2017 ISSUE 4

trajectory

THE OFFICIAL MAGAZINE OF THE UNITED STATES GEOSPATIAL INTELLIGENCE FOUNDATION

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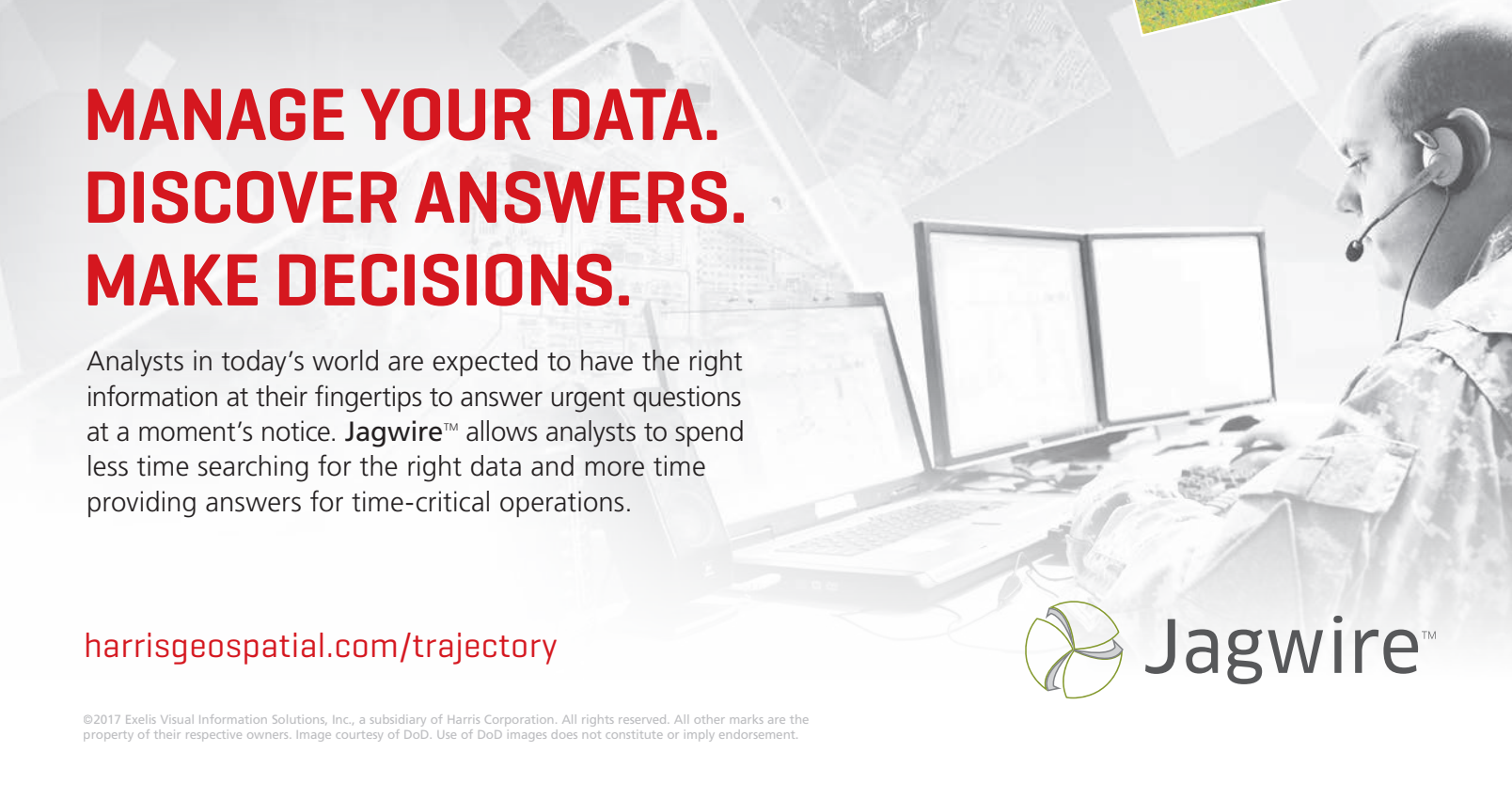

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TRJ-049

The Value of Volunteers

One of the distinctive underpinnings of a nonprofit organization is its engagement with—and quite often dependence upon—volunteers to create and sustain its ability to meet its objectives. Over time, I've taken the opportunity in myriad public forums, including this space in *trajectory*, to acknowledge and show my sincere appreciation for the significant contributions of USGIF volunteers.

Dating back to the formation of the Foundation, when now COO Aimee McGranahan was the first and only paid staff member, volunteers were integral to the creation of the bylaws, the planning and execution of events, and the establishment of the first accreditation standards for the Collegiate Accreditation Program.

John Westcott was a dedicated supporter of USGIF and the broader GEOINT Community.

Even as the Foundation's full-time staff has grown to 15, we are humbled by the work our volunteers perform on our Board of Directors, Academic Advisory and Certification Governance Boards, working groups, and committees.

Recently, two things occurred that caused me to pause and reflect on the value of USGIF volunteers. The first was the passing of John Westcott, an iconic GEOINT professional. John's federal service consisted of more than 37 years as an employee of the CIA and the National Imagery and Mapping Agency. He worked an additional 10 years as an employee of Boeing before entering into professional consulting.

John was a ubiquitous part of the GEOINT Community. He was a regular attendee and animated contributor at USGIF Planning Committee meetings. John supported our events, large and small. As I mentioned at our most recent GEOINTeraction Tuesday event, I'm not sure in the nine years I've hosted that particular series I recall not seeing John in the front row, ready to engage that evening's speaker.

I will miss John's wry smile and sincere counsel. USGIF will miss John's insightful input. The GEOINT Community will miss John's deep professional experience and his important role as a consummate connector. From the inception of the concept of GEOINT in 2003, John was all-in, and our Foundation and profession are significantly better because of him.

Another recent moment that caused me to reflect was when our Scholarship Subcommittee chair, Neil Billingsley of S2 Analytical Solutions, forwarded this year's nominations. Neil humbly requested—after 11 years on the Committee, including the last nine as chair—that he take some time off and cede the opportunity to someone new. It's hard for me to articulate the depth of my sincere appreciation for that level of dedication and commitment to the USGIF mission. Every GEOINTer should thank Neil, and the many other Foundation volunteers who exemplify the very best our Community has to offer.

The next wave of volunteers might even be included in this issue of *trajectory*. Once again, we've endeavored to serve up a rich offering of relevant and interesting content to inform, educate, and stimulate discussion—including the announcement of USGIF's 2017 scholarship recipients. This issue also features an important discussion of weather as it pertains to GEOINT, and a fantastic interview with legendary retired Maj. Gen. "Rosie" Rosenberg. Finally, visit *trajectorymagazine.com/special-edition* to view our first special edition of *trajectory*, focused on GEOINT for first responders, and share it with colleagues in those professions.

I look forward to seeing you in the halls of USGIF and at our array of GEOINT Community Week events in November, including our GEOGala—the Community's annual reunion and celebration.

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trajectory

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INTsider

COMMUNITY NEWS, EVENTS, AND EDUCATION

NGA Deputy Associate Director of Capabilities Kristin St. Peter spoke at GEOINTeraction Tuesday in September.

- USGIF NEWS
- GEOINT COMMUNITY NEWS
- EDUCATION
- APPLICATIONS
- CIVIL

Data Brokerage and Reorganization at NGA

Kristin St. Peter of the National Geospatial-Intelligence Agency (NGA) engaged an audience of nearly 100 people in a Q&A session Sept. 12 during USGIF's GEOINTeraction Tuesday event, which was hosted by CA Technologies at the CIT building in Herndon, Va.

St. Peter announced NGA's reorganization, mentioned her new title—Deputy Associate Director of Capabilities—and focused much of the discussion on public-private partnerships and NGA's goal to use data as currency.

"It takes 100,000 images to be able to train an algorithm to spot a plane, train, or automobile with a 90 percent level of accuracy," St. Peter said. "We have those data sets and want to be able to use them to partner with people who normally don't partner with government."

Gathering training data often can be more difficult for startup artificial intelligence companies than luring venture capital investors, she noted, and said that by bringing training data to the table, NGA hopes to drive forward its own missions as well as the industrial base. St. Peter also emphasized these nontraditional partnerships are intended to complement but not replace CRADAs and other more traditional information sharing agreements.

The audience asked for examples in which data brokerage models have been successful and how such a partnership would work logistically. St. Peter explained that when exchanging training data for algorithms and other AI tools, NGA would retain intellectual property rights in terms of a partners' ability to sell the data.

NGA is also in the process of a reorganization designed to enhance its business processes, according to St. Peter.

"We have gone to a model where titles look more like how the CIA is structured and how they assign and organize their work," she said.

NGA's Kristin St. Peter

Under the reorganization, NGA's associate directorates are: Operations, led by Maj. Gen Urrutia-Varhall; Capabilities, led by Dr. Anthony Vinci and his deputy, St. Peter; Support, led by Ellen Ardrey; and Enterprise, led by Dustin Gard-Weiss.

NGA's former chief of staff, Ed Mornston, now has the title of executive director. The executive director has more specific responsibilities to assist the director and deputy director in integrating agency activities and operations, where the chief of staff position was responsible for support office functions.

In addition to seeking nontraditional partners and reorganizing, St. Peter said the agency is adopting a coding training program at all levels of the organization as well as looking to hire more employees, including software engineers and data visualization experts.

It takes **100,000** images to train an algorithm to spot a plane, train, or automobile with 90 percent accuracy.

USGIF's new St. Louis Area Working Group met at the T-REX incubator space in St. Louis.

ST. LOUIS

USGIF's St. Louis Area Working Group Holds First Meeting

In August, USGIF's new St. Louis Area Working Group (SLAWG) held its first meeting at co-working space and technology incubator T-REX in St. Louis. The working group formed with the goal to expand the GEOINT workforce in St. Louis and the surrounding area as well as to create a lifelong learning pathway for GEOINT professionals.

Approximately 40 individuals attended, including representatives from the St. Louis mayor's office, the St. Louis Agency on Training and Employment, the St. Louis Development Corporation, NGA, St. Louis University, Project Connect, and other organizations in industry and academia.

INTERESTED in participating in the St. Louis Area Working Group? Email **slawg@usgif.org**.

The working group's co-chairs discussed the group's goals and objectives. Project Connect, an initiative led by the City of St. Louis, shared how it is collaborating with St. Louis residents for redevelopment efforts in the city's investments to support the Next NGA West campus.

"Current and future physical, social, and policy needs are being addressed, which includes collaboration across all agencies, city departments, and nonprofits working in the area," said Project Connect's Isa Reeb. "Project Connect is supporting the SLAWG with its knowledge of the social and political environment in and around the future NGA site."

Following the initial meeting, working group members were tasked with engaging K-12 schools in the city as well as to participate in local events to promote GEOINT awareness. The group will continue to meet monthly to develop its plans to build up the city's GEOINT workforce.

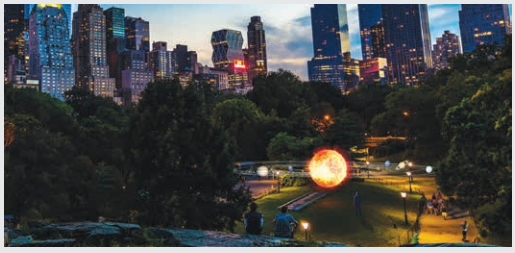
In Memoriam

John Westcott, a well-known member of the GEOINT Community, passed away Sept. 5 following a brief illness. Westcott graduated from the University of Vermont in 1965 and began a career with the CIA that lasted more than 37 years. He ended his government tenure as a senior intelligence officer with the National Imagery and Mapping Agency. After a brief, three-day retirement, Westcott began working with Boeing as the director of business development for GEOINT Programs. After 10 years at Boeing, Westcott retired for a second time. Unable to stay away from the community he loved, he began accepting consulting opportunities within a week. His presence will be missed at USGIF and other community events.

PROCRASTINATION TOOLS

Topo Maps+

Topo Maps+ wants users to adventure more. This app combines offline GPS with downloadable topographic maps from the U.S. Geological Survey, Mapbox, the National Oceanic and Atmospheric Administration, and more to be used deep in the backcountry without internet connection. Explorers can trace map trails, add waypoints, and record trips to measure distance, speed, and elevation data. Data gathered is exportable as KML or GPX files for sharing via other apps.
glacierpeakstudios.com



Solar

Tour the solar system with this augmented reality app created on the Aireal platform. Planets and stars are overlaid on the user's surroundings and anchored to the geospatial coordinates of a nearby location for a markerless augmented experience. Users can tap on individual planets for detailed information.
aireal.io/solar

Sensimob

More efficiently manage your field team with Sensimob. This GPS tracking and secure messaging network provides field team managers and first responders awareness of their team's whereabouts along with one-touch check-ins and alerts. The pro version is fully integrated with Esri's ArcGIS for seamless data visualization and sharing.
sensimob.com

YPG member Kevin Hyers

PHOTO COURTESY OF KEVIN HYERS

YPG

Young Professional Spotlight: Kevin Hyers

Kevin Hyers graduated from Virginia Tech with a bachelor's degree in geography in 2014. He joined Williams and Heintz Map Corporation in 2015 and was promoted from the press crew to a role in the pre-press department where he now serves as a cartographer.

What led you to choose this profession?

I was always interested in maps growing up. I originally thought I would pursue a degree in engineering, but found myself far more engaged as well as passionate and enthusiastic about my studies in geology, and decided to switch to geography when I learned more about GIS.

Where do you see cartography going in the next five to 10 years?

I see a lot more automation in the future. With the incorporation of more and more data in map-making, the wealth of information far surpasses what is immediately useful to the user. As generalization tools continue to improve, I see the job of cartography moving toward making less tedious corrections and more toward design. More data will be useful at more scales and resolutions.

What advice do you have for others just starting out in the GEOINT Community?

Get involved and engage with the opportunities that are there for you such as USGIF's Young Professionals Group (YPG). Be ambitious and look for things you know will be challenging. There is a lot of value in learning by experience and the more difficult and novel the experience, the more you can learn.

From left to right, USGIF staff members Justin Franz, Lindsay Tilton Mitchell, Julia Vanarsdall, and Bill Allder III

STAFF CORNER

USGIF Announces Staff Promotions

USGIF promoted four of its staff members in September. **Bill Allder III** is now USGIF's director of membership, leading USGIF's individual and organizational membership. **Justin Franz** is now USGIF's community and educational manager, overseeing the Foundation's working groups and volunteers. **Lindsay Tilton Mitchell**, formerly the Foundation's marketing and communications assistant, is now lead educational manager. Mitchell and Franz will lead the development of USGIF's K-12 educational outreach program. **Julia Vanarsdall** was promoted to USGIF's meeting and events manager, responsible for executing the planning of all USGIF events.

COMMERCIAL IMAGERY

Planet Awarded Second NGA Contract

NGA announced a $14 million, one-year subscription to Planet in July. According to the agency, the subscription—made through Planet's General Services Administration Information Technology Schedule Contract—enables the Department of Defense and the Intelligence Community to access Planet's imagery of more than 25 select regions of interest, ranging from portions of the Middle-East, Asia, and Africa to Central and South America. This contract follows a seven-month, $20 million pilot contract that began in September 2016.

This Planet satellite image was captured over Natal, Brazil.

PHOTO COURTESY OF PLANET

INTERNATIONAL GEOINT

DigitalGlobe Signs Contract with Australian Department of Defence

DigitalGlobe signed a Direct Access Program contract with the Australian Department of Defence. The four-year, $83 million contract will allow the Australian government to task and download imagery in real-time from all five DigitalGlobe satellites.

STEM

Sharing GEOINT with D.C. Area Students

INTERESTED in sponsoring an Intro to GEOINT presentation at a local school? Contact **lindsay.mitchell@usgif.org.**

USGIF staff presented at Fairfax County Park Authority's Science and Nature Camp this summer in Chantilly, Va., sharing an Intro to GEOINT presentation with 16 middle school-age students. In September, the staff also shared the presentation with 10th, 11th, and 12th graders enrolled in a GIS class at the Maret School in Washington, D.C. Intro to GEOINT is an interactive presentation that provides a basic overview of GEOINT to include lessons in maps, satellites, imagery analysis, GIS, remote sensing, and potential careers.

GPUs

USGIF and NVIDIA Launch Essay Challenge

USGIF partnered with Organizational Member NVIDIA to offer an essay challenge to individuals attending or working at one of USGIF's 14 accredited universities. Three challenge winners were selected to receive two NVIDIA Titan Xp graphics processing units (GPUs) each.

Applicants from USGIF-accredited schools were invited to write a four-page essay answering the challenge question: "If you were given dedicated access to an NVIDIA GPU-powered supercomputer, what problems could you solve?"

This challenge was open to students, researchers, staff, and faculty attending or working at one of the accredited universities under USGIF's Collegiate Accreditation Program.

"In a rapidly changing GEOINT environment, USGIF has close collaborations with industry to ensure our academic partners continue to advance their computational capability over the next decade and that they achieve scientific progress at all scales," said Dr. Camelia Kantor, USGIF's director of academic programs. "This challenge is just another example of USGIF's commitment to strengthen national and global security through our accredited programs."

The winners are:

- **University of Southern California**: "Spatiotemporal Predictive Analysis from Public Data using Deep Learning" by Weiwei Duan
- **University of South Carolina**: "Tagging the Earth with High-resolution Imagery and Deep Learning" by Zhenlong Li, Huan Ning, and Cuizhen (Susan) Wang
- **U.S. Military Academy at West Point**: Chris Oxendine and William Wright

HBCUs

The Future of GEOINT at HBCUs

PHOTO COURTESY OF TUSKEGEE UNIVERSITY

In July, USGIF and other representatives from government, industry, and academia visited Tuskegee University to discuss the future of GEOINT at historically black colleges and universities.

Representatives from academia, government, and industry met in July at Tuskegee University in Alabama to discuss the future of GEOINT programs at historically black colleges and universities (HBCUs).

The third annual event, "GEOINT at HBCUs: Integrating Geospatial Science in STEM Programs at Historically Black Colleges and Universities," was an opportunity for representatives from eight HBCUs to share the details of their geospatial programs, discuss challenges, and recognize successes. Representatives from industry and government participants such as NGA, the Office of the Director of National Intelligence, and Oak Ridge Institute for Science and Education attended to discuss ways to support GEOINT curricula at HBCUs.

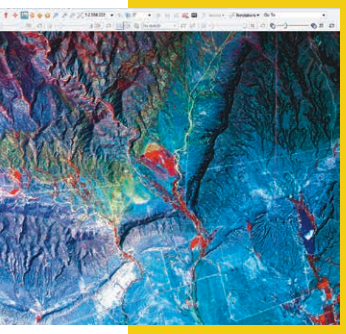
USGIF's Vice President of Professional Development Dr. Darryl Murdock and Director of Academic Programs Dr. Camelia Kantor attended to share the many ways the Foundation can support HBCUs through its Collegiate Accreditation Program, GEOINT Essential Body of Knowledge, and Universal GEOINT Certification Program.

"We wanted to share with HBCU representatives the value proposition of having USGIF academic GEOINT certificates at their programs to create a pipeline of professionals in the GEOINT space," Kantor said. "We also shared the certification opportunities USGIF offers GEOINT professionals once they've entered the job market."

SOFTWARE

Harris Offers ENVI+IDL to USGIF Scholarship Winners

USGIF and Harris Corp. partnered to grant each of the 2017 USGIF scholarship recipients a 12-month student ENVI+IDL license. The license provides college students access to Harris' geospatial analytics software, benefiting their academic work and research.



ENVI software

"Harris has a long history of supporting the academic community, and we are thrilled to be contributing ENVI+IDL licenses to the USGIF scholarship winners," said Robert Laudati, managing director of Harris Geospatial Solutions. "Our industry needs more bright minds to help tackle today's biggest geospatial challenges, and with ENVI+IDL these students get hands-on experience with the industry's leading image science software for geospatial analytics. By supporting the USGIF scholarship winners, they will soon be able to answer the most difficult GEOINT questions—whether they arise in the classroom, in the lab, or later on the job."

The 2017 scholarship winners were announced in early September. Turn to page 26 to learn more about this year's recipients.

ACCREDITATION

NOVA IMS & West Point Renew Accreditation

Universidade Nova de Lisboa's NOVA Information Management School and the U.S. Military Academy at West Point received certificates for their programs' re-accreditation at USGIF's GEOAcademic Summit in October. From left to right: Dr. Camelia Kantor of USGIF, Dr. Marco Painho of NOVA IMS, Lt. Col. Ian Irmischer of West Point, and Dr. Darryl Murdock of USGIF.

In August, USGIF granted renewed academic accreditation for the Universidade Nova de Lisboa's NOVA Information Management School (IMS) and the United States Military Academy at West Point's geospatial information science program.

NOVA IMS and West Point are among the 14 academic institutions accredited by USGIF's Collegiate Accreditation Program. West Point earned accreditation in 2011 and offers the USGIF GEOINT Certificate through its on-campus bachelor's degree program. NOVA IMS in Portugal was accredited in 2016 to award GEOINT Certificates through its online master's degree program. NOVA IMS is the first USGIF-accredited international program.

"NOVA IMS and West Point are two highly ranked universities in their respective countries," said Dr. Camelia Kantor, USGIF's director of academic programs. "Their GEOINT programs have met and exceeded USGIF's published criteria. They both have strong GEOINT Certificate programs with a well-rounded suite of curriculum supported by excellent faculty and lab space. USGIF strongly believes in cultivating a GEOINT workforce representative of contemporary global demographics."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tempests + terrain

Weather forecasting and GEOINT are naturally intertwined. As the former becomes more sophisticated, humanity stands better poised to predict and harness the power of the latter.

BY MATT ALDERTON

Beginning of a tornado on a deserted highway in the Oklahoma panhandle.

EVERY MUNDANE CONVERSATION you've ever had has probably included empty banter about the weather. And you're not alone. In 1897, American writer Charles Dudley Warner quipped, "Everybody talks about the weather, but nobody does anything about it."

Talk is the only thing about weather that's small, however. Everything else about it is big, including its effects, which have economic, social, and political implications of growing consequence for individuals, communities, businesses, governments, and militaries. This is particularly true in an era of increasing meteorological tumult, when extreme weather events like Hurricanes Harvey, Irma, and Maria are broadcasting in no uncertain terms, "Severe weather ahead!" As such events become more routine than rare, Warner's jocular observation begs a serious call to action: Instead of talking about the weather, the time has come to better anticipate, harness, and respond to it.

"Hurricanes, cyclones, thunderstorms, and other extreme weather events are becoming more common due to climate change and global warming," said Peter Platzer, CEO of Spire, a cubesat startup with plans to collect and distribute high-frequency weather data to commercial customers. "So the contribution you can make to humanity by improving weather forecasting is really substantial."

Weather has always been important. Not only because of the innumerable crises it has created, but also because of the many opportunities.

"In U.S. history alone, there have been all kinds of events where weather played an important role, going all the way back to George Washington crossing the Delaware to win the Battle of Trenton," said meteorologist Paul Dorian, a senior systems engineer at Vencore, whose weather division provides weather forecasting for government clients like the U.S. Air Force Weather Agency and NASA. "One of the most famous, of course, is D-Day. Weather was >>

critical for the Normandy invasion because Gen. Eisenhower made the decision to invade based on the weather forecast. It turns out we had better forecasters than the Germans did, and that's [a primary reason the] invasion worked out so well for us."

Bad forecasting can be just as impactful as good forecasting.

"In 1980, there was a hostage crisis in Iran and President Carter ordered a rescue mission," Dorian continued. "Helicopters flew into the Iranian desert to try to rescue the hostages, but the winds kicked up and dust was blowing everywhere. It brought down one of the helicopters, which [contributed significantly] to the mission being aborted."

Neither sandstorms nor hurricanes can be prevented. They can, however, be predicted. And if you can predict weather, you can manage it, according to Dr. Peter Neilley, an IBM Distinguished Engineer and director of weather and forecasting technologies for The Weather Company, which was bought by IBM last year and includes The Weather Channel and Weather Underground.

"Weather forecasts aren't perfect, and they never will be. But they have gotten a lot better," Neilley said. "As a result, decisions are being made every day based fundamentally on the weather forecast."

But meteorology alone can't ensure more D-Days and fewer failed missions. Because all weather has a location and all locations have weather, weather forecasting must work in concert with GEOINT, according to Neilley. "Weather is fundamentally a geospatial science," he continued, noting, for instance, the temperature differences between low and high elevations, and between inland and coastal communities. "The terrain can have a significant impact on what the local weather is."

It's not just terrain. Other GEOINT variables such as land type, latitude, water proximity, and even human geography also influence weather.

"GEOINT is the exploitation and analysis of imaging and geospatial information that's describing, assessing, and visually depicting physical features and geo-referenced activities. Weather exploitation is the same thing; it's exploiting and analyzing images and atmospheric information to describe, assess, and visually depict physical features that are geo-referenced," explained Eric Webster, vice president and general manager of environmental solutions at Harris Corp.

Understanding and exploiting these parallels could help humankind recast weather as an opportunity instead of a threat.

WHY WEATHER MATTERS

Few people understand the significance of weather better than Rep. Jim Bridenstine (R-Okla.), who serves on the U.S. House of Representatives' Armed Services and Science, Space, and Technology committees, and at press time was nominated by President Trump to be the new NASA administrator. "As a member of Congress from … Oklahoma, until this year I have had constituents die every year in tornadoes," said Bridenstine, a Navy combat veteran. "I will also tell you as a naval aviator—and now as a pilot in the Air National Guard—that I have been very affected by weather many times in my military career, from the ability to do strikes on a target to the ability to land on an aircraft carrier in high seas. So it's very important to me and very important for our country to make sure we're doing everything we can to get the right [weather] intelligence to the right people at the right time."

Weather forecasts are equally consequential for civilians and warfighters. For the former, it boils down to lives and livelihoods.

"The physical and economic losses the world suffers because of inaccurate weather forecasts are staggering," said Platzer, who added weather impacts a third of the global economy and 100 percent of the global population. "When the weather forecast calls for a blizzard

Airmen from the 3rd Weather Squadron set up a Tactical Meteorological Observing System (TMOS) during Spartan Warrior May 13, 2015, at Avon Park Air Force Range, Fla. TMOS is used in the field to measure wind speeds, cloud levels, and temperature.

PHOTO COURTESY OF U.S. AIR FORCE

in New York, but it actually takes place in Boston, there's loss of life, loss of property, and loss of money."

For the military, what's ultimately lost is the mission.

"Let's say you're going to take out some ISIS guys in Libya, and you're going to fly an airplane across the pond from the United States to do it," said Air Force Director of Weather Ralph Stoffler. "Obviously, you want to know from a weather perspective when is the best time to take off; when is the best time to conduct aerial refueling operations, and where; when is the target going to be clear, and if it's not going to be clear, should you use a different weapon that potentially works better when you can't see the target? Those are all questions that we help answer."

The Army leverages weather forecasting to answer similar questions, according to Bill Spendley Jr., weather team chief in the Army's Office of the Deputy Chief of Staff, G-2. "The Army has six warfighting functions, and every one of those warfighting functions has capabilities therein that are affected by weather," said Spendley, who described weather's effects on brigade combat teams as a "mud-to-sun situation."

In space, for instance, extreme weather can affect satellite communications and GPS signals. In the air, it can hamper the ability to drop weapons or paratroopers. And on the ground it can affect trafficability, interrupting the delivery of fuel, ammunition, supplies, and medical care.

"If weather impedes one warfighting function, that has repercussions for the entire brigade combat team in terms of being able to conduct its mission and defeat the adversary," Spendley said.

Because cloud cover can obstruct images taken by Earth observation satellites, which supply more than 90 percent of data used in weather forecasts, weather likewise is mission-critical for the Intelligence Community (IC), according to Air Force Col. Herb Keyser, a senior meteorology and oceanography (METOC) officer at the National Geospatial-Intelligence Agency (NGA). If you're looking at weather through an ISR lens, he said: "It's all about clouds. Not many people care about cloud forecasting to the extent that we do."

In truth, it's not all about clouds. It's also about context. "NGA is looking at population-forcing functions like potential landslides, vegetation health, and water security," Keyser continued.

Weather's impact on human geography can be simple—people stay home because they don't want to go out in the rain—or complex: Climatological problems catalyze large population shifts.

"Weather influences crops and drought, which influence political instability, which influences refugees," said Patrick Biltgen, director of data analytics for Vencore's intelligence group. "If you're able to forecast changes in weather and climate, you can predict massive geopolitical changes."

TARGETING TERRAIN

Citizens, soldiers, and decision-makers are no longer content with talking about the weather; faced with so many impacts, they're acting on it, too.

GEOINT deserves a lot of the credit, according to Bridenstine. "When you talk about national security, weather, and climate, all of it requires geospatial intelligence," he said, noting that Earth observation satellites launched for GEOINT missions are benefitting weather forecasters every day by collecting data about the atmosphere, lithosphere, hydrosphere, cryosphere, and biosphere—Earth's air, land, water, ice, and organisms, respectively. "[Using satellites], we're now discovering that we can see massive sandstorms in the Sahara Desert that are moving over the Atlantic Ocean, where they absorb large quantities of radiant energy from the sun. That affects the temperature of the ocean and in some cases actually mitigates the hurricane seasons that affect the United States … That's just one example of many where GEOINT has benefited the weather community."

"If weather impedes one warfighting function, that has repercussions for the entire brigade combat team in terms of being able to conduct its mission and defeat the adversary."

—BILL SPENDLEY JR., ARMY OFFICE OF THE DEPUTY CHIEF OF STAFF, G-2

GEOINT and weather are especially symbiotic in the military, according to Spendley and Stoffler, who agree that terrain is ground zero for GEOINT-weather synthesis.

"The intersection to a great extent happens at the tactical level," explained Stoffler, who said Army topography teams collaborate with Air Force weather officers to determine trafficability based on terrain and weather inputs.

"An example would be years ago when we deployed to Rwanda. We had to support a 1,000-truck convoy of humanitarian-relief mission sets," Stoffler said. "The Army was very concerned that the roads would wash out because of the monsoons that happen at that time of year, but they couldn't do a proper trafficability forecast because they didn't have the weather information. So we provided that to them and they in return provided things back to us, which allowed us to produce an integrated forecast on when the best time was to move those trucks and the best route to take."

Echoed Spendley, "The intersection of terrain and the atmospheric conditions touching that terrain is obviously critical in terms of being able to conduct operations. METT-TC—mission, enemy, terrain and weather, troops and support available, time available, and civil considerations—is the lens through which the Army plans, conducts, and executes operations. Notice how it's 'terrain and weather.'"

METOC personnel from across the services collaborated this year to author a new edition of Joint Publication 3-59: Meteorological and Oceanographic Operations for the chairman of the Joint Chiefs of Staff.

"The armed forces use joint doctrine as principles of how to fight and win wars," Spendley explained. "This entire joint publication was completely rewritten with a focus on the integration of the most accurate, timely, and relevant weather information into the joint force commanders' decision-making process."

Civil stakeholders also are invested in the terrain-weather nexus. An area of particular interest is flooding. In 2015, the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) launched the National Water Center at the University of Alabama in Tuscaloosa. Geospatial scientists and weather forecasters at the 65,000-square-foot facility collaborate to analyze, model, and forecast water conditions—including stream flow, water level, runoff, flood inundation, snowpack, soil moisture, and evapotranspiration—for 2.7 million rivers and streams.

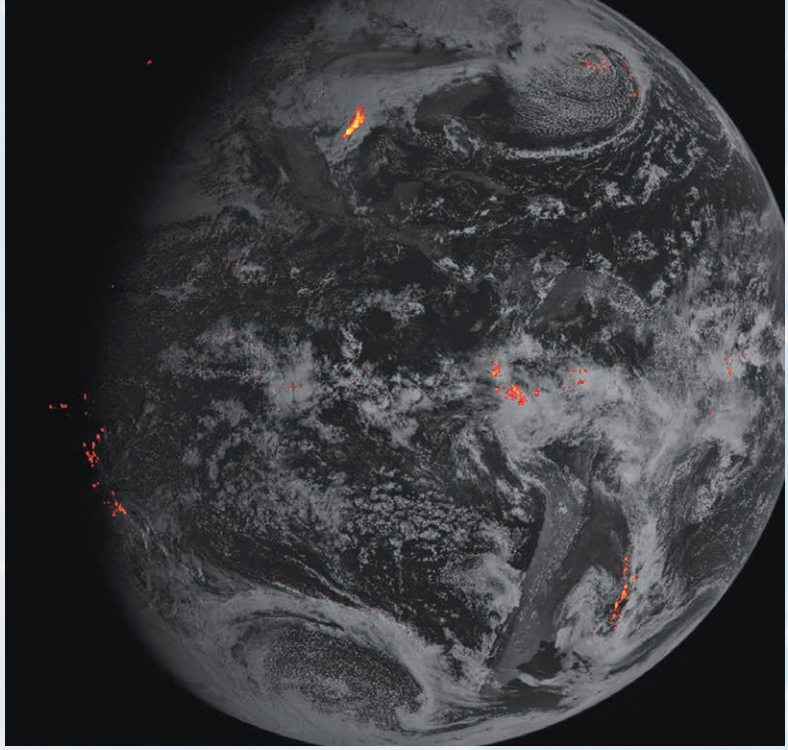

IMAGE COURTESY OF NASA

The Geostationary Lightning Mapper is a single-channel, near-infrared optical transient detector that can detect the momentary changes in an optical scene, indicating the presence of lightning.

"They have implemented a new National Water Model that uses geospatial information like terrain and slope to forecast basins so we know better how water is going to flow through them," explained NWS Observations Portfolio Manager Kevin Schrab.

Forecast models that fuse geospatial and weather information likewise can help mitigate wild fires.

"There are three primary drivers of wild fire behavior. One is terrain, or how the landscape is arranged. The other two are wind and fuels, both of which are dependent on what's going on with the weather," said former California State Fire Marshal Kate Dargan, co-founder and chief strategy officer at Intterra, a software company that provides situational awareness to public safety customers. Dargan is also a member of USGIF's Board of Directors. "So, everything about wildland firefighting and wildfire risk is geospatial and weather-based in nature."

FORTIFYING FORECASTS

The most coveted weather data includes forecasts that are more detailed, accurate, local, and protracted.

Improvements are inevitable yet incremental, according to Neilley, who said weather forecasting accuracy historically has improved at the pace of one day per decade, such that a three-day forecast today is as accurate as a two-day forecast was 10 years ago. "Weather forecasting is an evolutionary science, and there's a perpetual pipeline of things that are coming along and contributing to those evolutions," he explained.

The most significant items in the weather pipeline today are the next generation of weather satellites, which are fundamentally better than their predecessors, according to Neilley. Specifically, NOAA operates two types of satellites: Polar Operational Environmental Satellites (POES), which provide global coverage twice daily, and Geostationary Operational Environmental Satellites (GOES), which have a fixed position from which they provide near-continuous observation of a certain region. NOAA and NASA are collaborating on upgrades to both.

At press time, the next iteration of POES, the Joint Polar Satellite System (JPSS), is scheduled to launch its second of five satellites, JPSS-1/NOAA-20, in November. Carrying a payload of five weather-monitoring instruments, the system will gather global measurements of atmospheric, terrestrial, and oceanic conditions. Its measurements will support accurate seven-day weather forecasts that will help meteorologists predict the intensity and location of severe weather events days before they occur.

The next iteration of GOES, the GOES-R Series, launched its first of four satellites, GOES-R/-16/-East, in November 2016 with a payload of six instruments. The satellite, slated to become operational in November, has already demonstrated a number of new capabilities that promise to improve the detail and accuracy of weather forecasts.

GOES-R satellites feature an advanced baseline imager (ABI) that views Earth across 16 spectral bands. It can scan the entire Western Hemisphere every five minutes or take multiple images concurrently, in which case it's capable of imaging the Western Hemisphere every 15 minutes, the continental U.S. every five minutes, and two specific storms every 60 seconds. The previous generation of GOES features five spectral bands and can image the Western Hemisphere just once every 30 minutes.

"The picture is much clearer; there's three times the spectral bands, which allows you to see variations in temperatures and other things within clouds; and you're able to get information to forecasters much more quickly," said Webster of Harris, which developed the GOES-R ABI for NOAA.

That increased capability will assist not only with forecasting weather on Earth, but also in space.

"Space weather is becoming more important as electronics and satellites become more and more embedded in our society," said Dorian of Vencore, which is working with NOAA on GOES-R in a systems engineering capacity.

Destructive solar storms represent a growing threat to satellite operations and communications.

"GOES-R gives us better capability to monitor solar activity, which is critical to the Intelligence Community because satellites can be impacted as a result of solar wind," Dorian added.

Another notable instrument aboard GOES-R satellites is Lockheed Martin's Geostationary Lightning Mapper (GLM), a sensor that can detect and measure lightning activity continuously.

"This is the very first lighting sensor from space that's in the geostationary orbit," said Dr. Allan Weiner, senior scientist in charge of the GOES-R ground processing system at Harris. "This particular sensor in combination with the ABI is going to be very exciting because we're going to learn all-new information from it."

Historically, meteorologists have forecast storms based on cloud formation and rainfall. Measuring lightning activity alongside those traditional inputs adds another dimension to

weather forecasting that will make it easier to identify whether storms are escalating or de-escalating. GLM images the Earth at a rate of 500 frames per second, then performs onboard image processing in the form of automated change detection. The resulting data is especially promising for forecasting tornadoes.

"Right now the accuracy of predicting tornadoes is quite terrible. Even with all the information [meteorologists] have, it's on the order of 60 percent of the time that they're wrong," said Dr. Samantha Edgington, Lockheed Martin's chief GLM scientist.

Weather forecasters typically rely on radar to identify tornadoes—which often leads to missed tornadoes when radar coverage is poor.

"As you can imagine, if you live in a place where there are tornado warnings often, and more than half of the time they're wrong, eventually you stop paying attention to them," Edgington continued. "The goal of lightning data is to not only detect those tornadoes that are missed because of poor radar coverage, but also to make tornado predictions more accurate so that when the National Weather Service says a tornado is coming, people will actually listen and do something about it."

BRIDGING THE WEATHER GAP

Despite the advent of new satellite systems like JPSS and GOES-R, the U.S. Government Accountability Office (GAO) says the country is facing an "imminent satellite data gap."

"Federal agencies are currently planning or executing major satellite acquisition programs to replace existing polar and geostationary satellite systems that are nearing the end of, or are beyond, their expected life spans," the GAO reported to Congress in early 2017. "However, these programs have troubled legacies of cost increases, missed milestones, technical problems, and management challenges that have reduced functionality and delayed launch dates. As a result, the continuity of weather satellite data is at risk."

Of special concern, according to the GAO, are aging polar satellite systems the Department of Defense (DoD) operates. Not only has DoD been slow to plan and launch replacements, it said, but the department has also been plagued with misfortune. For example, its newest weather satellite, Defense Meteorological Satellite Program (DMSP)-19, launched in 2014 but experienced a power failure in 2016 and was subsequently lost.

"There's a gap that's coming," Webster said. "The military has acknowledged that, and now they're trying to figure out how to fill it."

One potential solution represents yet another shared interest between weather and GEOINT: commercial data sources.

"We have made it clear to the commercial world that we are very interested [in commercial weather data]," Stoffler said. "Within DoD, to maintain our own capability that covers the entire globe is a challenge. It costs a lot of money to do that. And frankly, we've been relying a lot upon international players … [that] are now being replaced by Russian and Chinese capabilities that we legally can't use—and wouldn't use even if we could."

Bridenstine is among commercial weather data's biggest advocates. "I've been working on … encouraging the Department of Defense and other government agencies—NOAA, specifically—to purchase commercial space-based weather data," he said. "A lot of commercial entities are launching satellites to furnish this data because private industry has signaled demand for it. Transportation companies, agriculture companies, and insurance companies all are interested in gaining a competitive advantage by being able to better predict the weather. The question is: Will the government purchase the same data to improve our weather prediction capabilities?"

Bridenstine co-sponsored the bipartisan Weather Research and Forecasting Innovation Act of 2017 that President Donald Trump signed in April, giving NOAA permission to explore, test, and purchase commercial weather data.

"NOAA already is conducting a pilot project to test and validate that data," Bridenstine continued. "The next step is to have the Department of Defense do the same thing, and we're going to accomplish that through the National Defense Authorization Act and defense appropriations."

Of greatest interest is commercial GPS radio occultation (GPS-RO) data, which is being furnished by companies like Spire and PlanetiQ. Spire, which was awarded NOAA's first-ever commercial weather contract in September 2016, already has 40 cubesats in orbit, with plans to eventually have more than 100. PlanetiQ plans to have a constellation of 12 to 18 microsatellites in orbit by the end of 2019, the first two of which are expected to launch in summer 2018.

"GPS radio occultation is pure physics," said Chris McCormick, PlanetiQ's chairman, founder, and former CEO. "It's refraction. When you see the sunrise and sunset, the reds, oranges, and yellows are light being refracted, or bent, by the atmosphere … GPS signals also get bent by the atmosphere."

When the atmosphere bends GPS signals, it delays them. Measuring the delay allows scientists to deduce the makeup of the atmosphere, including its temperature, pressure, and—most importantly—moisture.

"The next day's weather, or the next week's weather, is created in the ocean by the sun-ocean interface," McCormick explained. "If you know how much water

PHOTO COURTESY OF SPIRE

Shaina Johl, one of Spire's engineers, inspects an early Lemur-2 satellite model while Joel Spark, co-CTO at Spire, looks on from outside the clean room. Lemur-2 satellites are among the 40 cubesats Spire currently has in orbit. The company was awarded NASA's first commercial weather contract in 2016.

In a world where extreme weather events are increasingly common, action will be weather forecasting's most important output—not only for citizens in the path of destructive storms, but also for military commanders and intelligence officers seeking strategic advantage over powerful enemies.

PHOTO COURTESY OF SPIRE

vapor is in the atmosphere, and what the variability is of the temperature of that water vapor, it's much easier to predict where clouds will form, when, and for how long."

The more measurements one has, the more accurate the forecast. "It's not the size of the sensor, but the number of sensors, that drives value," Platzer said. "That's why companies like Spire can make a difference."

COMPUTING AND COMMUNICATION

What ultimately will unlock the next generation of weather forecasting are computing and communication, both of which will enable a new order of GEOINT-weather integration.

The observations of next generation weather satellites will be rendered useless without sufficient processing power to interpret them. Quantum computing is one likely solution. Artificial intelligence and machine learning is another.

"DoD, specifically, has been working on service-enabling weather data to be able to get it to organizations like NGA … so [analysts] can search for patterns that they can then extract intelligence from," NGA's Keyser said. "Because we don't have time for somebody to sit and look at a wind gauge, for example, we need to be able to do machine-to-machine processing that frees up the analyst to actually think about problems instead of just looking at them."

Which leads to forecasting's other major opportunity: communication.

"The weather community needs to do a better job of being less esoteric," Platzer said.

Echoed Biltgen, "Generally, people don't really understand the weather. The forecaster comes on TV with a map that has triangles and half-moons and 'high pressure' and 'low pressure,' but all anyone really wants to know is: Do I need a jacket and an umbrella?'"

Neither civilians, warfighters, first responders, nor intelligence analysts care about weather science; all four, however, care about weather impacts, which can be understood and communicated better with the assistance of GEOINT. For example, the National Center for Atmospheric Research is testing technology that marries ground data with atmospheric predictions to give wildland firefighters real-time, location-based insights.

NWS is doing similar research via its Weather Ready Nation (WRN) program, whose charge is exploring new ways to present and disseminate weather information so decision-makers and citizens will take it seriously.

"One of our sterling successes has been a storm-surge inundation map," said WRN spokesperson Douglas Hilderbrand. "A few years ago, the way we quantified and communicated storm surge was very complicated; you had to go to the National Hurricane Center and the National Ocean Service, consult a tide chart, and incorporate on your own wave and elevation information to answer the basic question: Is my house vulnerable to storm surge? Now we have a very intuitive map that incorporates all the storm surge science and allows people to determine their home's risk in a much more visual way … We're trying to make NOAA information more personal and more applicable … because that's when people listen and take action."

And in a world where extreme weather events are increasingly common, action will be weather forecasting's most important output—not only for citizens in the path of destructive storms, but also for military commanders and intelligence officers seeking strategic advantage over powerful enemies.

"If you've got a brigade combat team commander with a rotary wing assault force that needs a 500-foot cloud ceiling and two-mile visibility, they need to know if there's only a 300-foot cloud ceiling and a quarter-mile visibility so they can make decisions in the most informed way possible," Spendley concluded. "They're not interested in knowing that there's a high chance of rain today; they're only interested in what the effects of weather will be on their mission, either where they're operating or where they're projected to operate. That's where the rubber meets the road."

AFTER DISASTER STRIKES

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Image of Rockport, TX post Hurricane Harvey.
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the genesis of geo

The history and future of the software that made GEOINT mainstream and changed the way we view the world

BY ANDREW FOERCH

gle earth

IN AUGUST 2005, Hurricane Katrina ravaged the Gulf Coast of the United States, bursting levees throughout Louisiana and Mississippi and submerging the streets of south Florida. According to the National Hurricane Center, it was the deadliest hurricane since 1928, claiming at least 1,800 lives and causing more than $108 billion in damages. >>

Google Earth images of Gulfport, Mississippi's shoreline before and after Hurricane Katrina in 2005.

The U.S. Navy, Coast Guard, and other federal relief groups deployed helicopter teams to rescue people stranded in New Orleans without the resources to escape or survive in their homes. Hurricane victims dialed 911 for urgent help at specific street addresses, but it was impossible for first responders to find them without precise GPS coordinates—street signs and house numbers were invisible beneath the deluge. In the absence of traditional situational awareness, responders were operating blind.

In California, a team from the recently minted Google Earth program launched into action, creating real-time imagery overlays of heavily affected areas on top of its existing 3D globe platform. Fly-by aerial photos from the National Oceanic and Atmospheric Administration (NOAA) and satellite imagery from DigitalGlobe—one of Google Earth's primary providers—revealed the scope of the hurricane's destruction. Google Earth made this data publically available and responders had eyes again.

Now, they could input a caller's location into Google Earth paired with case-specific details—for example, a target trapped in a two-story house with a clay roof next to an oak tree. Equipped with up-to-date imagery from Google Earth, relief teams saved thousands of people from Katrina's aftermath.

Years later, the Louisiana Governor's Office of Homeland Security and Emergency Preparedness would pair internal data with Google Earth Enterprise (GEE)—the desktop software suite for private or offline use of Google Earth—to create 3D globes for emergency response and infrastructural planning.

Today, Google Earth is among the most popular geospatial software in the world, boasting upward of one billion downloads. With it, students take virtual tours of the world's wonders from their classrooms, house hunters evaluate prospective properties without leaving home, and much more. The U.S. military employs GEE for secure mission planning and intelligence professionals use it to visualize points of interest and detect change. Google's spinning globe truly represents the democratization of geospatial intelligence.

In the case of GEE, government and military organizations became so dependent on the software's private storage and visualization capabilities that not even a depreciation announcement from Google two years ago stopped them from using the platform.

As a result of the community's reliance on GEE, earlier this year Google decided to make the software's code open source and available for public download on GitHub.

With its future in the hands of its users, GEE is poised to remain at the center of mission planning and situational awareness efforts for the defense and intelligence communities—at least until a supported platform of equal utility arises.

A GIANT'S INFANCY

At the time Hurricane Katrina made landfall, Google Earth software had been available to the public for only three months. But the story of Google Earth began to take shape 10 years earlier at a computer hardware company called Silicon Graphics (SGI).

Michael T. Jones, then a member of SGI's computer engineering team, had developed an invention that would revolutionize the firm's 3D graphics offering, which at the time was used primarily for flight simulation.

"It was called clip mapping. That's the fundamental hardware feature SGI had that let it do this amazing, smooth flight around the world," said Jones, now a managing partner at Seraphim Capital.

Jones' technique displayed a small region of graphics—the region under examination—in high resolution while the peripheral regions were displayed in low resolution. Jones, along with SGI engineers Chris Tanner, Chris Migdal, and James Foran, patented the method in 1998. Clip mapping required powerful supercomputers to run, but enabled a high-fidelity texture map that became the centerpiece of SGI's final graphics system, Infinite Reality, which at the time boasted the fastest 3D graphics in the world.

Federal agencies such as the National Geospatial-Intelligence Agency (NGA) and the National

Michael T. Jones

PHOTO COURTESY OF WIKIPEDIA

Reconnaissance Office (NRO) would later follow suit, Jones said, using clip mapping to build data visualization platforms of their own.

To demonstrate the vastness of Infinite Reality's capabilities, SGI created a demo called "Space to Your Face." It began with a wide view of Earth from space, slowly zooming into Europe. When Lake Geneva became visible, the program would focus on the Matterhorn in the Swiss Alps. It would continue to zoom until reaching a 3D model of a Nintendo 64 console on the mountainside. Then it would zoom in even more, settling on the Nintendo's MIPS r4000 graphics chip—a microprocessor created by SGI—before snapping smoothly back to space.

The demo was well received. Educators were excited to see an interactive, classroom-friendly global map tool, and video game developers had never seen such fluid graphics.

Seeking a new home for their brainchild, Jones, Tanner, and former SGI engineers Remi Arnaud and Brian McClendon founded a company of their own. Called Intrinsic Graphics, it focused on developing high-quality 3D graphics for personal computers and video games.

In October 1999, Tanner took the concept further when he designed a software version of the clip mapping feature that allowed a user to "fly" within a 3D visualization of Earth.

"People were blown away," Jones said. "They were looking at Google Earth."

Though the software platform wasn't Intrinsic's primary product—the graphics themselves were—Jones was intrigued and continued refining the spinning globe.

Yet running the software required expensive and highly specialized computing hardware not available to most of the private tech industry, let alone the commercial user.

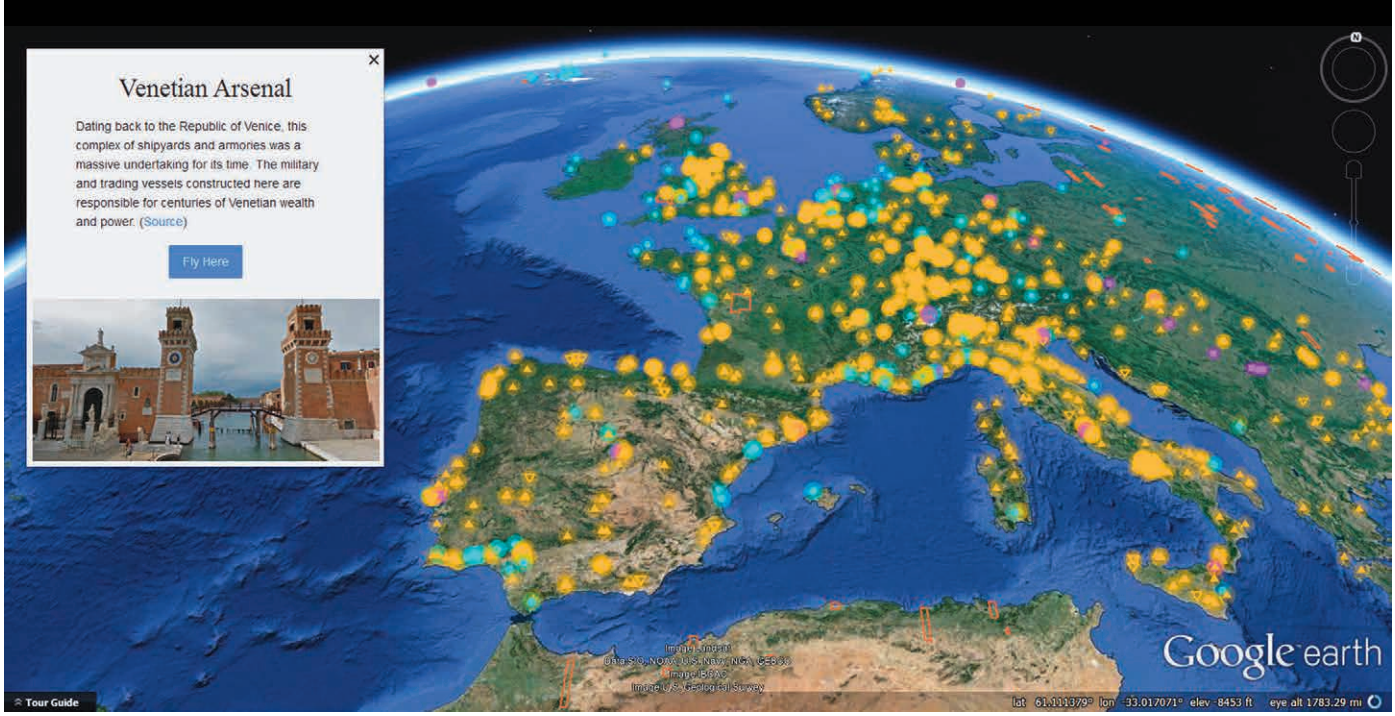
"That machine cost $250,000. We wanted to be able to offer this without the specialized hardware," said McClendon, now a research professor at the University of Kansas. "To be able to get that performance out of a PC meant we could share it with the world. The moment you realize you can transmit this data over the internet, you begin to realize the impact. A group of us at Intrinsic thought, 'We need to build a company around this.'"

And before long, yet another company was founded. In 2000, Jones, McClendon, Tanner, and a few others spun out the software from Intrinsic Graphics to launch Keyhole. In early 2001, Keyhole raised first round funding from NVIDIA and Sony Digital Media Ventures, making official its existence as a standalone company. Keyhole's first product, EarthViewer 1.0, was the true precursor to Google Earth.

Using public data gathered from NASA's Landsat constellation, IKONOS imagery, and aerial photos of major U.S. cities, Keyhole built a complete digital Earth. Though pixels were beginning to proliferate, high-resolution imagery was mostly limited to U.S. metropolitan areas.

Under the direction of newly appointed Keyhole CEO John Hanke, the company marketed EarthViewer to the commercial real estate and travel industries. Civil engineers also purchased it for the ability to sketch out location information when planning construction projects.

> "[Users] will create data files ... rapidly and not to spec, put them in Google Earth, and they'll run somehow. That's really the reason why no other applications have been able to enter this space as dominantly as Google Earth."
>
> —AIR FORCE LT. COL. MIKE RUSSELL, NGA



On Google Earth's 10th birthday it introduced a new feature called Voyager. This image shows different imagery types in Voyager by color.

"Intelligence agencies wanted this capability as well, but they wanted to use their own data," McClendon said.

The Intelligence Community (IC) was intrigued, but wanted to use classified geospatial data gathered through National Technical Means rather than the data on Google's public server. To accommodate such buyers, Keyhole began offering an enterprise version of its software, allowing large-scale users to stand up private network servers and host their own data on a replica of EarthViewer's 3D globe.

NIMA Backing The National Imagery and Mapping Agency (NIMA) was the first agency to take note of this unprecedented capability. Under the leadership of then director James Clapper and deputy director Joanne Isham in 2001, NIMA launched a research and development directorate known as InnoVision. The new directorate sought to leverage state-of-the-art technologies from industry to help the IC adapt to the changing face of conflict in the aftermath of 9/11.

Isham, a former CIA employee, was well versed in In-Q-Tel, the CIA's non-profit venture capital initiative. She approached Robert Zitz, InnoVision's first director, about collaborating with In-Q-Tel to find partner companies.

"We sat down together with In-Q-Tel and went over what our most urgent requirements were," said Zitz, now senior vice president and chief strategy officer of SSL MDA Government Systems. "In-Q-Tel started trying to locate companies and [in 2002] discovered Keyhole."

In-Q-Tel was impressed by the low barrier to entry and EarthViewer's ease of use.

"With [EarthViewer], you just click on the icon and all of a sudden you're flying around the globe," said Chris Tucker, In-Q-Tel's founding chief strategic officer and now the principal of Yale House Ventures. "There had been some way earlier-era, very expensive defense contract iterations [of a 3D digital Earth], but none at a consumer level that a regular analyst could make sense of without being a missile defense expert or some other technical user."

In 2003, In-Q-Tel invested in Keyhole using NIMA funding. It was the first time an intelligence agency other than the CIA had employed In-Q-Tel. NIMA experienced an immediate return on its investment. Within two weeks, the U.S. military launched Operation Iraqi Freedom, which Keyhole supported in its first mission as a government contractor.

"We wanted a capability that would help military planners visualize and seamlessly move through datasets pertaining to particular target areas," Zitz said. "We also wanted the ability to rapidly conduct battle damage assessments. NIMA was supporting joint staff in the Pentagon, and to sense how effective a strike was after-the-fact was very labor and imagery intensive. With Keyhole, we were able to streamline that process."

EarthViewer quickly gained public exposure through TV news coverage using its battlefield imagery.

One of McClendon's junior high school classmates, Gordon Castle, was CNN's vice president of technologies. McClendon approached Castle with his EarthViewer demos. Castle was wowed, and CNN became one of Keyhole's first media customers. The network routinely used EarthViewer to preview story locations during broadcasts. When the U.S. invaded Iraq, CNN used the software heavily—sometimes several times an hour—to show troop movement or combat locations.

THE BIG BREAK

Realizing its technology could improve people's understanding of the planet, widespread commercialization became Keyhole's mission. But Keyhole was a small company, and scaling up its computing infrastructure to handle more traffic was expensive. An annual EarthViewer Pro subscription still cost $599—a price justified by the company's high operating costs. Keyhole's bottom line stood in the way of its goal.

"[We wanted] everybody that opened the app to be able to find their house," McClendon said. "It's the first thing everybody searches for. If that experience isn't good, the user thinks the product isn't good."

That first step required high-quality coverage of the entire land surface of Earth—a seemingly unattainable achievement for Keyhole's 29 employees, even with In-Q-Tel backing. And the startup's network bandwidth wasn't strong enough to offer a high-resolution 3D globe to millions of consumers

worldwide. McClendon recalled making regular trips to Fry's electronics store to purchase hard drives, struggling to keep up with demand.

"To provide high-resolution data for the whole world was an epic undertaking … that would've taken us probably a decade to build up on our own," he said.

For its vision to materialize, Keyhole needed more capital to scale up imagery procurement and to build powerful data infrastructure to store high volumes of imagery. In 2004, as if on cue, along came Google—one of the few companies powerful enough to manifest Keyhole's mission. And they wanted to buy.

"It seemed like a tough road. Everybody was impressed with what we had done, but there was going to be competition and we needed to move quickly," Jones said. "So we sold to Google because our dream would happen."

As part of the acquisition, the Keyhole team maintained control of the program as it evolved. Most personnel, including McClendon and Jones (Tanner had since departed Keyhole), became executives at Google, developing their software unrestricted by the need to keep a startup afloat.

Once at Google, the program began to operate on an entirely different scale. Instead of acquiring licensing deals for small portions of a vendor's imagery at a time, Google bought out all the imagery a vendor had available at once. Google also provided access to a rapidly growing user base already hooked on its web search platform.

Before debuting a Google-branded product, the former Keyhole team had to rewrite EarthViewer's service code to run within Google's infrastructure. Additionally, pre-release engineering refinements focused on adding data around the globe, making the program accessible to non-English speaking users, and simplifying features. Finally, Google Earth launched in June 2005.

The software exploded in the commercial marketplace. Where Keyhole's consumer version of EarthViewer was too expensive for most casual civilian users, Google Earth was downloadable for free.

"We had millions of users in the first few days and tens of millions in the first year," McClendon said.

Keyhole brought to Google a new form of interactive information that mimicked the real world and helped people understand their place in it. A GEOINT tool had finally made it to the mainstream.

In 2006, Google released Google Earth Enterprise for organizations seeking the capabilities of Google Earth but with private data in a secure, offline environment. The GEE suite included three software components: Fusion, the processing engine that merged imagery and user data into one 3D globe; the Earth server that hosted the private globes built by Fusion; and Client, the Javascript API used to view these globes.

Whether to disseminate that data after creating proprietary globes in GEE was, and still is, up to the user. This was the final evolution of the EarthViewer enterprise suite used by the Pentagon at the outset of the Iraq war.

GEE IN ACTION

In the years following its launch, government agencies, businesses, and state municipalities began to deploy GEE at internal data centers to produce 3D globes using sensitive or classified data.

The city of Washington, D.C., for example, has used GEE to model and visualize public safety data including crime, vehicle and fire hydrant locations, and evacuation routes.

Arguably the largest user of GEE is the U.S. Department of Defense (DoD). When Google Earth was first released, military customers had an explicit need for this capability to function in a highly secure private network.

For example, the Army Test and Evaluation Command (ATEC) uses private data on enterprise servers such as Google's to evaluate a wide range of weapon systems as well as ground and air operations.

At ATEC's Yuma Proving Ground (YPG) in Arizona, proprietary terrain data, imagery, and operations maps are overlaid on Google Earth and used to plan and schedule launches.

"Knowing where everyone is and moving in a secure range and air space is important to our operations," said Ruben Hernandez, an Army civilian in the YPG's engineering support branch. "Much of this data is also armed for range awareness display."

For example, prior to an indirect fire artillery test, personnel use YPG data within GEE to assess the safest positions on base to conduct the test—when to fire, where to fire from, and what to fire at. That information is disseminated throughout YPG for awareness.

"Many of these munitions have extensive footprints. We want to find out how much air and land space [the blast] is going to consume. Safety is a big component of how these overlays are planned," Hernandez said.

NGA is another major GEE stakeholder. In 2008, the agency's new GEOINT Visualization Services (GVS) program invested in the enterprise server. GVS has since produced a proprietary version of Google Earth for warfighters featuring classified NGA data.

According to GVS program manager Air Force Lt. Col. Mike Russell, "GVS was built around providing a version of Google Earth in the secret and top secret

THE HISTORY OF GOOGLE EARTH ENTERPRISE

1996 Silicon Graphics releases "Space to Your Face" clip mapping demo.

1998 Brian McClendon, Michael Jones, Chris Tanner, and Remi Arnaud found Intrinsic Graphics.

1999 Intrinsic Graphics releases a software demo that allows users to "fly" within a 3D visualization of Earth.

2000 Keyhole is spun out of Intrinsic Graphics and led by CEO John Hanke.

2001 Keyhole raises first round funding from Sony Digital Media Ventures and NVIDIA, and subsequently launches EarthViewer 1.0.

2003 In-Q-Tel invests in Keyhole using funding from NGA's predecessor, the National Imagery and Mapping Agency. The U.S. invades Iraq and CNN becomes one of Keyhole's first media customers.

2004 Google acquires Keyhole and the company realizes its goal of acquiring high-quality coverage of the entire land surface of Earth.

2005 Google Earth is officially launched and soon after plays a critical role in Hurricane Katrina emergency response efforts.

2006 Google Earth Enterprise (GEE) is launched for organizations seeking the capabilities of Google Earth but with private data in a secure, offline environment.

2008 NGA's GEOINT Visualization Services program invests in the GEE server.

2011 Google Earth reaches 1 billion downloads.

2015 Google announces the depreciation of GEE.

January 2017 Google announces it will publish GEE code on GitHub.

March 2017 GEE code is uploaded to GitHub and Google stops supporting GEE.

September 2017 GEE-OS version 5.2.0 is released by Thermopylae Sciences & Technology.

domains so users could visualize classified information geospatially and temporally in a common operating picture."

Now, NGA's private Google Earth globes are mission critical for more than 30,000 customers daily, including DoD Combatant Commands, the FBI, CIA, NRO, National Security Agency, and Federal Emergency Management Agency. NGA's current release is the second largest Google Earth globe in the world and is used across the DoD and IC for common situational awareness, tracking vehicles and personnel, delivering intelligence briefings, and more.

Russell praised Google's efficient rendering of data files in the Keyhole Markup Language (KML) format. KML was created for file building in Keyhole's EarthViewer platform and has since become an industry standard for visualizing geospatial data.

"[Users] will create data files like the location of an IED or a live dynamic track of an aircraft. They can build these files rapidly and not to spec, put them in Google Earth, and they'll run somehow. [Competitors] can only render smaller KMLs or those built to spec. That's really the reason why no other applications have been able to enter this space as dominantly as Google Earth," Russell said.

THE UNBUNDLING

GEE served a far more specific client and purpose than the commercial Google Earth services, but its rate of adoption was noticeably low compared to most Google products.

According to McClendon, "Continuing to innovate on a hosted service exclusively for the enterprise community was not financially viable."

In March 2015, Google announced the depreciation of GEE. After a two-year transitional maintenance period, the company stopped supporting GEE software in March 2017. Though it was being phased out of Google's product line, GEE remained in use by invested customers relying on it to meet mission demands and house their data.

Hernandez recalled pushback from teams at Yuma who were not keen to change their data storage and visualization system. According to Russell, GVS feared losing its primary product and stranding customers without an application to replace it.

To accommodate the ongoing need, Google announced in January it would publish all 470,000 lines of GEE's code on GitHub, allowing customers to continue using the software they'd grown loyal to and to improve the product independently.

For customers who prefer to transition to a supported enterprise software, Google has coordinated with Esri to offer free software and training for GEE customers who migrate to Esri's ArcGIS platform.

The open-source GEE (GEE-OS) suite includes the Earth server, Fusion, and a portable server allowing users to run GEE on a mobile device or desktop computer not connected to a centralized server. The GEE Client software, which is required to connect to the Earth server and view 3D globes, was not carried forward into the open-source environment. Instead, it will continue to be maintained and provided by commercial Google Earth.

Thermopylae Sciences and Technology (TST), separately from its Google contracts for Earth software engineering, is managing GEE's transition to GitHub. TST began a partnership with Google in 2007 through a series of federal government customer engagements supporting Thermopylae's own Google Earth-based tracking console. When the open-source announcement was made, Thermopylae's Earth Engineering team was reassigned to the company's Open Source Development Office to create the GEE GitHub site and migrate the source code.

On Sept. 14, TST's open source team released GEE-OS version 5.2.0, which matches the last proprietary release as well as fixes bugs that emerged during the two-year deprecation period.

"When we pulled the code out from [Google's] proprietary side, there were a lot of things that needed to be built back up or replaced with open-source components," said Thermopylae CEO AJ Clark. "Really these first few months are just about providing feature parity with where the code was at its last state inside Google."

The team aims to release GEE-OS 5.2.1 by the end of 2017.

Now that parity is achieved and the program's performance is stabilized, developers will begin submitting expanded code contributions. According to Clark, the first value-add propositions will most likely begin to flow in early 2018. Meanwhile, DoD and IC users are eager to discover how they can further adapt the software for their specific missions.

Hernandez said the planning crew at Yuma, a TST customer, is looking forward to new software capabilities that could be built out at the request of the test community and with help from TST engineers. Among these features, he said, is the ability to "grab geospatial objects and collaborate on them between multiple users; to grab, extend, and change the shape of a [weapon] footprint in 2D or 3D; and to provide a simulation of an object's line trajectory."

According to Jon Estridge, director of NGA's Expeditionary GEOINT Office, the agency has committed to provide enhancements and ongoing sustainment to open-source GEE on Github through at least 2022.

"A few specific examples would be multi-threading the fusion process to support massive terrain and imagery updates, enhanced 3D mesh management, and inclusion of ground-based GEOINT content like Street View," Estridge said.

Open source means more customizability for users with niche wants and needs. No two proprietary Google Earth globes look the same, and teams will have more command over the unique data they store, visualize, and analyze within the program.

"It's very positive," Russell said. "[Open source is] an opportunity for NGA to partner with Thermopylae to tie the proprietary and non-proprietary pieces together, and it allows us to sustain Google Earth for our user community for a longer period of time."

The decision to make GEE code open source only improves the program's accessibility and potential use cases, and will bolster the software's longevity. Code sharing is a growing trend in the IC, and Google has provided government, military, and industry unlimited access and control of one of the most useful enterprise GEOINT tools on the market.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next generation of GEOINTers

USGIF AWARDED $117,000 in scholarship funds this year to students studying the geospatial sciences and related disciplines. The annual USGIF Scholarship Program recognizes the achievements of graduating high school seniors as well as undergraduate, graduate, and doctoral students. The program's goal is to further the advancement of the geospatial tradecraft.

USGIF awarded 26 scholarships this year to six high school seniors, six undergraduate students, 10 graduate students, and four doctoral candidates. The Foundation also awarded the $10,000 Ken Miller Scholarship for Advanced Remote Sensing Applications for the second year. The Ken Miller Scholarship is presented to a master's degree candidate studying remote sensing who plans to enter the defense, intelligence, or homeland security workforce.

Since the USGIF Scholarship Program began in 2004, more than $1.1 million in funds have been awarded to students with GEOINT aspirations.

THE 2017 SCHOLARSHIP WINNERS

KEN MILLER SCHOLARSHIP FOR ADVANCED REMOTE SENSING APPLICATIONS

Offered in partnership with USGIF Organizational Member Riverside Research

Andrew Knight
University of Georgia
Geography
Knight holds a bachelor's degree from James Madison University in geographic science with a concentration in applied geographic information sciences. His research goals include applying remote sensing methods to humanitarian issues. For his thesis, Knight is studying the intersection of machine learning and unmanned aerial systems. He currently works as a research assistant at the University of Georgia's Center for Geospatial Research.

DOCTORATE

Michael Brady
Rutgers University
Geography
Brady, a former enlisted member of the U.S. Coast Guard, earned both his bachelor's and master's degrees in geography at Hunter College of the City University of New York under the GI Bill. In his doctoral research, Brady maps shoreline risks with whaling communities that live along Alaska's northern coastline. He is particularly interested in collaborative research using participatory geospatial methods.

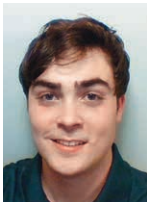
Carolyn S. Fish
Pennsylvania State University
Geography
Before returning to graduate school, Fish was a cartographic product engineer at Esri. She also completed her bachelor's degree in geography at Penn State University and her master's degree in geography at Michigan State University. Fish's research aims to understand how maps are designed and used to convey climate change in many contexts, including national security, with the goal of improving such visualizations for better decision-making.

Cara Murphy
Rochester Institute of Technology
Imaging Science
Murphy is a full-time employee at Systems & Technology Research and a part-time Ph.D. student with the Center of Imaging Science at Rochester Institute of Technology (RIT). Previously, Murphy received her bachelor's degree in physics and mathematics at Merrimack College and her master's degree in imaging science with a concentration in remote sensing from RIT. Her work focuses on solving problems in forensics, defense, border protection and monitoring, and other law enforcement and intelligence applications.

James Walker
University of California, Los Angeles
Geography
After a decade of working in the nonprofit sector, Walker returned to school to obtain a bachelor's degree in global studies and a master's degree in geography from UCLA. His doctoral research is focused on the adoption of remote sensing and GEOINT analysis by human rights groups. Using methods drawn from critical geopolitics and science and technology studies, his research explores how GEOINT technology empowers non-state actors in their efforts to shape international crisis response.

GRADUATE

Roxanne Ahmadi
Pennsylvania State University
Homeland Security – GEOINT
Ahmadi is currently an intern with the National Geospatial-Intelligence Agency and graduates with her master's degree this spring. Ahmadi's research interests are object-based image analysis and automation as well as the increasingly relevant integration of human geography and remote sensing.



Colin Bunker
Ohio State University
Electrical and Computer Engineering
Bunker earned his bachelor's degree in mechanical engineering from Purdue University. He currently works at the Air Force Research Laboratory in Dayton, Ohio, as a Pathways intern. His research interests include object detection and tracking, high-level scene recognition, and image geo-location.

Courtney Connor
Middlebury Institute of International Studies at Monterey
Nonproliferation and Terrorism Studies
Connor holds a bachelor's degree in modern languages and literatures with a minor in psychology from California Polytechnic State University, San Luis Obispo. Her interests lie in GEOINT fusion and how algorithms and software can be streamlined to aid in the successful identification and rescue of human trafficking victims, while also bringing their traffickers to justice.

Jace Ebben
Pennsylvania State University
Homeland Security – GEOINT
Ebben works in St. Louis for Booz Allen Hamilton as a geospatial analyst assigned to the National Geospatial-Intelligence Agency. Ebben served for six years as an intelligence analyst in the Wisconsin Air National Guard and attended the University of Wisconsin, graduating with a bachelor's degree in geography and political science. Ebben also holds a graduate certificate in >>

GRADUATE

geospatial intelligence analytics from Penn State. His current interest is in machine learning and its application as a force-multiplier for analyzing remotely sensed information.

Linnea Johnson
George Washington University
Data Science
Johnson graduated in 2013 from Mount Holyoke College, where she studied geography and Chinese. During her time at Mount Holyoke, she had several internships and research experiences that allowed her to work with geospatial technologies, and received several scholarships to improve her Chinese language abilities. After earning her bachelor's degree, Johnson spent a year in Taiwan as a Fulbright Scholar, and upon her return began working as a research specialist with the Department of Defense.

Phil McTigue
Northeastern University
Emergency Management & Geospatial Information Technology
McTigue's collegiate education began with an undergraduate degree in homeland security from American Military University. His concentration is focused on geospatial information and intelligence as it relates to homeland security. One of his specific areas of interest is the use of unmanned aerial systems for imagery capture.

Travis Meyer
Pennsylvania State University
Geographic Information Systems
Meyer's undergraduate degree is in marine environmental science from the State University of New York Maritime College. He spent nine years as a U.S. Marine and Naval officer. Meyer's research is focused on using bathymetric LiDAR and photogrammetry to analyze the vulnerability of American coastlines to sea level rise, coastal erosion, and storm surge. Meyer is currently a curriculum developer and instructor at the Naval Meteorology & Oceanography Professional Development Center.

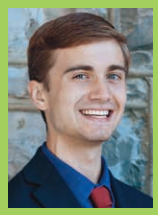
Andrew Ryan
George Mason University
Geoinformatics and Geospatial Intelligence
Ryan graduated with a bachelor's degree in geography from Virginia Tech in 2015, after which he completed an internship with the State Department's Office of the Geographer. He currently works full-time as an all-source geospatial analyst with DigitalGlobe. Ryan's research interests include social media analysis, activity-based intelligence, data mining, machine learning, and deep learning.

Jesse Sprague
University of New Mexico
Computer Science and Geography
Sprague earned a bachelor's degree in Earth and planetary science from the University of New Mexico, and has worked for the U.S. Geological Survey and private firms using geospatial information sciences for environmental management. Sprague now runs a spatial data company and is interested in deep belief networks and virtual augmentation of human experiences with low-latency spatial data.

UNDERGRADUATE

Luke M. DeJong
American Military University
Homeland Security
DeJong brings his experience in the Marine Corps geospatial intelligence field to his pursuit of a degree in homeland security. He believes the future of our nation and the safety of American citizens can be best secured through using intelligence gathering to prevent terrorist attacks.

Norman Dela Fuente
University of California, Los Angeles
Geography
Dela Fuente's geospatial interests include disaster response, urban planning, and nation security. He is also in the UCLA Army ROTC program and upon graduating will be commissioned as a second lieutenant in the California National Guard. Dela Fuente plans to utilize the leadership and critical thinking skills he's learned as an Army officer to complement his civilian career.



Daniel Gurley
James Madison University
Geographic Science
Gurley is interested in the use of GIS to better implement international development programs and humanitarian responses to crises. He is currently a returning intern with the State Department's Virtual Student Federal Service using remote sensing and research to help the Bureau of Overseas Buildings Operations select sites for new embassies and consulates. He is also involved in a research lab focusing on the infrastructure, history, and biodiversity of Gonâve Island in Haiti and its surrounding coral reefs.

SPOTLIGHT Read extended profiles on some of the 2017 USGIF Scholarship winners online at **trajectorymagazine.com.**

More than **$1.1 million** in funds have been awarded since the USGIF Scholarship Program began in 2004.

Erin Manth
Mercyhurst University
Intelligence Studies
Manth has spent two summers as a GEOINT analyst intern for a federal agency and has previous work experience at the National Student Leadership Conference on Intelligence and National Security. Manth is interested in GEOINT applications to national security and humanitarian response, specifically in the Middle East and North African regions.

Emma McFee
University of Utah
Geography
McFee is continuing her pursuit of a geography degree with an emphasis in hazards, resources, and human security. Her passion for GEOINT stems from experiencing two major floods while growing up in Upstate New York. After being displaced from her home twice, she knew she wanted to help people in similar situations. She is also interested in how GEOINT can influence business decisions.

Elijah Staple
University of Colorado Boulder
Computer Science
Staple's computer science interest is in deep machine learning networks. He has interned at two major Silicon Valley companies, the National Geospatial-Intelligence Agency, and the National Air and Space Intelligence Center. Staple's goal is to employ advanced computational techniques to enhance the GEOINT tradecraft by enabling analysts to provide actionable intelligence to policy and decision-makers.

THANK YOU

All scholarship recipients were selected by USGIF's Scholarship Subcommittee, which evaluated applicants based on academic and professional excellence. USGIF would like to recognize the following members of the subcommittee:

- Committee Chair: Neil Billings, S2 Analytical Solutions
- Cathy Alt-Shoemaker, Booz Allen Hamilton
- David Beddoe, CARTO
- Jack Greenspan, Booz Allen Hamilton
- Michael Hauck, private consultant
- Jill Horn, Vencore
- Mike Malgieri, Deloitte
- Gary Rogers, Strategic Alliance Consulting
- John Thorn, S2 Analytical Solutions

GRADUATING HIGH SCHOOL SENIORS

Robert Cordts
South Lakes High School in Reston, Va.
Now attending James Madison University
Cordts became interested in GIS after taking a dual-enrollment geospatial analysis class offered through James Madison University in his senior year of high school. For his final project, Cordts used GIS tools to analyze where to place a new swim team in his hometown to increase participation in swimming among minorities and low-income families. He is majoring in geographic information science and looks forward to solving real-world problems.

Caitlin Gormley
Sayville High School in West Sayville, N.Y.
Now attending the University of Toronto
In high school, Gormley was fortunate to gain experience in GIS as part of her school's scientific research program. Her research used geospatial methods to investigate hydraulic fracturing and its potential impacts to the health of local communities. She was subsequently named one of the 2017 Regeneron Science Talent Search Scholars. Gormley hopes to major in urban studies and human geography with a minor in geospatial information systems.

Lily Nalulani Jenkins
Molokai High School in Kaunakakai, Hawaii
Now attending the University of North Carolina at Chapel Hill
In her free time, Jenkins would participate in wetland and fishpond restoration projects and conduct research projects on the effects of invasive marine species on coastal ecosystems. While conducting these research projects, Jenkins found her passion for using geospatial technology as a tool to tackle environmental issues. She plans to pursue a bachelor's degree in environmental science and a master's degree in information systems.

Haley King
Tuscarora High School in Leesburg, Va.
Now attending George Mason University
During high school, King studied geospatial sciences through a dual enrollment program with James Madison University. Her final projects focused on first responders and precision agriculture. King also completed pre-college software development courses and cybersecurity courses at George Mason University and was a GIS analyst and summer intern for Dewberry. King plans to study geography and GIS.

Joshua Queja Orteza
Westside High School in Jacksonville, Fla.
Now attending the University of Florida
Orteza is majoring in mechanical engineering and participating in the Army ROTC program, and is interested in both aerospace and national security. If he earns a commission as an Army officer, Orteza would like to work with satellites, either helping maintain them or using the information they provide. Later, as a civilian, Orteza intends to work on satellites with a large aerospace company.

Timothy Vrakas
Brookfield East High School in Brookfield, Wis.
Now attending Stanford University
Vrakas is pursuing a degree in electrical engineering. For the past two years, he has explored interests in this field through his work for the Arizona State University Mastcam-Z Team, developing imaging hardware and software to support the cameras on NASA's 2020 Mars Rover. Vrakas hopes to continue this work while in college.

PHOTO COURTESY OF OGSYSTEMS

Co-founders Garrett Pagon (front right) and Omar Balkissoon after cutting the ribbon at OGSystems' grand opening open house at the company's Chantilly, Va., headquarters in December 2015.

OGSystems: West Coast Vibes in Washington

Garrett Pagon, co-founder and president

Q What led you to found OGSystems?

About 13 years ago, I was just out of the Air Force and Omar Balkissoon, now OGSystems CEO and co-founder, had just completed his role at the Naval Research Lab. We were both contractors working on a big Intelligence Community (IC) project for about a year, and nothing was getting done. The straw that broke the camel's back was an all-day meeting, the result of which was another all-day meeting. It was so frustrating. That opened our eyes to what could be done differently. Thinking about a better way to do things led us to start our own business. We realized that customers don't want these five- to 10-year projects, because by the time they're delivered, the technology is outdated. So, when we were in our 20s, we created a West Coast-style entrepreneurial, collaborative company to show that innovation is possible in the government and IC.

Q What are some of your customers' most pressing problems?

Ninety percent of our customers are in government, defense, and security. On the geospatial side, the biggest issue we're seeing is how to deal with the exploding amount of location-based data. How do you derive information from that data, how do you make sense of the conclusions, how do you deliver intelligence that's actionable? That's where people are struggling. That's one of the reasons we built BlueGlass—which takes unclassified, location-based data and uses machine learning, artificial intelligence, and pattern recognition to come up with predictive analytics. That frees up our customers' analysts to do higher-level work.

Another thing we are starting to see is the move from two-dimensional to three-dimensional representation. In 2015, we acquired Urban Robotics, whose PeARL airborne imaging system provides real-time tactical pictures. We also developed a three-dimensional technology that's being used in theater right now. The next step is doing that for any data type as a cloud-based product—something no one else is doing.

Q Given that you emphasize a nimble approach to solving difficult problems, are most of your contracts on shorter timelines?

We prefer the shorter ones. When it's a three- to six-month time frame, it's

really about delivering results. If it doesn't work, you should cut it off. That's one of the problems with longer projects; there's inertia around them that leads to them lasting longer than they should. If it's successful, you scale up. If not, you find alternatives. We do have a couple of five-year programs, but I don't want to wait five years to develop and deliver to the customer. Well before then, you need to figure out if you're on the right track.

Q How do you stay innovative?
The biggest aspects are workforce and culture. You can't just say we're going to pivot and learn from our mistakes unless people aren't afraid of losing their jobs. I don't care if you're a junior staff officer or a senior satellite engineer—we want our people to always try to do things more efficiently. So it's about saying, "OK, we're going to try new things and you're going to be rewarded." This allows us to build things for the customer faster than the competition. And it's not just the big things. We see it in things like our contract with U.S. Special Operations Command to deploy hardware. We got kudos from the customer because we reduced the QRC (Quick Reaction Capability) process from four hours to two. That's really what the company is all about—bringing innovation to all areas of national security.

Q Can innovation be taught?
We started OGS University in 2015 and now offer two courses a month. They're held at our office for customers, employees, and partners, and they cover geospatial topics and approaches to innovation such as our Immersive Engineering methodology. The idea is to educate everyone and really break down the process—for example, showing participants how they can use technology to make projects shorter.

Q You're trying instill a West Coast ethos in D.C. Have you experienced any pushback?
Not so much pushback as not knowing what to do about it. There's a huge opportunity for Department of Defense (DoD) innovators—that's what we call ourselves, versus DoD contractors—but the biggest drawback to being first to market is the community is still risk averse. The mission is critical, and often the cost of failure is high, so it's a balance of doing things quickly and reliably. The IC hasn't become totally West Coast yet, but we're pushing forward. The government's No. 1 evaluation criteria in four of our last five bids was innovation. That's telling.

Q Describe your office and how it's unconventional by D.C. standards.
Everything's open. When you walk in, you can see everyone else. There's glass everywhere. The best thing is that we have a lot of unscripted collisions in the office. For example, we built Scholaris—a semantic search tool to mine historic company data—because the proposal team was talking informally to the software team about a challenge they were facing. The message is that anyone in the company can be innovative.

Q How do you keep abreast of GEOINT news and trends?
By reading *trajectory*! And by building a lot of new things and interacting with developers. When you're out there building something for the unclassified field, you're ahead. We also have a strong focus on communication and transparency. We put out a weekly video to our company's 350 employees, have weekly get-togethers at contract sites, send out weekly emails, and have an active Twitter account. This is also where the benefit of membership with organizations like USGIF come into play. These organizations provide opportunities for thought leadership and networking with potential partners, customers, and job candidates. That leads to personal information exchange and is one of the most important ways ideas travel.

Q What do you consider most exciting about GEOINT today?
It's cool to see the new providers and the democratization, if you can call it that, of GEOINT. The barriers to entry are lower. When we founded OGSystems, GEOINT was mostly military, and you had to be an expert in all areas. Today, you can just be a software provider or data provider, and because of the cloud, you don't need a lot of infrastructure. The technology is changing quickly.

Q Your biography says you are teaching your sons how to build the "ultimate tree house." Are you a big maker and builder outside of the office?
Yeah, I love pulling things apart and putting them back together. When I got out of the Air Force I thought about being a builder of houses, but fortunately it didn't work out. It's been a little bit of a trial with my boys—sometimes it's forced family fun. But at the end of the day, it's nice to have built something you can sleep in.

Mapbox: Empathy and Fire

Robert Ames, director of government business and technology strategy

Q When did you begin working at Mapbox?
I joined Mapbox in March. Prior to that, I spent six years at In-Q-Tel—a technology innovation channel funded by the government. Before that, I spent 11 years at IBM, where I was deputy CTO for IBM Federal.

PHOTO COURTESY OF MARISSA FULLORD/MAPBOX

Mapbox employees gathered at the company's San Francisco office.

Q Even though Mapbox employees don't have official titles (and you made up one for the purposes of this interview), is yours a new position within the company?

It is a new position, recognizing that government is a big part of Mapbox's business. I bring experience in inserting technology and innovation into government missions, and I bring a deep understanding of technology and mission problems that can be addressed by the emergence of mobility and the richness of location data.

How has mapping fundamentally changed in the last decade, and what role has Mapbox played? In the past five to 10 years, maps have gone from being this very fixed, stagnant, paper concept—a hard-to-consume medium, like pulling an encyclopedia off the rack—to being highly dynamic, responsive, and customizable. Today's maps fuse contextual information such as what restaurants and friends are nearby.

PHOTO COURTESY OF MARISSA FULLORD/ MAPBOX

Robert Ames (standing) speaks with colleagues at Mapbox's D.C. office.

Q How is Mapbox preparing for the future of GEOINT?

In three important ways. First, we're developing the mapping platform for the future. That platform is going to be critical in the mobile world. When you think about people deployed with limited connectivity, making these maps accessible at a low bandwidth is an area we're taking forward for GEOINT.

Second is this notion of context—how do I understand what's going on around me, in the past and currently, and how do I optimize my experience or outcomes?

Third, we see a future in which users can interact with maps in the space around them through augmented reality. Imagine being able to interact with a three-dimensional representation of the Earth that moves with you. This isn't happening in the distant future, but soon.

Q What do you consider most compelling among Mapbox's projects?

Definitely the virtual reality space and its implications for mapping and GEOINT. Another exciting area: We want to bring machine learning and artificial intelligence to augment everyone's understanding of their surroundings and continue to enrich people's context around a map. We see our competitors moving in this direction, and we are actively investing in this area. Look at Snapchat's SnapMap, which Mapbox helps power. It maps geo-tagged snaps that users have decided to share. If I'm interested in what's going on in Dupont Circle or Trafalgar Square in London, or anywhere people are actively creating content, I can open SnapMap and see that content as a hotspot. It's completely customizable, and the interface is intuitive and fun with this cartoony, emoji feel. But it is a very powerful and rich example of the future of context.

> "We are the people that often enable the mapping you use, but you don't necessarily know it's Mapbox."
>
> —ROBERT AMES, MAPBOX

Q What is surprising about Mapbox?

People are often surprised about our breadth and depth. We are the people that often enable the mapping you use, but you don't necessarily know it's Mapbox. Our maps are installed in approximately 4,000 applications worldwide.

Q Your hiring strategy is somewhat nontraditional. According to your company website, "empathy" and "fire" are two traits Mapbox looks for in its employees. Can you explain this?

The company was founded by Eric Gundersen. He was inspired to create Mapbox when he was struggling with inferior maps while trying to monitor elections in Afghanistan. His intention was clear—to help make the world a better place. That's led to the ethos of finding people who are passionate, no matter what their professional history. I'm an example of that. Before I got into IT, I was a professional opera singer.

Q What results from cultivating a workforce with myriad backgrounds?

Mapbox has a diverse set of employees who come from rich and varied backgrounds. I believe this leads to an understanding that people interact with maps and information in very different ways. We believe it's important to customize maps, the experience to the user, and the environment with dynamic styling. Cartogram, for example, allows you to upload a picture, and the application will style your map to match that picture. I took a picture of my cat, so I have my cat map. We just released a mapping style a week ago that looks like comic books. Things like that are the results of having folks from all backgrounds.

Q What's most exciting to you about the modern GEOINT space?

What's interesting is that GEOINT is everywhere, because we all want to know what's going on around us. Because of that, innovation is pouring in. I'm taking my daughters to Rome in a couple weeks. My entire search on activities and sites in Rome is a GEOINT-type application. I use such tools as Foursquare, which is powered by Mapbox, to identify interesting places. So if I want to take a tour, I find out where it is, what's around it, and I read reviews—but it all starts with a geo-query. Then you go to social media and say, 'I'm visiting this area, what should I do, what shouldn't I do?' and you get recommendations about places. We're all thinking GEOINT without knowing it.

Individual Membership Spotlight: Harnessing Emerging Tech

Tony Frazier, president, Radiant Solutions

Frazier was introduced to the GEOINT Community seven years ago when he led marketing and products for commercial satellite imagery provider GeoEye, which was acquired by DigitalGlobe in 2013. DigitalGlobe later acquired Radiant, and Frazier was appointed president of Radiant Solutions in October when MDA acquired DigitalGlobe, merging multiple geospatial brands. Prior to GeoEye, Frazier served as senior director of product management for Cisco Systems and held senior marketing and product roles at IBM, Infor Global Solutions, iPhrase Technologies, and pcOrder.com. Frazier has been a USGIF Lifetime Member since 2015.

Q What is your advice for young, aspiring GEOINT professionals?

This is an awesome community. It's very rare that you can work on cutting-edge technology and apply it to missions that matter—from tools we use every day like consumer maps all the way to things that support warfighters and first responders. I'm relatively new to GEOINT after spending a couple decades working in commercial tech, and the principal thing I've noticed is you can continue to run at the pace of Silicon Valley but do it for a much more meaningful purpose.

Q What lessons learned can you share with regard to working with the federal government?

One of the perceptions of government is that all of their solutions are custom built. There was a call to action on display at the GEOINT 2017 Symposium by the government to tap into more sources of commercial innovation. In order for the community to get where it wants to be, we must go beyond just leveraging technology best practices and also embrace open innovation business models. For example, I've collaborated with USGIF on initiatives such as hackathons and educational missions like Massive Open Online Courses. If we can share data and tools more broadly, we help eliminate barriers to collaboration and accelerate the process of innovation.

For example, this past year DigitalGlobe had a really great experience with a program called SpaceNet. It was a collaboration among DigitalGlobe, CosmiQ Works, and NVIDIA to make satellite imagery and labeled training data open and available to the machine learning community with the goal of accelerating innovation in the application of computer vision to mapping imagery. In round two of that challenge, we saw the quality of these algorithms go from 30 percent accuracy to, in some cases, more than 80 percent accuracy in a matter of months. We are contributing these automated feature extraction algorithms to the open source community. Over time we feel these capabilities can help automate mapping.

Q What trends are you seeing in the remote sensing field and how are you responding to them?

One of the areas I'm really excited about is how we can tap into technology accelerations enabled by pervasive sensors, cloud computing, open-source software, and open data to change how we do business.

With more sensors in space and on the ground, we'll have the ability to really sense the planet. The bottleneck is going to be how we can extract information, discover patterns, and deliver insights at that scale. Applying artificial intelligence, machine learning, and big data analytics are the enablers that will help our community ride this tidal wave of data to move the needle for the mission. If you look at where DigitalGlobe is going with our MDA merger, we will be able to harness all types of sources like radar and weather data that will help us provide those insights.

> "My team had 24 interns this past summer and to see some of the projects they were able to deliver in a 10-week internship program was amazing."
>
> —TONY FRAZIER, RADIANT SOLUTIONS

Q What excites you about the future of the GEOINT industry?

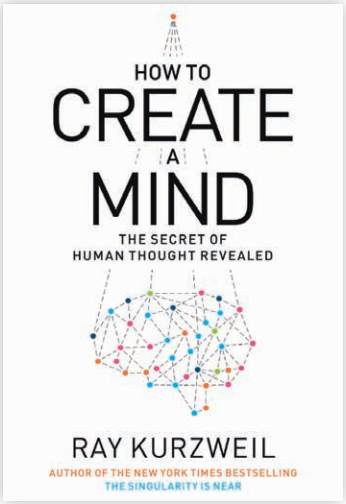
I think the quality of new talent we're attracting is exciting. I'm a big believer in education—my mother was a proponent that education creates opportunity. Now, we're able to expose youth to crowdsourced mapping tools like OpenStreetMap and Tomnod. That's an interesting pattern, that the technology is becoming more accessible. It's allowing us to attract a new group of talent. My team had 24 interns this past summer and to see some of the projects they were able to deliver in a 10-week internship program was amazing. I'm confident we're going to be able to recruit the best and brightest and focus on where we can take industry in the future.

Q How has USGIF Membership helped your career development?

I've been a USGIF Lifetime Member for two years. USGIF has been a great resource. Coming into [the GEOINT industry] close to seven years ago, I had no knowledge about this space. Early on, [USGIF] was a platform of learning through events like the GEOINT Symposium and other networking exchanges. Now, USGIF provides me a platform for taking ideas and getting those ideas to scale. Whenever there's the notion that DigitalGlobe wants to do something in partnership with the community, we look at USGIF as a channel to make that happen.

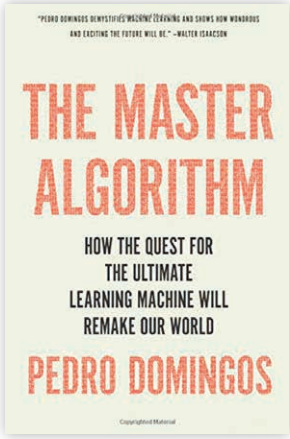
horizons

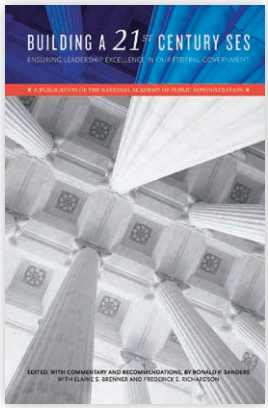
READING LIST + USGIF EVENTS CALENDAR



How to Create a Mind: The Secret of Human Thought Revealed
By Ray Kurzweil
Kurzwiel explores the advancement of artificial intelligence and machine learning by reverse engineering the human brain. He describes a series of thought experiments and research that suggest the brain's neocortex contains a system of pattern recognizers—a potential roadmap for the creation of machines even more intelligent than their creators.

The Master Algorithm: How the Quest for the Ultimate Learning Machine Will Remake Our World
By Pedro Domingos
From curating Netflix suggestions to curing cancer, machine learning is the future of discovery. This book explores the quest for a master algorithm, a universal learner capable of discovering any information from data. Domingos optimistically discusses what such an algorithm would mean for business, science, and culture, and how it would change human understanding of the world.





Building a 21st Century Senior Executive Service
Edited by Dr. Ronald Sanders, Dr. Elaine Brenner, and Frederick Richardson
This free book published by the National Academy of Public Administration addresses a "mid-life crisis" faced by the Senior Executive Service (SES). The book's 22 authors contend the SES requires significant reforms in order to address the challenges of governing in the 21st Century. Decades of government experience provide the basis for 23 recommendations for modernizing the SES.

NOVEMBER 11
GeoGala
McLean, Va.

NOVEMBER 13-17
GEOINT Community Week
Northern Virginia

NOVEMBER 14
GEOINTeraction Tuesday
Chantilly, Va.

JANUARY 8
GEOINT Community Job Fair
Fairfax, Va.

JANUARY 23-24
Small Sat Workshop
Springfield, Va.

APRIL 22-25
GEOINT 2018
Tampa, Fla.

PEER INTEL

President Trump nominated **REP. JIM BRIDENSTINE (R-OKLA.)** as the next NASA administrator. Bridenstine has served on the U.S. House of Representatives' Armed Services and Science, Space, and Technology committees and is a former Navy pilot.

Orbital Insight named **CHRIS INCARDONA** vice president of public sector and strategic program development. In this role, Incardona will pursue clientele in the defense, intelligence, and civil sectors of government.

President Trump nominated retired **VICE ADM. JOSEPH KERNAN** to be Under Secretary of Defense for Intelligence. Kernan formerly served as the senior vice president of corporate development for SAP National Security Services.

The MITRE Corporation announced five senior leadership appointments. **MARK MAYBURY, PH.D.**, will serve as vice president for MITRE's intelligence portfolio; **JOHN KREGER** will become vice president of Public Sector Programs; **EILEEN BOETTCHER** will serve as vice president for Joint & Services Programs; **KERRY BUCKLEY, PH.D.**, will be vice president for Intelligence Programs; and **DOUGLAS ROBBINS** will serve as vice president for Air Force Programs.

Nitro Solutions selected **LISA MONNET** as its new CEO. Prior to joining Nitro Solutions, Monnet served as a senior advisor providing multidiscipline support to the Intelligence Community and Department of Defense worldwide.

President Trump appointed **JOHN SHERMAN** chief information officer of the Intelligence Community. Sherman has spent more than 20 years in various roles in the IC, including most recently as deputy director of the CIA's Open Source Enterprise.

BARRY TILTON joined Vricon as vice president of engineering and chief technology officer for the company's government programs. Tilton will spearhead efforts to create new content and improve response times and product quality. Additionally, Vricon added **ERIC VON ECKARTSBERG** as its senior vice president of government and chief revenue officer.

RANDALL A. WOTRING was named AECOM's chief operating officer effective July 1. Wotring has more than 30 years of experience in the engineering and construction industry and helped grow AECOM's federal services business with the U.S. Departments of Defense, Homeland Security, and Energy.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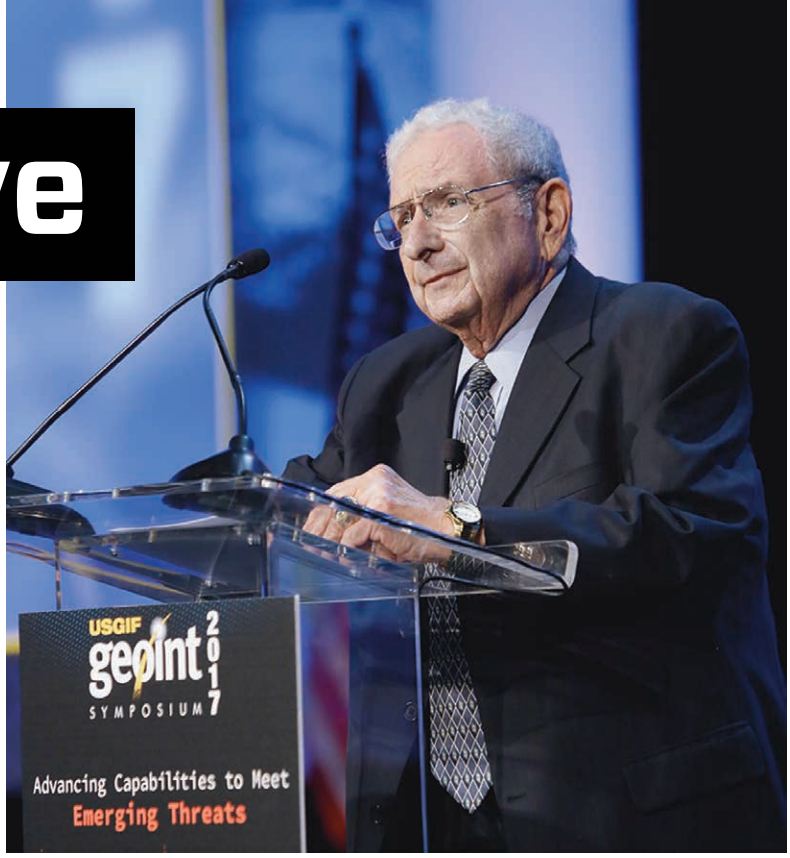
MISSION FIRST

Q&A with Maj. Gen. (Ret.) Robert "Rosie" A. Rosenberg, former director of the Defense Mapping Agency



Maj. Gen. (Ret.) Robert "Rosie" A. Rosenberg served 30 years in the U.S. Air Force and was instrumental in the U.S. satellite program. He participated in the initial development, testing, and launch of what became National Reconnaissance Office (NRO) satellite systems, later serving as mission controller of on-orbit reconnaissance satellites. He also served as acting director of the NRO staff, and then was intelligence and space policy advisor on the National Security Council. Rosenberg was director of the Defense Mapping Agency (DMA), a predecessor to the National Geospatial-Intelligence Agency (NGA), from 1985 to 1987. During his tenure as director, Rosenberg made DMA essential to the success of the nation's warfare capabilities. At the GEOINT 2017 Symposium, USGIF named Rosenberg the recipient of its Arthur C. Lundahl—Thomas C. Finnie Lifetime Achievement Award.

Q You have a reputation for not being afraid to "break the rules" in the name of progress. Could you provide some examples of instances in which this approach served you well?

Well, I've got a long list! I guess that's why I only made two stars instead of four. [Laughs] When I was working on the National Security Council, I discovered a program called GPS, which the Air Force was not interested in and which wasn't included in the Secretary of Defense's budget to the White House. I snuck it in, and that originated the funding of GPS. After it went to Capitol Hill, I got a phone call from an Air Force three-star saying, 'I don't know who you think you are but your career is over, you put that useless piece of space junk in the budget.' GPS is now a critical element of the geospatial information foundation and it was essential to make our nation's military and intelligence programs far more successful.

Later, I was running a GPS advisory board for the Air Force. In Afghanistan, the Air Force only supported requirements for 24 GPS systems. There were several hours per day in which GPS was not available to our military because of the mountainous terrain that interfered with having three satellites in the line of sight, which is mandatory to get a GPS signal. We had six spares in orbit. I led an operational analysis that showed if we changed the orbital structure to 27 it would improve the availability. And, by the way, our enemies in Afghanistan knew when we didn't have coverage.

I took this study to Space Command leadership who in turn shared it with Strategic Command, which challenged my recommendation. I said on the day before Christmas, 'Move them now or my next call is to the Sec Def!' That Christmas Eve, the order was made to start moving the extra satellites. It's our job to ensure our GPS is the gold standard rather than a foreign technology.

Q How has the creation of NGA since benefited the geospatial industry and the nation?

I want to give James Clapper a lot of credit. The various fiefdoms that had been forced to stand up the National Imagery and Mapping Agency still owed their loyalty to where they came from. But NGA created a true geospatial information system, so GEOINT became the cornerstone of national security through its place at the center of many diverse intelligence methods. To help all that along, NGA has established a lot of academic and business opportunities that didn't exist in my day.

The DoD and IC now use Google and a whole host of other commercial applications. NGA is a leader in making that happen. Through research, grants, and small business initiatives, NGA is embracing the private sector to lead a convergence of geospatial information not only for the IC, but also for a better society.

And with the creation of USGIF—the only organization of its kind aimed at bringing together the GEOINT sector—NGA leadership personally participates in the GEOINT Symposium, lecture series, and everything USGIF does.

Q Given your successful career of more than 50 years, what advice do you have for future GEOINT leaders?

Make sure what you do is right, not what is the rhetoric of flawed, outdated policy. Demand that such be changed. The mission is not to follow the regulation book but to provide operational military capabilities vital to our nation's survival and freedom. Break down barriers that prevent sensible solutions. Your boss is not always right—as matter of fact, he or she is wrong a lot of the time. Earn the trust of your bosses. I was fortunate to have bosses who tolerated near anarchy.

You are responsible for the freedom and good life of future generations, not just your own. As you climb the ladder, remember good managers only do things right. Good leaders do the right things. You have to take risks. Followers never fail. It's only people who take risk and fail that learn how to become leaders. As a leader, don't issue orders and expect to be followed. Roll up your sleeves, get your fingers dirty, and lead by example. People will understand you mean business. Empower people. Make change the baseline. You must never think about what to do to get promoted. Do the above and you will serve your business, country, and society best. Promotions will follow.

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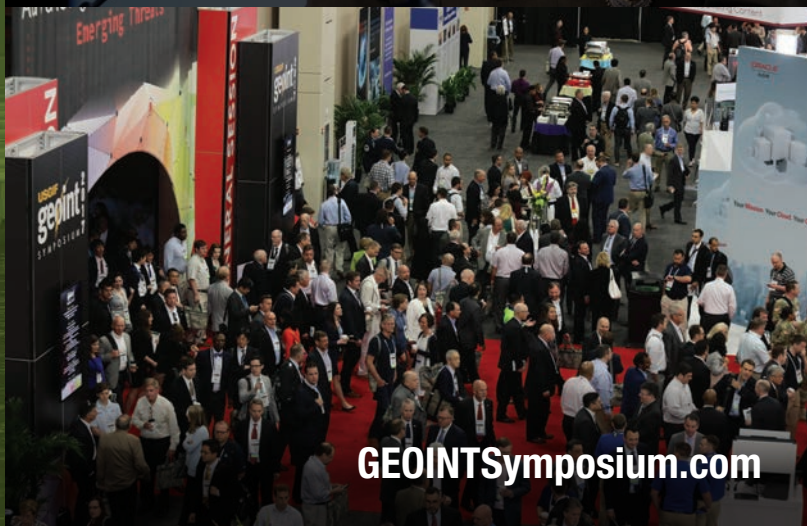

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