Tom Powell, Paul Olson, John Del Coliano, Elliott Kaplan, Jalal Mapar and William Bollwerk

AFRL and the Air Force Life Cycle Management Center (AFLCMC) presented a resilient Embedded GPS/INS prototyping initiative, a part of the Air Force’s general “Cyber Campaign” to harden and improve the efficiency and effectiveness of PNT capabilities.

The SPAWAR Systems Center Pacific presented the GPS-Based PNT Service (GPNTS) Update, providing a summary of GPNTS, current status, current assured PNT (APNT) capabilities, and future opportunities. GPNTS is the next generation PNT system for the U.S. Navy surface fleet that enables current and future capabilities to provide assured PNT.

The US Naval Observatory (USNO) discussed its System To Estimate Latitude and Longitude Astronomically (STELLA) and Other Celestial Navigation Products and Services. This presentation focused on the Navy’s renewed practice of celestial navigation, reinstatement of training on celestial techniques, and the USNO modernization of its support for celestial navigation.

Representatives from the U. S. Army Aviation and Missile Research Development and Engineering Center (AMRDEC) presented results for the validation of a PNT test bed for unmanned aircraft systems (UAS). With the growing predominance of this technology, a corresponding need has arisen to address potential threats against UAS. One such threat is a degradation or denial of GPS signals, which have a significant role in the complex navigation solutions used by UAS. The test bed provides for testing, evaluating, and mitigating the effects of these navigation threats to Army UAS platforms in a realistic, relevant simulation environment.

Plenary: The Foundation for Military Ops

The plenary speakers, addressing the conference theme of “Military Navigation Technology: The Foundation for Military Ops,” focused on users and new developments.

Thank You to Our Sponsors
Dr. Brian Teeple, deputy chief information officer (CIO) of the DoD, was keynote speaker for the classified session. His remarks established the context for the rest of the program by highlighting the depth and breadth of DoD PNT developments, especially as they are reported to Congressional defense authorization and appropriation committees.

Kevin Coggins, the Army lead for executing assured PNT (APNT) capability, provided a detailed overview of the interdependencies and challenges of PNT equities operating in a “multi-domain battlespace.” He explained how increasing adversarial threats requires the need for robustness and resiliency of complementary technologies that can be leveraged and utilized across multiple platforms and systems and seamlessly integrate with Joint and Coalition partner hardware.

Mike Emerson, director of Marine Transportation Systems at U.S. Coast Guard Headquarters, addressed increasing civil sector dependence on GPS, and concerns with jamming and cyberattacks as justification for establishing a backup system. This discussion was the basis for follow-on insights into new concepts and technologies for the future of marine navigation and waterway.
At 40th Anniversary of NTS-2
GPS Historians Spread a PNT Gospel

The history of the Global Positioning System is getting more exposure as the result of the efforts of ION member Richard Easton and Eric Frazier, authors of GPS Declassified: From Smart Bombs to Smartphones, published as an imprint of University of Nebraska Press.


The authors‘ had a more select and knowledgeable audience a year ago, when they gave a talk at Peterson Air Force Base, Colorado, as part of the National Security Space Institute (NSSI) speaker series. In the audience was Gen. John Hyten, then the head of Air Force Space Command (AFSPC) and now commander of U.S. Space Command, the Navigation Technology Satellite 2 (NTS-2), was launched into circular orbit from Vandenberg Air Force Base, California. Carrying the first cesium clock sent into space, the NTS-2 began transmitting the NTS-2 pseudorandom noise (PRN) subsystem assembly on July 20, 1977.

The following day, a Rockwell Collins engineer named David Van Dusseldorp sat on the rooftop of a company building in Cedar Rapids, Iowa, adjusting an antenna every five minutes to receive a signal from the NTS-2. The PRN message was successfully received and decoded by Rockwell’s first GPS receiver station, a six-foot-tall assembly in a room inside the building — a far cry from today’s chip-scale GNSS receivers.

At the NSSI presentation, Frazier and Easton focused on how GPS ended up becoming a public utility that affects nearly everyone.

Both Easton and Frazier are concerned about the overreliance society has on GPS. “Overdependence on GPS is a problem,” Frazier said. “Our enemies are looking at how to nullify our GPS advantage,” added Easton.

For now, GPS is more secure than the Internet, Frazier said, but that didn’t stop him from speculating about the public reaction if recent headlines had been about GPS being hacked, instead of Internet sites.

The best part of the talk at Peterson AFB would only be clear to insiders,” Easton says. “Our main address began at 3 p.m. We had an hour for our talk and 30 minutes for Q&A. People said that it was very unusual for Gen. Hyten to set aside 90 minutes for a lecture.”

Usually, at 4:30, all would rise and Gen. Hyten would be the first to leave. At Easton and Frazier’s presentation, however, 4:30 came, and the general told audience members that they could leave but he was staying.

“He talked with us for another 10 minutes,” Easton said. “That’s when you know that your speech was successful!”

“GPS is one of our favorite topics,” said Gen. Hyten, reflecting the AFSPC’s overall responsibility for operation of the system. “Everyone understands GPS.”

Gen. John Hyten, Air Force Space Command commander, introduces Eric Frazier, left, and Richard Easton, authors of GPS Declassified: From Smart Bombs to Smartphones. The book was part of the National Security Space Institute’s reading list and the authors made a presentation to members of Team Pete on July 21, 2016 as part of the NSSI speaker series. (U.S. Air Force photo by Dave Smith)

Strategic Command (USSTRATCOM). The speaker series features authors of books included on the NSSI reading list.

Released in 2013 by Potomac Books, the book benefited from Easton’s insider perspective as the son of Roger L. Easton, who led the Space Applications Branch of the Naval Research Laboratory (NRL) that oversaw the development of the several generations of satellites, including a forerunner of GPS.

Just over 40 years ago — on June 23, 1977 — the NRL-built Navstar GPS Phase I spacecraft, the Navigation Technology Satellite 2 (NTS-2), was launched into circular orbit from Vandenberg Air Force Base, California.
During World War I both airplanes and airships— including blimps, dirigibles, and Zeppelins— brought a new, lethal dimension to war. Although the military advantage was yet to be fully realized, air warfare brought a psychological reign of terror, particularly to the British, whose civilians had never been directly attacked at home in any previous conflict.

In January 1915, Germany launched a series of Zeppelin attacks on the east coast of Britain. The invention of Count Ferdinand von Zeppelin, a retired German army general and aircraft manufacturer, the flying weapon was lighter than air, filled with hydrogen, and held together by a steel framework. Zeppelins were capable of travelling at about 85 miles per hour and carrying up to two tons of bombs. (Count Zeppelin’s idea for the dirigible was inspired by an observation balloon ride he’d taken in Minnesota during his extended trip to observe the Union Army during our Civil War.)

There were no air defenses in 1915; so, these new aircraft appeared invincible. However, by 1917, the British had found the airships’ Achilles heel and developed a combination of incendiary and explosive rounds that ignited the lighter-than-air hydrogen used to keep the Zeppelins airborne.

A 20-year-old pilot named William Leefe Robinson became the first “Zepp Slayer” using the new weapons.

According to a Wikipedia entry, in his combat report to his commanding officer, Leefe Robinson wrote, “The next ship I saw I determined I would attack from the first position I found. I met her just after two o’clock. She was flying at 10,000 feet. Soon she appeared to catch fire in her forward petrol tank. The flames spread rapidly along her body. She made off eastward on fire. In several minutes she dipped by the nose, and dived slowly in flames to the earth. I was so pleased that in my excitement I pulled the ‘joy stick’ and looped the loop several times. Then I showed my signal to stop firing and came back.”

During their brief but deadly dominance, the airships killed more than 500 people and injured more than a thousand up and down Britain’s east coast. The last Zeppelin attack on Britain took place over the Norfolk coast in August 1918.

Airplanes or Airships?
After the war was over, the world’s most powerful nations launched commercial and military efforts to extend the range of airplanes and airships from the WWI maximum of 500 miles. Charles “Lucky Lindy” Lindbergh’s famous 1927 continent hop in the Spirit of St. Louis caused an international frenzy. The American aviator’s transatlantic solo nonstop flight from the United States to Europe led many to believe that airplanes were the answer to all future
long-distance transportation needs. But in the late 1920s and early 1930s most of the world’s major countries and powerful corporations were placing most of their commercial investments not into airplanes, but airships.

The leader in airship technology was naturally the German consortium led by the Zeppelin Company. In 1931, construction began on the largest airship ever built, the AZ-129 Hindenburg dirigible, with support for its funding from Nazi leaders Hermann Göring, the minister of the German Air Force, and Josef Göbbels, the minister of German Propaganda. In 1936, it flew for the first time. Its 830-foot length made it nearly as long as three football fields. Its width in the center was over 100 feet. For nearly 100 years, the Goodyear “Blimp” has created a sensation whenever it passed over a residential neighborhood, but comparing its size to that of the Hindenburg is like comparing a golf ball to a basketball. (Goodyear, by the way, constructed airships with Zeppelin between the wars.)

The Hindenburg was without a doubt the most luxurious airship ever built. It was an airborne hotel, easily capable of carrying 100 people. It contained 25 passenger cabins with 50 full berths, baths with showers, a dining room (complete with an aluminum piano), a reading and writing room, and two promenade decks where travelers could gaze through canted windows at the scenes below. This airship, levitated by highly flammable hydrogen, even had places where passenger smoking was permitted.

In addition to serving the rich and privileged for transoceanic voyages lasting one third of the time that a cruise ship would take, it was also a darling of the German propaganda machine, participating in the 1936 Berlin Olympic ceremonies and as a leaflet distributor for the Referendum of March 1936 concerning the remilitarization of the Rhineland.

Navigating the Zeppelin

Hindenburg’s fastest crossing of the North Atlantic took place in August, 1936; the ship lifted off from Lakehurst, New Jersey at 2:34 AM on August 10th and landed in Frankfurt the next day, after a flight of just 43 hours and 2 minutes. By the end of 1936, Hindenburg had crossed the Atlantic 34 times, carrying more than 3,500 passengers and more than 66,000 pounds of mail and freight. It looked as if regular transatlantic airship service had arrived. But there was still the issue of navigation. Lindbergh was indeed lucky to have navigated his single engine monoplane using relatively crude dead reckoning techniques consisting of a magnetic inductor compass, air speed indicator and pre-flight Mercator projection chart. But almost a decade later, the AZ-129 Hindenberg, with its 16 Mercedes’ engines propulsion system, was still relying on dead reckoning techniques for its transoceanic navigation. But its complement of navigation equipment was sophisticated, commensurate with the importance and value of its missions.

The dirigible’s heading was determined by an Anschütz gyrocompass. Gyrocompasses had come into common use before World War I, as iron ships replaced wooden ones. As discussed in the Summer 2007 ION Newsletter, Hermann Anschütz-Kaempfe of Kiel, Germany, had secured a U.S. patent for a gyrocompass in 1906. Further developments included a gyrocompass damping system to counteract ships roll in stormy seas.

In America, Elmer Ambrose Sperry of Wall Street, New York obtained patents for gyroscopic apparatus and formed the Sperry Gyroscope Co. in 1910. In 1911, Sperry launched a gyrocompass on the commercial market. When Sperry sold a gyrocompass to the Imperial German Navy in May 1914, Anschütz and Co. sued for patent infringement.

The German court in Berlin requested the expert opinions of a university physics professor and former Swiss patent examiner, Albert Einstein, to clarify the technical differences between the gyrocompasses in the patent dispute. Einstein eventually sided with the Anschütz company, while he concurrently was completing what many historians consider the foremost intellectual achievement ever: the Theory of General Relativity.

The Hindenburg’s navigation suite included conventional celestial navigation techniques,
following known wind pressure patterns, and an optical device called a drift meter. This drift indicator or drift sight is used to improve dead reckoning for aircraft navigation. It consists of a small telescope extended vertically through the bottom of the airship with the eyepiece inside the fuselage at the navigator’s station.

The drift meter’s reticle, normally consisting of spaced parallel lines, is rotated until objects on the ground are seen to be moving parallel to the lines. The angle of the reticle then indicates the aircraft’s drift angle due to winds aloft and can be used to calculate the ground speed. A skilled operator, while over the ocean, could also use the drift meter’s tracking of wave caps, to estimate speed with respect to the water.

Oh, the Humanity!
With its remarkable sophistication and luxury, the Hindenburg still came to a bad end, as we all know. On Saturday, May 6, 1937, as the giant airship attempted to land at the U.S. Naval Air Station in Lakehurst, New Jersey, it suddenly burst into flames and was totally destroyed in less than 35 seconds.

Of the 98 members of “humanity” on board the Hindenburg that day (37 passengers plus a crew of 61), 62 of them miraculously survived. This fiery disaster would mean that not only the Hindenburg, but the age of lighter-than-air transportation had come to a tragic end.

See also <https://www.ion.org/museum/cat_view.cfm?cid=1&scid=2> for a description and image of a driftmeter and <www.airships.net> for a discussion of the differences among lighter-than-air craft and for information on Hindenburg flight operations procedures.

Marvin B. May is Chief Scientist of the Pennsylvania State University's Navigation Research and Development Center where he teaches navigation courses. His email is <mbm16@arl.psu.edu>.

An earth inductor compass replica from Charles Lindberg’s Spirit of St. Louis, Lindbergh (Time and Navigation exhibit, Smithsonian Air and Space Museum)
Before departing on the Fourth of July recess, the House Armed Services Committee (HASC) voted 60–1 to authorize $631 billion in base defense spending for Fiscal Year 2018 (FY18) and $65 billion for Overseas Contingency Operations in the FY18 National Defense Authorization Act (NDAA).

Earlier in the day, the Senate Armed Services Committee (SASC) passed its own draft of the FY18 NDAA, with a different top line ($700 billion) and a different set of priorities. In contrast, the White House budget reflected a total of $603 billion in defense funding for 2018.

All three of these FY18 authorization levels exceed the sequestration spending caps, which are noted to be $549 billion. For Congress to reach an agreement on the defense authorization, and then appropriate the necessary funding, forecasts some challenging legislative activity in the months ahead.

Viewing the developing legislation with a focus on GPS and PNT references, a number of sections in the HASC markup as well as in the SASC summaries will be particularly interesting to watch as the final bill language is negotiated between the two houses.

Section 1255 of the HASC markup requires the Secretary of Defense to develop a plan and provide a report not later than April 1, 2018, to “Counter the military capabilities of the Russian Federation . . . by accelerating programs to improve the capability of United States military forces to operate in a Global Positioning System (GPS)-denied or GPS-degraded environment.”

The HASC Subcommittee on Strategic Forces markup includes language on the reliance of GPS for defense of the homeland. The markup states:

“The committee is aware that the Department of Defense is coordinating with the Department of Transportation and the Department of Homeland Security on efforts to strengthen positioning, navigation, and timing (PNT) capabilities, including considering redundant systems. The committee notes that section 1618 of the National Defense Authorization Act for Fiscal Year 2017 (Public Law 114-328) required a report on requirements and technology options to address PNT resilience. In addition to this assessment, the committee directs the Secretary of Defense, in coordination with the Commander of U.S. Northern Command, to provide a briefing to the Committee on Armed Services of the House of Representatives by December 15, 2017, on the risks associated with disruptions to the Global Positioning System (GPS) that could affect defense of the homeland and other defense activities in the United States. The briefing shall include the requirements for PNT reliability and redundancy for Department of Defense operations in the United States, an analysis of the extent to which defense of the homeland operations rely on accurate PNT signals from GPS, and an assessment of alternative sources of PNT that could be used as a backup to ensure continuity of operations in the event of a major disruption to GPS.”

The reference to the FY17 NDAA (Public Law 114-328) and specifically Section 1618 includes a requirement for DoD and DOT to “jointly conduct a study to assess and identify the technology-neutral requirements to backup and complement the positioning, navigation, and timing capabilities of the Global Positioning System for national security and critical infrastructure.” The language further directs that the two departments prepare a report addressing, “The identification of the respective requirements to backup and complement the positioning, navigation, and timing capabilities of the Global Positioning System for national security and critical infrastructure.”

Delivery of the FY17-directed report is required not later than one year after the enactment of the FY17 NDAA, which took place on December 23, 2016. Referring back to the draft FY18 committee language, it adds the requirement that the DoD include an assessment of the domestic risks that could affect the defense of the homeland and other domestic activities of the DoD given a disruption of GPS. This added assessment is to be provided by December 15, 2017.

It will be interesting to see if the final report that is being prepared in response to the FY17 NDAA and the additional assessment activity forecast in the FY18 draft will become a matter of public record.

Returning to the draft FY18 NDAA language, the issue of a GPS backup is further addressed in Section 1617. This section includes the requirement for a, “Demonstration of Backup and Complementary Positioning, Navigation, and Timing Capabilities of Global Positioning System. This section would require, during fiscal year 2018, the Secretary of Defense, the Secretary of Transportation, and the Secretary of Homeland Se-
curity to jointly develop a plan for carrying out a backup capability demonstration for the Global Positioning System (GPS). The plan would be required to be based on the results of the study conducted under section 1618 of the National Defense Authorization Act for Fiscal Year 2017 (Public Law 114–328) and include the activities that the Secretaries determine necessary to carry out such demonstration.”

The language requires a briefing on the plan within 120 days of the date of enactment of the Act and authorizes $10 million for an 18-month backup capability demonstration (if the funds are appropriated).

GPS to GNSS for MGUE

The draft FY18 NDAA also includes under Section 1618 (not to be confused with Section 1618 of the FY17 NDAA as noted above) a requirement that the DoD develop and implement a plan “To increase resilience for the positioning, navigation, and timing (PNT) capacity for the Department of Defense . . . to ensure that military GPS user equipment (MGUE) terminals have the capability to receive signals from the Galileo satellites of the European Union and the QZSS satellites of Japan, beginning with increment 2 of the acquisition of such terminals.”

The draft language indicates that the plan, “Include an assessment of the feasibility, benefits, and risks of MGUE terminals having the capability to receive foreign PNT signals, beginning with increment 2 of the acquisition of such terminals; . . . options to use hosted payloads to provide redundancy for the GPS signal; ensure that the Secretary of Defense, with the concurrence of the Secretary of State, engages with relevant U.S. allies to enable MGUE terminals to receive allied signals and negotiates other potential agreements relating to PNT enhancement; and include any other options the Secretary of Defense determines appropriate. Finally, this section would require the Secretary of Defense to submit the plan along with certain evaluations to specified congressional committees not later than 180 days after the date of the enactment of this Act.”

Given the challenges that the DoD is currently experiencing with MGUE increment 1, the requirement to develop a plan within 180 days to expand the capability of MGUE increment 2 by adding both Galileo and QZSS signals to GPS M-Code while at the same time including QZSS as a potential host payload platform to “Provide redundancy for GPS” will likely be viewed as too aggressive and one that the Air Force would likely not want to see reflected in the final FY18 NDAA.

The SASC markup is handled in a classified setting (Secret level) and, therefore, no specific GPS and/or PNT language is available. However, the SASC did provide a summary of its work, and one item that could have an impact on GPS, PNT, and Navwar is a suggestion to further realign responsibilities within the DoD Chief Information Officer (CIO) organization beyond those already required in the FY17 NDAA.

That SASC realignment vision would have the responsibilities of the current DoD CIO shared between the Chief Management Officer (who would perform the CIO’s current business functions) and a new Chief Information Warfare Officer who would occupy a presidentially appointed and Senate-confirmed position reporting directly to the Secretary of Defense. This new position would assume responsibility for all warfighting matters relating to the information environment of the DoD, including cybersecurity and cyber warfare, space and space launch systems, electronic warfare, and the electromagnetic spectrum.

The SASC summary does not specify how the continuing responsibilities of overseeing the DoD PNT Enterprise, which is integral to warfighting aspects of the DoD information environment, will be addressed in the realignment. Should the final bill not provide additional guidance, it will be very important that the DoD take the necessary steps to accommodate the DoD PNT Enterprise within the realigned organizational structures.
CONGRESSIONAL FELLOW REPORT

Behind the Scenes of the Senate Legislative Process
Dr. Kyle Wesson

The 114th Congress introduced more than 12,000 pieces of legislation, only about three percent of which became law. The current Congress remains on a similar trajectory, introducing over 5,000 bills and resolutions prior to the August recess with a mere one percent enacted.

Despite a vanishingly small chance that a bill becomes a law — historical rates fall between two and six percent — Congress still produces an incredible amount of legislation, most for the explicit purpose of messaging, posturing, and politicking. Behind the scenes, engaged staffers, lawyers, researchers, stakeholders, and advocates push and pull to craft those bills during a span of weeks and months. Based on my time on the Hill, here is one route through the many wickets that lead to a bill’s introduction.

Just a Twinkle in a Staffer’s Eye
Inspiration for legislation can come from almost any source — from constituents and stakeholders, to news articles and government reports. If internal office discussions conclude that the idea is consistent with the Senator’s policy interests and sufficient staff time and resources exist, then the whole process begins.

Senator Richard Blumenthal’s office, where I serve, encourages all staff members, including fellows, to propose and pursue ideas for legislation.

Meetings with Stakeholders
For every issue, there will be a half dozen or more groups with interests and concerns. Meeting with those groups, sometimes multiple times, places the issues in context and allows the office to develop a strategy for crafting the bill. These early meetings quickly reveal the challenges as well as where the “bodies are buried,” especially if Congress had previously attempted to legislate the issue.

The nonpartisan Congressional Research Service serves as a vital resource for Congress during this phase and can supply any Hill office with reports, briefings, and research on key issues. A staffer who spends time in dozens of initial meetings can smooth the review process once the draft legislation returns to those same stakeholders later for their comments.

Drafting Services in the Senate
During our orientation, we got a word of advice: don’t attempt to write your own legislation. Instead, rely on the teams of legal professionals in both chambers whose job it is to prepare the bills.

In the Senate, this job falls to the Office of the Legislative Counsel, known simply as “Leg Counsel,” who may well be the unsung heroes of this entire process. They provide confidential, nonpartisan drafting services for the Senate upon request and consult with offices on a wide range of issues, ranging from legal and administrative to budgetary and parliamentary.

They start with notes of almost any level of legal detail, or lack thereof, and turn those thoughts into official legal language complete with the sectioned and numbered pages that adorn the pages of any bill. Like any other written activity, the verb “drafting,” as in drafting legislation, is accurate, as staffers work through revisions with Leg Council to address concerns as the language matures through review.

Reviewing Legislation
To conduct that review, staffers solicit feedback from many of the same stakeholders and groups who were instrumental in the bill’s creation. Staffers review the language closely at this stage to ensure that it is effective and that it avoids negatively affecting constituents, businesses, and interests in the legislator’s home state.

Securing Co-Sponsors and Endorsements
Since legislation can be dense and opaque, staff generally prepare a one-page overview and a section-by-section summary to pair with the bill. When other offices or groups consider endorsing the bill, they can start with these to get a high-level understanding of the bill and refer to the bill’s specific language as necessary.

Those one-pagers need to be clear and concise if they are to convince other busy, political offices and groups to support the legislation. The more endorsements and co-sponsoring senators, and in particular the more bipartisan the mixture of co-sponsors, the greater the likelihood of success for the bill after introduction.

Introducing Legislation
With the bill text finalized, approved, and endorsed, it can then be introduced — provided the timing fits with the current politics and news cycle. The steps to introduce the bill include printing the bill on paper, obtaining the Senator’s signature on the front page, and submitting the text to the respective Democratic or Republican cloakroom located adjacent to the Senate floor.

Cloakroom staff confirm receipt and
pass the legislation on to other government groups to document and post online at <Congress.gov>. It is at this point in the process that the bill receives its very own number. After introduction, the Senator often holds the floor to discuss the merits of the legislation.

To see a recent bill from Senator Blumenthal’s office, look up S. 1418, known as the “Airline Passengers’ Bill of Rights.” Bills can also amend larger legislation that must be re-approved every year, with the goal of passing both the larger bill and the tacked-on amendment. For example, the Senator introduced a half dozen smaller amendments derived from S. 1418 to amend the FAA Reauthorization Act that passed out of the Commerce Committee in late June.

How Legislation Passes the Senate
From here you can search the Web or your favorite civics textbook to find a description or chart that explains how legislation passes the Senate (or the House) as it navigates to the President’s desk for a signature or veto. The hurdles in the Senate include the committee review, markup and vote, the committee report, debate in the Senate with time for amendments, and finally the roll call vote. From here, much of the policy work is complete, and a bill’s fate rests with the politics, procedures, and whims of the Congress.

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Late in June, a restrained safety alert from the United States Maritime Administration politely asked mariners to exercise caution when transiting the Black Sea at 44-15.7N, 037-32.9E. Suspected GPS interference, it said.

An article by Dana Goward in Maritime Executive magazine went into the back story. A vessel nearing the coast of Novoros-siysk, Russia on June 22 reported that its GPS equipment had been going off and on over a couple of days — sometimes indicating a lost signal, at one point reporting a location 25 nautical miles off.

The Coast Guard reported nothing was out of the ordinary with GPS signals, space weather, or tests. Check your software updates, they told the ship’s master.

He checked. His GPS equipment was fine. But at least 20 other vessels in the area were having the same problems.

The article said experts analyzed the supporting documentation sent in by the master and concluded “this was a fairly clear, if not subtle, case of ‘spoofing.’ . . . They point to the receiver saying its antenna is 39 meters underwater, that all the GPS satellites it is using have the same high signal strength, and that the WER, or Word Error Rate, is 97 percent (normal is less than 10 percent).”

The author said although there are many anecdotes about spoofing in Russian waters, this was the first well-documented public account.

Russia has equipped 250,000 cell towers with GPS jamming devices as a defense against attack and, clearly, relations are tense between Russia and Europe and the U.S.

Goward, the author of the article, is president of the Resilient Navigation and Timing Foundation, a Virginia-based organization that recognizes that satellite navigation is critical infrastructure and is concerned about world reliance on GNSS alone.

A spoofed GPS signal showed a ship’s location inland near the resort town of Gelendzhik (pictured above), when it was 25 nautical miles away on the Black Sea.
Rats, the Nimble Navigators

What self-driving cars need to become really useful are some nice, healthy rat neurons. Put an ordinary rat in an unfamiliar space — crowded, convoluted, curved, or changeable — it doesn’t matter: the rat figures it out and remembers where it’s been and how it got there.

IEEE Spectrum science writer Jean Kumagai says “[S]pecialized neurons in its 2-gram brain fire, or spike, in response to landmarks or boundaries. Other neurons spike at regular distances . . . creating a kind of mental representation of space. Yet other neurons act like an internal compass, recording the direction in which the animal’s head is turned ...Whenever it follows the same path, the spikes strengthen, making the rat’s navigation more robust.”

Researchers at Queensland University of Technology in Brisbane, Australia have spent a decade and a half studying these rodent brains and developing generations of robotic navigation systems built on their neural model. The goal: enable robots to move through dynamic environments without sensors such as lidar or computer-intensive algorithms.

They combined what they knew about rat neural circuits with simultaneous localization and mapping (SLAM) algorithms and developed what they called RatSLAM.

Right now, the team is working with heavy equipment manufacturer Caterpillar to develop mapping systems for remotely operated mining vehicles, using their rat-brain–inspired navigation algorithm to go where GPS cannot.

Turn Your Backyard into a Battlefield!

A tech toy manufacturer based in Los Angeles and Hong Kong wants kids in the leafy suburbs to enjoy the same thrills as those in Mosul. In August, Skyrocket Toys introduce RECOIL, an immersive GPS-enabled augmented reality (AR) war game where “couches become cover. Trees become barricades.”

The Wi-Fi game hub transforms up to 500 square feet into a battlefield, where players can turn the rhododendrons into virtual bunkers, sniper nests, and other military-mimicking emplacements. Players use haptic weapons — a technology that allows players to feel recoil and other sensations (but not serious wounds . . . yet.) 3-D positional audio tells them where enemy fire is coming from.

Players’ smartphones act as heads-up displays. Meanwhile the game’s mobile app locates all players and track their movements and allows the players to organize location-based objectives that are integrated into the lawn . . . uh, combat zone.

Raspy-voiced actor Michael Madsen, of Kill Bill and Reservoir Dogs fame, plays the coach in the ad rollout now in progress: He’s old warrior Striker, telling the kids he “walks along the perimeter of sanity, and sees reality — where you see Mama’s meat freezer, I see cover from raining hellfire.”

The company promises it’ll get the kids off the couch and into the fresh air, where as many as 16 players at a time can virtually blow each other up.

Corporate Profile

Oscilloquartz
An ADVA Optical Networking Company
www.oscilloquartz.com

Oscilloquartz is a pioneer in time and frequency synchronization. We design, manufacture and deploy end-to-end synchronization systems that ensure the delivery and assurance of highly precise timing information over next-generation packet and legacy networks. As an ADVA Optical Networking company, we’re creating new opportunities for tomorrow’s networks.

Whether at the edge or core of the mobile backhaul network, deep in the radio access network, in utility distribution networks, or in defense communication networks, Oscilloquartz’s portfolio of synchronization devices provides you with the ideal solution. Complemented by our powerful synchronization network management system, configuration, management, monitoring and assurance of your entire network synchronization infrastructure becomes a simple task. What’s more, our miniature network synchronization solutions enable precise synchronization in the most space-restrictive environments, indoor and outdoor, and even in deep urban canyons with no clear sky view.

For more information on corporate membership in the Institute of Navigation, please contact Kenneth P. Esthus at 703-366-2723 extension 1004.
Resilient PNT Update

Dana A. Goward

The “Father of GPS” has three wishes:

1. That deployment of eLoran begins immediately
2. That low-cost very jam resistant GNSS receivers are commercially available, and
3. That FCC does not approve repurposing of adjacent spectrum until/unless proposal passes realistic evaluation of all current and future GNSS signals, applications and techniques.

On June 27, Dr. Brad Parkinson spoke to a joint meeting of ION’s Washington, D.C., Section and the Resilient Navigation and Timing Foundation (RNTF) aboard the historic USS Constellation in Baltimore’s Inner Harbor. His “Three Wishes” presentation (available on the blog at <RNTFnd.org>) mirrored his previous calls for “Protect, Toughen and Augment GNSS” — a mantra that has been taken up by the RNTF in its policy recommendations.

The event was attended by ION members, government officials, members of the U.S. National PNT Advisory Board and representatives from six different nations. Sixteen companies in the resilient PNT space were represented by either a CEO, president, vice-president, or director.

The event — was also the annual meeting for RNTF, a Virginia 501(c)3 charity — got me thinking about resilience models to complement and back up GPS. And public statements by several current and past administration officials in the last year have indicated that the threat of a major GPS disruption is increasing, and the United States is well overdue for a complementary and backup PNT system to be implemented.

2. Low-Cost Very Jam Resistant Receivers – Well, “low cost,” is relative, I suppose, but such receivers and technology are certainly more available now than ever. Michael Jones’ recent article “Anti-jam Systems, Which One Works for You?” in GPS World provided a nice overview. And this year the Department of Homeland Security issued guidelines and best practices, especially for owners and operators of critical infrastructure.

We at RTNF are still concerned, though, that manufacturers could do more to educate customers who, at present, seem to be focused only on low price. And we wonder if there is not a greater leadership role for government in encouraging, or perhaps in some instances, mandating some capabilities.

3. FCC & Adjacent Spectrum Use – RNTF and others submitted comments to the FCC docket on this in 2016, and the issue remains prominent. The Department of Transportation hosted its sixth Adjacent Band Compatibility Workshop in March of this year and much discussion about the subject took place at this June’s National PNT Advisory Board meeting. In fact, the board resolved to send another strong recommendation to the administration about testing and standards. Also, on June 27 a group of 22 diverse companies and organizations sent a letter to the FCC opposing an application for use of spectrum adjacent to that used for GNSS signals (letter available on the blog at <RNTFnd.org>).

While the last 12 months have seen progress on many fronts, PNT resilience has had few, if any, clear wins. Looking forward, it is up to all of us to keep these kinds of issues visible and provide the benefit of our expertise and experience to our fellow citizens and public leaders.

For more information on anything mentioned in this article, please visit <www.RNTFnd.org>, especially the blog posts which typically contain numerous links and references. Or email <inquiries@RNTFnd.org>.

Dana A. Goward is an ION member and the president of the Resilient Navigation and Timing Foundation.
ION Participates in the European Navigation Conference

Above: Americans represent ION and GPS at the European Navigation Conference (ENC) held May 9-12, 2017 at EPFL in Lausanne, Switzerland. Presentations were made by Frank Zane, National Coordination Office for Space-based PNT; Capt. David Besson, USAF GPS Directorate; and Dr. Tom Powell, The Aerospace Corporation who presented a keynote presentation on the roots of satellite navigation.

ION Student Academy Awards

Cadet Matthew S. Schoen was presented with the Institute of Navigation Student Academy Award at the U.S. Coast Guard Academy Graduation Award Ceremony on May 17, 2017.

ION News and Notes

DAYTON SECTION NEWS

The Dayton Section convened for its last luncheon meeting of the year on May 11 at Northrop Grumman in Beavercreek, Ohio. The speaker was Dr. Sanjeev Gunawardena, research professor at the Air Force Institute of Technology’s Autonomy & Navigation Technology (ANT) Center.

Dr. Gunawardena spoke about overcoming signal multipath through the application of correlator beamforming as an economical and practical alternative to controlled reception pattern antenna (CRPA) digital beamformers for GNSS integrity-monitoring applications. He presented comparisons of multipath rejection performance for several receiver/antenna combinations, including the same multi-element antenna with both traditional CRPA processing and correlator beamforming. The new approach was shown to be almost as effective as the traditional one in rejecting the multipath signals.

On June 22, members met at the Wright-Patterson AFB Club for the annual dinner and election of officers for 2017–2018. Mark Carroll was elected chair; Robert Leishman, vice chair; and Captain T. J. Montgomery, executive secretary. Boyd Holsapple will continue to serve as section treasurer and George Simons as facility coordinator. The first luncheon meeting of the new season will be in September.
**GNSS Program Updates**

**News from Systems Around the World**

**GPS**

The U.S. House of Representatives has approved a National Defense Authorization Act (NDAA) for Fiscal Year 2018 that includes $1.1 billion for the GPS program, $10 million more than requested by President Trump.

A companion measure approved by the Senate Armed Services Committee calls for $1.22 billion in expenditures. However, legislation passed in the House Appropriations Committee that would actually allocate money for the Department of Defense cuts the White House proposal on GPS spending by $30 million to $1.06 billion.

Meanwhile, the U.S. Air Force plans to open competition soon to build the next batch of GPS III satellites, referred to as SV 11+ referring to space vehicle 11 (SV11) and the satellites that come after it. The request for proposals should go out by the end of September, according to a presentation made by GPS Directorate Deputy Director Col. Gerry Gleckel in late June to the National Space-Based Positioning, Navigation, and Timing Advisory Board.

Plans call for an On-Orbit Reprogrammable Digital Payload on SV11 as well as high power amplifiers and 18 decibels of additional power for regional military protection of M-Code signals. An energized charged particle sensor would be added for increased space situational awareness, plus a search and rescue payload and a Nuclear Detonation Detection System that’s been redesigned to address obsolescence issues as well as reduce size and weight.

Technology insertion points are planned at SV17, SV23 and SV27. Air Force Space Command is also working with the Air Force Research Laboratory at Wright-Patterson Air Force Base on “new technology to increase resiliency and evolve to mitigate threats.” Delivery of SV11 is planned for the first quarter of FY26. The last satellite, SV32, is to be delivered in the second quarter of FY33.

**Galileo**

Two more Galileo satellites entered into service at the end of May, bringing the total number of satellites available for service in Europe’s GNSS system to 16.

The European GNSS Agency (GSA) announced the completion of in-orbit testing (IOT) of the satellites, SV ID 07 and SV ID 05, which were launched last November from the European spaceport near Kourou, French Guiana.

The satellites, along with two others (SV ID 03 and SV ID 04), were the first to be launched using an Ariane-5 rocket. Launch of another four satellites on an Ariane 5 is scheduled for later this year.

In June, the European Space Agency (ESA) signed a €324-million ($378-million) contract for manufacturing of eight additional Galileo satellites. The deal continues the role of Germany’s OHB System AG as the prime contractor, with UK-based Surrey Satellite Technology Ltd. (SSTL) overseeing the navigation platforms. OHB and SSTL produced the first 22 full operational capability (FOC) Galileo satellites.

Following a six-month handover phase, on July 1 the GSA began overseeing the operations and service provision for Galileo. GSA responsibilities include overseeing the operation of such key service facilities as the Galileo Security Monitoring Center in France and the United Kingdom, the European GNSS Service Center in Spain, and the Galileo Reference Center in the Netherlands.

**GLONASS**

According to Russia’s TASS news agency, the Russian government has approved requirements for GLONASS or GLONASS/GPS user equipment manufactured in Russia. The share of foreign components for equipment production shall not be more than 50 percent of the total number of components from January 1, 2018, and not more than 30 percent from January 1, 2020, according to a decree signed by Prime Minister Dmitry Medvedev and posted on the Russian Cabinet website.

**BeiDou**

The output value of BeiDou and China’s location-based service industry, increased more than 22 percent from a year earlier to more than 211 billion yuan (about $30.8 billion) in 2016, according to Chinese news reports.

The industry’s core output value totaled 80.8 billion yuan (about $11.84 billion), 70 percent of which came from the country’s BeiDou Navigation Satellite System, according to a white paper released by the Global Navigation Satellite System and Location Based Service Association of China.

**Regional/Augmentation**

The Japan Aerospace Exploration Agency (JAXA) and Mitsubishi Heavy Industries, Ltd., launched the second spacecraft in the country’s Quasi-Zenith Satellite System (QZSS) on June 1.

Once complete, the QZSS constellation will initially consist of four satellites: three in inclined geosynchronous orbits and one in geostationary orbit, although a Japanese government official said in May that addition of another three spacecraft, which would provide an autonomous regional GNSS capability, is under consideration. JAXA plans to send aloft three of the Michibiki satellite series by the end of fiscal 2017. QZSS is scheduled to start full operation in fiscal 2018.
matching to produce a dead-reckoning navigation system accurate to 50 feet.

Rupert Murdoch’s News Corporation bought Etak in 1989 and sold the company to Sony Corporation in 1996. In May 2000, Etak was acquired from Sony by Tele Atlas and became Tele Atlas North America. Tele Atlas was ultimately acquired by Netherlands-based TomTom in 2008, but Etak had ceased to exist as a separate company long before then.

On September 26, Honey will deliver the keynote address on “Navigation Adventures” at the plenary session kicking off the ION Satellite Division’s GNSS+ 2017 conference and exhibition in Portland, Oregon.

A former research engineer at SRI International, Honey led the development of 1st & Ten, the SportsVision Inc. technology behind the bright yellow line on televised football games that shows where an offensive team needs to reach in order to get a first down.

Honey was a cofounder, president, and CTO of SportsVision, which also created RACEf/x. The latter technology uses an on-board GPS system, other vehicle sensors, and an onboard computer to create a digital record of the event in real time that can be displayed on a television screen.

Those and related efforts brought Honey three personal Emmys for technical innovation in sports television. But his plenary presentation will focus not on his experiences as a technology entrepreneur but on his experiences as a record-setting high-seas navigator.

From 2004 to 2010, Honey was technical director and navigator, sequentially for the ABN AMRO Volvo Ocean Race Team, Team Origin America’s Cup Team, and Cammas/Groupama sailing team. He then served as director of technology for America’s Cup Event Authority from 2010 to 2013.

Most recently, he crewed on the fastest transatlantic crossing by a monohull, the Comanche, in 5 days, 14 hours, and 21 minutes. Honey will be joined in the plenary session by Carla Balo, assistant vice-president for mobility research and business development at The Ohio State University. Her presentation is entitled “Smart Mobility and Smart Cities — The Importance of GIS in the Internet of Things.”

Dr. Chris Hegarty, The MITRE Corporation, will chair the plenary session.

Tutorials, Free and Otherwise

The Tuesday night plenary session will be preceded on Monday by the free introductory tutorials introduced at last year’s event. These are hour-and-a-half short courses provided on a complimentary basis to all paid ION GNSS+ attendees with the compliments of the Satellite Division and the ION Master Instructors.

ION’s traditional fee-paid tutorials will resume on Tuesday, with registrants having a choice of six 3-1/2–hour courses. Patricia Doherty, Boston College, is this year’s tutorials chair.

Also taking place on Monday and Tuesday is the 57th meeting of the Civil GPS Service Interface Committee (CGSIC), which is free and open to the public at no charge. CGSIC subcommittee meetings take place on Monday, with the plenary session on Tuesday — all co-located with ION GNSS+ 2017 at the Oregon Convention Center.

The Honorable Andre Hentz, Department of Homeland Security, Deputy Under Secretary (Acting) for Science and Technology, will present the plenary’s keynote address.

Some 36 technical sessions are scheduled for Wednesday through Friday with hundreds of papers and panel discussions planned.

General Chair for ION GNSS+ 2017 is Dr. Frank van Diggelen, Google. Program co-chairs are Dr. Alex Stratton, Rockwell Collins, and Dr. Michael Veth, Veth Research Associates. Registration details and the full program are available on-line at <https://www.ion.org/gnss/program.cfm>