

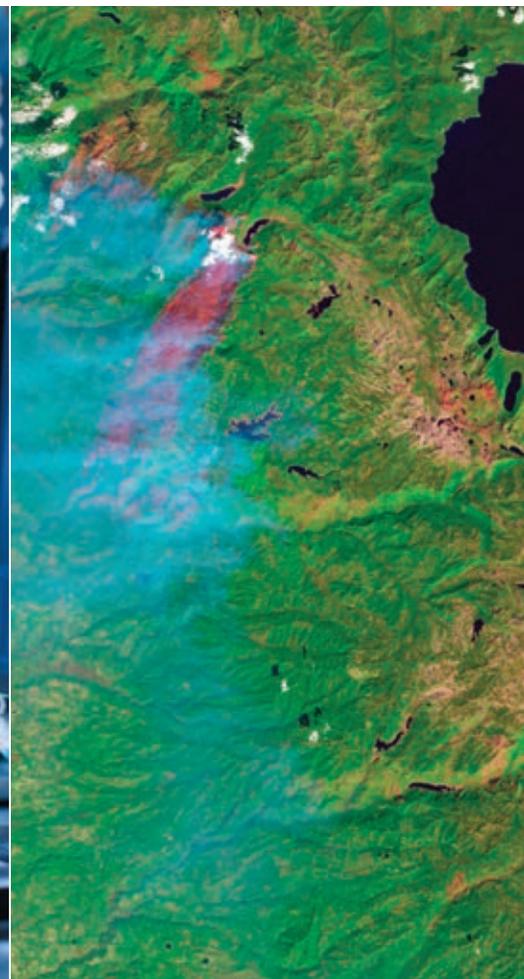
trajectory

THE OFFICIAL MAGAZINE OF THE UNITED STATES GEOSPATIAL INTELLIGENCE FOUNDATION

Polar GEOINT

U.S. national security interests in the Arctic heighten as ice melt transitions the region from a state of isolation to one of increasing access.

- Blockchain and cryptolocation
- Entrepreneurship and innovation in Asheville, N.C.
- Q&A with Gary Blohm, U.S. Army Geospatial Center



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This ICEYE-X2 radar satellite image from Prince William Sound in Alaska shows ice flowing to the sea. Image courtesy of ICEYE



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EVENT RECAPS

Visit us online for full-length recaps of all USGIF events, including workshops, GEOINteraction Tuesdays, and more.

GEOINT 2019

Visit the *trajectory* website throughout the Symposium for round-the-clock coverage of keynote speeches, panel discussions, exhibit highlights, and much more!

The Power of Progress

Fueled by analytic insight, innovation and disruption are occurring with accelerating speed and complexity. Technology enables change, and the fundamental needs, expectations, and desires of individuals and communities of interest are thereby globally strengthened. Technology powers human progress, and as it becomes increasingly ubiquitous, people have a vital role. This revolution is indeed human led.

As USGIF prepares to gather the community at GEOINT 2019, there is excitement in the air. Geospatial data has gone mainstream and is opening doors to opportunity and innovation. The exponential increase in geographically tagged data offers improved understanding of Earth's complexity and promotes game-changing advances. Advanced analytic techniques are tackling previously unsolvable problems that are now amenable to new solutions when humans and artificial intelligence work together. Harnessing this power yields improved speed to decision.



As an educational foundation, we celebrate these leaps and bounds in geospatial pedagogy. In February, USGIF published version 2.0 of its GEOINT Essential Body of Knowledge. Dr. Camelia Kantor, our VP of Academic Affairs, was instrumental in driving this substantive advance. The new document leverages the knowledge of our entire community of practice, which includes industry, government, and academia with 17 USGIF-accredited colleges and universities. I was pleased to see Indiana University of Pennsylvania's department of geography and regional planning achieve USGIF accreditation this year. Personally, this is exciting because my grandfather served as the university's president.

By defining curricula and offering professional certifications, USGIF strengthens and extends our community and provides value to our Organizational and Individual Members. GEOINT is an ever-evolving discipline that demands innovative and creative thought leadership to drive change. We can no longer afford to be tribal and prone to habit. The research and development among USGIF Members and the thought leadership demonstrated in our Working Groups and annual State and Future of GEOINT Report are powerful catalysts for our tradecraft to redefine the understanding of humans and their interactions on our planet. The networking and mentoring across the geospatial ecosystem remind us of the power of collaboration. These

ingredients promise practitioners both exciting careers and a dynamic future helping to address real challenges.

The Foundation includes young professionals on our Board of Directors. Their insights and leadership have proven to be invaluable. Isaac Zaworski is one such example, and I thank him for his dedication and service to the Board of Directors. In addition, his leadership with the USGIF Young Professionals Group (YPG) has resulted in demonstrable dividends in workforce development. As part of our YPG portfolio, the USGIF Golden Ticket program invites 30 young professionals to join us at GEOINT 2019. Each year, all who interact with this cohort leave the exchange excited for our shared future.

Our staff expertise has grown with Karin Fitzgerald and Ronda Schrenk bringing important capabilities and experience. The USGIF team is leveraging their skill sets and has fully integrated them into its operational cadence. USGIF will soon move our Herndon, Va., operation across the street to be co-located with the new Trajectory Event Center. This large, flexible conference space will allow us to better serve our community by providing facilities to facilitate the exchange of ideas. USGIF's Jeff Ley has been leading the development of this new space, and we are excited for our members to see first-hand the opportunity it will provide to help us all advance tradecraft, innovation, and community.

I hope you enjoy this issue of *trajectory*, and I look forward to seeing you soon at GEOINT 2019.

THE HONORABLE JEFFREY K. HARRIS
CHAIRMAN, USGIF BOARD OF DIRECTORS

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How GEOINT and Technology Drive Real-World Problem Solving for Government Agencies

By Lacey Wean, Geospatial Manager, Carahsoft

Accurate data is critical in all aspects of GEOINT. Sometimes this data already exists and other times it doesn't exist digitally and has to be collected or recreated. The data could be a combination of imagery, construction plans, maps or information. Regardless of the data type, all data is tied to a location.

That's where the benefits of geospatial intelligence technologies kick in. Technologies such as drones, manned aircraft, satellites and scanners can be paired with sensors for LiDAR, thermal, hyperspectral, multi-spectral and others to make it possible for agencies to quickly capture accurate data.

These technologies are enabling agencies to collect more data than ever before, dramatically increasing the workload for those people who process and analyze the data. To keep up with demand, automation is necessary. By forming public partnerships and implementing artificial intelligence, automation and augmentation, agencies can filter the incoming data and alert analysts rather than requiring them to examine everything manually.

GEOINT Data: Key to Solving Big Problems

By modeling different scenarios, agency teams can project costs for upgrades and repairs to buildings, bridges and dams, for example. Many of these assets are aging, and there's no historical data available digitally, so that data has to be collected.

Once the data is collected, it can be used to create 2D and 3D visualizations that can be put into a map. Algorithms are used to process the data into 3D point clouds and models and produce outputs. With that knowledge in hand, analysts are able to better prioritize among competing demands. Agencies can take projects a step farther by bringing the data to life in Virtual Reality or physically through 3D printing, providing additional ways to enable agencies to accurately leverage data for real-time decision making.

“Agencies can take projects a step farther by bringing the data to life in Virtual Reality or physically through 3D printing, providing additional ways to accurately leverage data.”

Advances in User-Friendly Tech

Geospatial intelligence technologies have come a long way. On one hand, they've made it possible to gather extensive data and then create high-quality outputs, such as maps and 3D models. At the same time, developers have simplified the user experience, so that generating outputs is more intuitive. Even when users lack a strong background in GIS, they can still produce the high-quality outputs.

Sourcing is Easier Than Ever

Access to GEOINT technologies for government agencies interested in deploying these game-changing technologies is easier than ever, thanks to a Blank Purchasing Agreement recently created by GSA and NGA. The initiative allows commercial purchases by government organizations for geospatial earth observation data, products and services, including GIS products, laser scanners, unmanned aircraft systems and more. More information at Carahsoft.com/GEOSPATIAL.

GEOINT 2019 Carahsoft Partner Pavilion Booth #617

Visit more of our partners on the show floor!

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June 4 | 5-8pm
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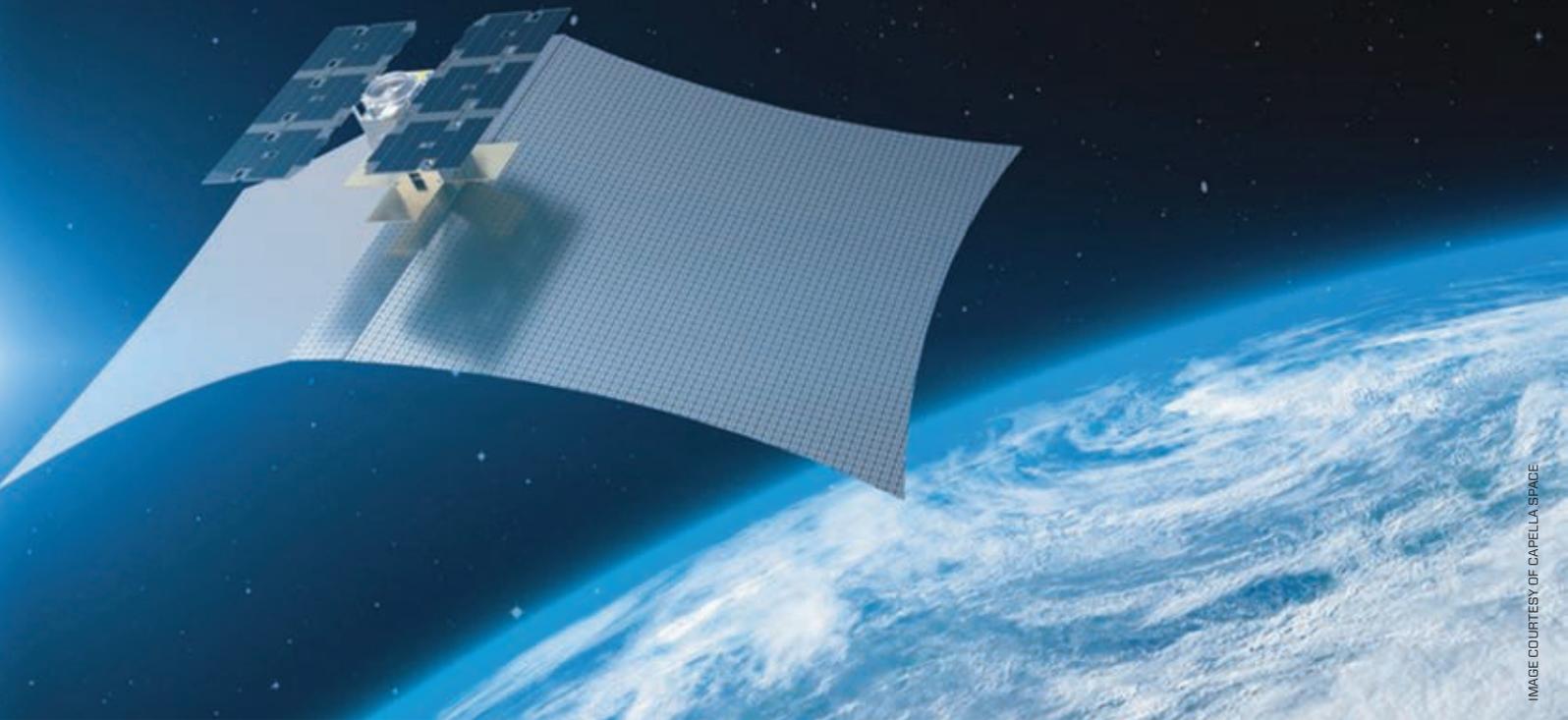


IMAGE COURTESY OF CAPELLA SPACE

The Next Era of the Small Sat Revolution

Nearly
300
people
attended the
unclassified
portion of
USGIF's
fifth Small
Satellite
Workshop.

Since USGIF's first Small Satellite Workshop in 2015, the conversation has evolved significantly from a focus on form factors to an emphasis on data and analysis.

"The last 10 years answered, 'What is the utility of a small sat?'" said Dr. Peter Wegner, chief strategy officer of Spaceflight Industries, as he moderated a panel discussion at the most recent workshop. "Now, we're starting to answer, 'How do you fuse all of this data together?'"

Nearly 300 people attended the unclassified portion of USGIF's fifth Small Satellite Workshop Feb. 19 at the National Geospatial-Intelligence Agency (NGA) in Springfield, Va.

The discussions focused on the latest industry advancements in small satellites and launch as well as the future of the technology.

ONGOING INDUSTRY INNOVATION

Two of the day's panel discussions focused on the continuous small sat advances being made by commercial providers. Panelist Keith Barber, VP of federal strategic partnerships for Planet, shared how the company has

been able to innovate as a result of both government and commercial investments. One use case he shared was the Russian nuclear triad—daily monitoring of air, sea, and land targets over a vast geography. Planet's growing portfolio of 3-meter-resolution Dove small sats paired with 1-meter SkySats allow it to tip and cue when an area or target requires more detailed observation.

The company's new analytics dashboard offers "efficiencies to gain across the board," Barber said. "There's a lot of content being created every single day that's going to have to get looked at."

Increasingly, the human insights enabled by small sats are becoming the primary focus of the technology.

"In some examples, the last thing people care about is the image," Barber said. "But they do care about the speed, the analysis."

Payam Banazadeh, CEO of Capella Space, said his company is on a mission to "bring SAR back home" on the commercial side, with the goal to launch a fleet of 36 small sats to provide high-resolution, persistent, global coverage. Capella's satellites weigh 40 kilograms on the ground, then

Vector Launch's Vector-R solution will be able to launch payloads of up to **60 kg** for **\$1.5M**

transform into larger structures once on orbit.

"36 satellites spread equally within many [orbital] planes," Banazadeh said. "Three years ago, that was hard—today it's only hard because of launch."

Launch is the next evolution of the small sat revolution, according to the panelists.

ADVANCES IN LAUNCH TECHNOLOGY

Stella Guillen, VP of sales and marketing for Arianespace, said her company currently has three commercial launch vehicles and promotes its ability to launch any mass, to any orbit, at any time. With 60% of the company's business being commercial, they are adapting to accommodate small sats. In August, Arianespace had its first purely rideshare mission, and it is currently building two new launch vehicles, one of which is specifically designed with small sats in mind.

Vector Launch was founded in 2016 with the goal of creating small sat launch vehicles at a new price point, according to Greg Orndorff, VP of government services. The company's Vector-R solution will be able to launch payloads of up to 60 kilograms at a price point of approximately \$1.5M, and its Vector-H will handle payloads of up to 290 kilograms for around \$4.5M.

Vector's portable, trailer-based infrastructure offers a turnkey solution, though will not include mission assurance. Orndorff said the company has already made two Vector-R sales and is reserving two vehicles for the DARPA Launch Challenge later this year.

VOX Space, a subsidiary of Virgin Orbit, is developing the capability to quickly send small sats into low Earth orbit using its LauncherOne two-stage rocket, which is deployed from a Virgin 747 aircraft.

In theory, this method could allow for launch from any airport, according to Dan Burkett, VOX Space director of strategy and business development, who added the company recently

received Federal Aviation Administration approval for four launch sites.

Potential challenges that lie ahead for these capabilities include concerns about crowded skies, particularly in low Earth orbit, as well as interference with national airspace.

DEMOCRATIZING SPACE

Though venture capital has been flowing into new space companies for the past several years, some warned about the risk of the bubble bursting.

"The loop is not getting closed because these companies aren't being purchased," said Banazadeh. "If we don't start seeing a lot of exits ... we won't see as much VC coming in."

Some potential solutions to this, according to panelists, would be investments in space-based innovation by prime contractors or perhaps government-led merger and acquisition policies.

Chirag Parikh, director of NGA's Office of Sciences and Methodologies, gave a keynote address in which he said, "What's the point of all of these small sats, all of this information, if we don't actually get it to the people who need it?"

Parikh compared the advances in small sat-derived data to the ever-growing variety, velocity, and volume of television programming. Television has evolved from traditional providers (the networks), to focused content providers (specialized cable channels), to providers who bundle programming and even create their own (Netflix, Hulu, etc.). Similarly, GEOINT has evolved from traditional government providers, to commercial providers and small sats, to the current epoch of analytics-as-a-service providers, Parikh said.

He added the focus needs to be not "Can you get this data off of this satellite in space?" but "Can you get the data to this particular person?" To do so, he said, will require the agency to focus on more flexible policy, better standards, and content ingestion and discovery.



PROCRASTINATION TOOLS



Civilisations AR

BBC's augmented reality app offers a way to interact with historical art and cultural artifacts from across the world. Users can explore a collection of more than 30 items including an Egyptian sarcophagus, sculptures from Henry Moore, and Renaissance masterpieces from Tintoretto, Bellini, and others. A "restore" feature shows the effect of time on history's greatest

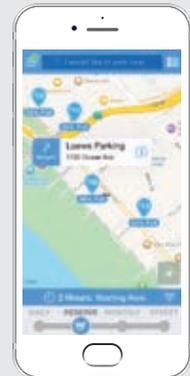
treasures by estimating their appearance when new, and an "X-Ray" feature shows secrets that might be hidden from plain sight.

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inrix.com/mobile-apps



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content to learn more about the solar system and beyond.

nasa.gov/connect/apps.html

IMAGE COURTESY OF VOX SPACE



IC ITE's "Second Epoch"



IC CIO John Sherman

The Intelligence Community (IC) is entering the "second epoch" of its Information Technology Enterprise (IC ITE), IC Chief Information Officer John Sherman said earlier this month in his remarks at USGIF's GEOINteraction Tuesday event hosted by OGSsystems.

Sherman has held the post of Assistant Director of National Intelligence and IC CIO with the Office of the Director of National Intelligence (ODNI) since September 11, 2017.

Sherman said he intends to build upon the many new IC ITE services launched—Amazon C2S, the IC GovCloud, the IC Apps Mall, and more—as well as to make necessary changes along the way. He cited one notable change as the

shift away from the IC Desktop Environment (DTE).

"[DTE was] a noble, great idea but as we got into it we recognized a one-size-fits-all solution wasn't going to work," Sherman said. "This had to change as we marched into the second epoch."

Sherman outlined the five pillars he is using as guidelines for the next evolution of IC ITE:

- 1. Agility & Adaptability:** The IC's move to the cloud has enabled it to achieve things inconceivable only a few years ago, Sherman said. Moving forward, the IC will seek to modernize capabilities in data extraction, correlation, and enrichment as well as to embrace new capabilities such as quantum computing and high-performance analytics.
- 2. Security & Resilience:** Sherman's IC CIO mission statement is "to modernize and protect." He is working closely with chief information security officers across the community to launch a cybersecurity implementation plan that includes: knowing your network; correcting inefficiencies; leveraging better technologies such as AI and machine learning to understand the enterprise; and sharing the state of the enterprise by passing information about malicious activity against IC systems through the IC Security Coordination Center in Reston, Va.
- 3. Interoperability:** Following the pivot from DTE, Sherman stood up a new group within the IC CIO organization with a focus on embracing reference architectures to ensure interoperability. He described this as moving to a "wheel of seals" where officers can access information from across intelligence organizations.
- 4. Usability & Accessibility:** This emphasizes ensuring capabilities the IC deploys do not leave those in the field behind, which Sherman said will be more critical than ever as machines are used to augment intelligence.
- 5. Affordability:** Though the IC has experienced savings already from IC ITE, Sherman said there are always new ways to achieve goals more economically and to leverage new technologies. He cited moving to the cloud, and therefore shifting from a capability expenditure model to an operational expenditure model, as one of the biggest accomplishments under the first epoch of IC ITE—and one he plans to continue.

All five pillars share a common goal, Sherman said: "Decision advantage for our policymakers and warfighters like we've had in the very best moments of our nation and allied history."

 SPOTLIGHT

Dean Alvarez: A Future in Computer Science

When attending USGIF's GEOINT Symposium, you never know who you will meet and where those connections might lead you. Take, for example, the experience Dean Alvarez, a senior at Strawberry Crest High School in Dover, Fla., had when he attended GEOINT 2018 in Tampa.



USGIF invited Alvarez, then a junior, and three other Tampa area high school students to share their science fair posters during GEOINT 2018's GEOINT Foreword alongside 22 college students from across the country. Alvarez's research focused on the "Effect of Various Pooling Methods on Robustness to Adversarial Examples in Convolutional Neural Networks."

"It was really cool to talk to people who understood what I was doing," Alvarez said. "I learned a lot, not just from the experience of talking about my poster to professionals in the field, but also from what many of them had to tell me in terms of my research. It was also interesting to hear from the speakers [at GEOINT Foreword] about how they are applying similar technologies."

One of the attendees Alvarez had the opportunity to share his project with was Jasen Halmes, CACI's director of artificial intelligence. As a result of their interaction, Alvarez and Halmes exchanged contact information. Following the Symposium, Alvarez interviewed and was selected for a summer internship with CACI as a junior research scientist. Through the internship, he worked with the organization's computer vision research team and conducted experiments to help advance knowledge of deep neural network applications to GEOINT challenges.

"Our team was very impressed with Dean's abilities," Halmes said. "I was struck with both his individual contributions and left with the impression that we should do more as a community to foster exposure to our industry technologies. Dean proved that we could be doing a lot more to encourage our future technology leaders."

Alvarez will graduate this spring from his high school's International Baccalaureate program. He is still deciding which college he will attend in the fall and hopes to major in computer science with a focus on artificial intelligence. He will be interning at CACI once again this summer and intends to build upon last year's experiences by performing his own research experiments.

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agi.com/geoint



 REPORT CARD

USGIF Participates in Review of the Nation’s Spatial Data Infrastructure

In February, the Coalition of Geospatial Organizations (COGO), of which USGIF is a member, released the second Report Card in its ongoing review of the U.S. National Spatial Data Infrastructure (NSDI). The document serves as a periodic assessment of the nation’s geospatial data infrastructure, which, like other forms of public works, is essential for the country’s economy, health, safety, and activities of daily life.

The Report Card leveraged the input of subject matter experts with knowledge in each of the eight national framework data themes: addresses, cadastres, elevation, geodetic controls, governmental units, hydrography, orthoimagery, and transportation. USGIF Vice President of Academic Affairs Dr. Camelia Kantor serves as the Foundation’s COGO delegate and contributed to the report as a reviewer in the area of transportation.

Each team assessed the developments and advances within their respective themes since the original Report Card was published in 2015 and engaged with the Federal Geographic Data Committee as they determined new individual scores. The NSDI as a whole received a grade of B-, reflecting some improvements from its 2015 grade of a C.

“Our country relies on these systems and data every day,” said Shelby Johnson, the 2019 COGO Chair. “It helps us in so many ways. It makes us more efficient and prosperous. The challenge is maintaining the themes where we are doing well, then finding the will and the means to improve on the rest. Our hope is this will assist government agencies in collaboratively completing and maintaining the NSDI. We still have a long way to go.”

The latest assessment is intended to encourage continued and critical improvements to U.S. national geospatial infrastructure.



 ST. LOUIS

SLU and NGA Host Geospatial 101 Series

Saint Louis University (SLU) and the National Geospatial-Intelligence Agency (NGA) hosted a four-part presentation series that explores how geospatial data is used to visualize patterns of poverty, crime, and unemployment in the St. Louis region. The “Geospatial 101” series was a result of a Collaborative Research and Development Agreement NGA and SLU signed to establish a joint geospatial research and training initiative. Presentations were held in February and March at SLU’s Learning Resources Center and were free and open to the public.

“Our country relies on these systems and data every day. It helps us in so many ways. It makes us more efficient and prosperous.”

— SHELBY JOHNSON, 2019 CHAIR, COGO



 TRADECRAFT

The GEOINT Essential Body of Knowledge 2.0

USGIF published version 2.0 of its GEOINT Essential Body of Knowledge (EBK) in February. The GEOINT EBK is the foundation for USGIF’s efforts to create a pipeline for the global GEOINT workforce via its K-12, Collegiate Accreditation, and Certified GEOINT Professional (CGP™) programs.

The EBK is developed by conducting a cross-industry job analysis to identify the knowledge, skills, and abilities critical to the GEOINT workforce, and outlines standards for the broad practice of GEOINT.

“Version 2.0 of the EBK is significantly more comprehensive and helps guide the pathway into GEOINT learning starting from high school, moving into college, and into the professional workforce,” said USGIF Vice President of Academic Affairs Dr. Camelia Kantor. “With this newly revamped document, the intent is to bridge the gaps between high school prerequisites, collegiate credentials, and professional certifications in a continuum of building blocks.”

As the GEOINT profession continues to evolve, so does the EBK, reflecting meaningful changes to the tradecraft and incorporating new technology and methodologies.

 USGIF’s Dr. Kantor recently spoke about the revised EBK in a webinar co-hosted by *Directions Magazine* and the GeoTech Center. Check it out at directionsmag.com/webinar/8109.



K-12

A Variety of EdGEOcation Events

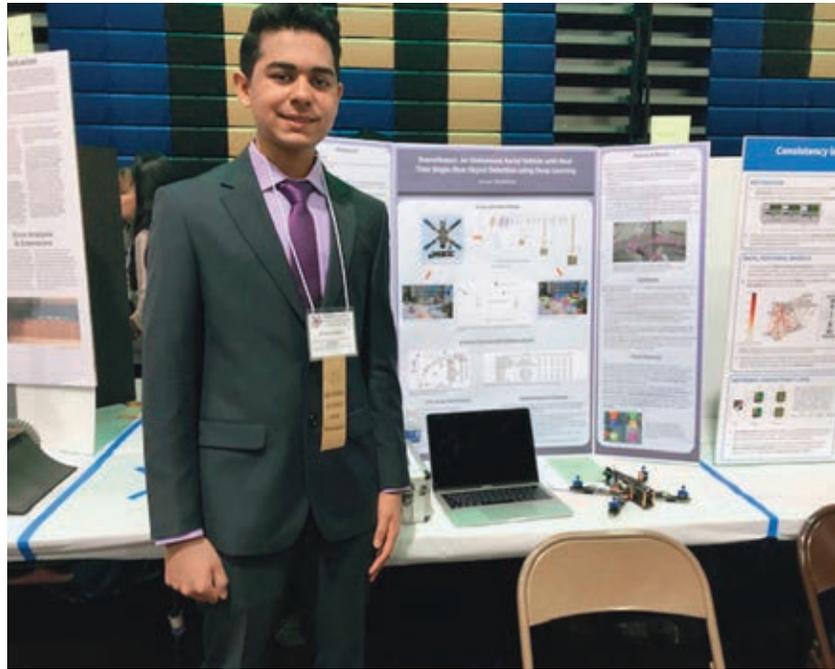
Following the winter break, USGIF was back in classrooms sharing GEDINT knowledge. In January, USGIF gave geometry students from Seneca Ridge Middle School in Sterling, Va., a lesson on similar triangles and rates and proportions using GIS to calculate island erosion and distances across rivers.

In March, USGIF's Portable Planet map visited Creighton's Corner and Moorefield Station Elementary Schools in Ashburn, Va. More than 450 students completed activities on the map.

USGIF also visited John Champe High School in Aldie, Va., to help with a research project focused on identifying pollutants in Loudoun County. The Foundation and Esri teamed up with juniors and seniors in AP environmental science and computer science classes to assist in visualizing their data using ArcGIS.

Also in March, USGIF and members of its Young Professionals Group (YPG) participated in a variety of STEM events. USGIF exhibited at the first annual Dyslexic Edge: Pathways to STEM Excellence Conference and Festival at George Mason University, an event hosted by Sliding Doors STEM & Dyslexia Learning Center. The group also attended *WashingtonExec's* K-12 STEM Symposium in partnership with Riverside Research. At both events, children built their own satellite models and learned how to analyze satellite images.

USGIF also participated in the Fairfax and Loudoun County Regional Science Fairs, awarding students with \$500 each for the best project in geospatial achievement.



Madison High School student Arnav Wadehra won \$500 from USGIF for his geospatial project in the Fairfax County Science Fair.

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- Optics and photonics
- Plasma physics



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RIVERSIDE RESEARCH



YPG members learned about contract types and vehicles during an Acquisitions 101 presentation hosted by Planet.



Young Professionals in Action

In February, YPG hosted the second edition in its Acquisitions 101 series at Planet’s office in Washington, D.C. Keith Barber from Planet and Nick Buck of Buck Consulting Group spoke about contract types and services as well as licensing versus services.

YPG also participated and exhibited at NGA’s Interagency Mentoring and Collaboration Workshop at both NGA Campus East and West March 23. This event is an opportunity for young professionals to attend sessions on career development and connect with peers and potential mentors.

Meanwhile, USGIF’s YPG is expanding its outreach in St. Louis, Mo. Members of YPG based in the St. Louis area have hosted informal networking events each month, gaining traction for a potential St. Louis YPG chapter.



To learn more about USGIF’s YPG, visit usgif.org/community/YPG.

“The students, faculty, and administration at IUP are extremely excited about USGIF’s accreditation.”

—JOHN BENHART, JR., INDIANA UNIVERSITY OF PENNSYLVANIA



Indiana University of Pennsylvania Earns USGIF Accreditation

USGIF added Indiana University of Pennsylvania (IUP) to its growing Collegiate Accreditation Program, bringing the total of USGIF-accredited colleges and universities to 17.

IUP offers both undergraduate and graduate GEOINT Certificates as part of the university’s department of geography and regional planning. The department has a long history of geography education with strong programs in cartography and geographic information science.

“The students, faculty, and administration at IUP are extremely excited about USGIF’s accreditation,” said John Benhart, Jr., Chair of IUP’s Department of Geography & Regional Planning and Director of Geospatial Intelligence Certificate Programs. “USGIF accreditation is an acknowledgment of the quality, rigor, and applicability of the department’s geospatial curriculum, and will provide students vastly increased opportunities for internships, professional development, and employment in the fast-growing geospatial intelligence sector.”

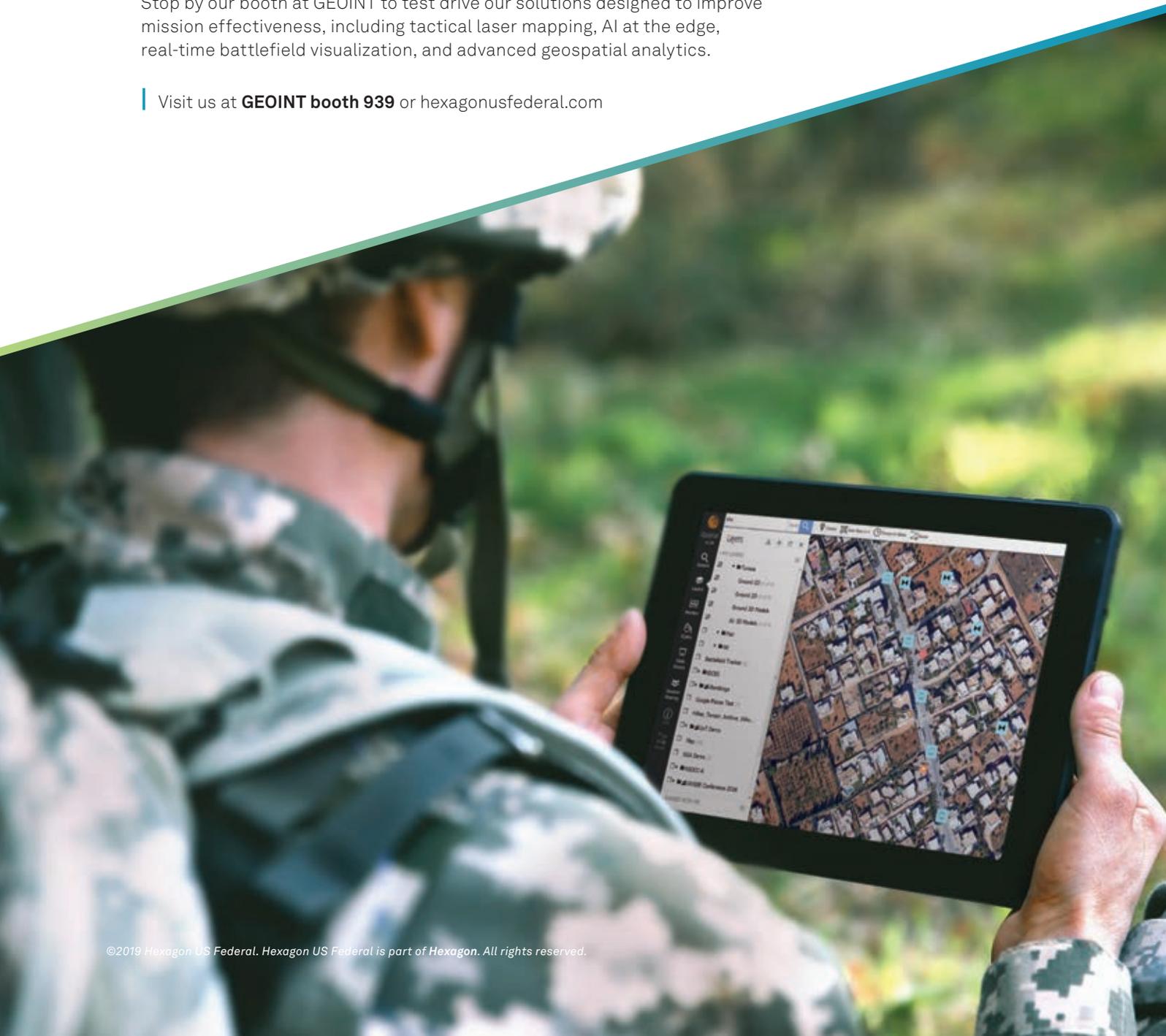


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POOL

**U.S. national security interests
in the Arctic heighten as
ice melt transitions the region
from a state of isolation to
one of increasing access.**

BY KRISTIN QUINN

- ▶ **THE FUTURE
OF DIGITAL
ELEVATION
MODELS**
- ▶ **GUARDING THE
ARCTIC COASTS**
- ▶ **EYES ON THE ICE**

ar GEOINT

 **UNTIL RECENTLY**, the world knew more about the terrain of the moon and Mars than it did about Earth's polar regions. But today, thanks to groundbreaking collaboration among geospatial experts across United States government, industry, and academia, the Arctic is now one of the best-mapped places in the world. >>

According to nearly all scientific accounts, the Arctic is also one of the fastest naturally changing places on Earth and is experiencing global warming at extreme rates. In May 2013, the White House published the country's first National Strategy for the Arctic Region, followed in November of that year by the Department of Defense's (DoD) release of its Arctic Strategy. Both documents acknowledge heightened U.S. national security interests in the Arctic as ice melt causes it to transition from a state of isolation to one of increasing access.

"The [DoD strategy] recognizes the role that the Arctic region will play in shaping the global security environment in the 21st century," then Secretary of Defense Chuck Hagel wrote in the foreword. "As we monitor how changes in the Arctic influence geopolitical landscapes, we will balance our Arctic investments against the Department's responsibilities and objectives around the world, while collaborating domestically and internationally to help develop effective solutions."

The Arctic gained even more national attention in 2015, when the U.S. took the helm of the Arctic Council, an inter-governmental forum among eight stakeholder nations that rotate chairmanship every two years. In a related Executive Order titled "Enhancing Coordination of National Efforts in the Arctic," the White House listed U.S. interests in the region as: "national defense; sovereign rights and responsibilities; maritime safety; energy and economic benefits; environmental stewardship; promotion of science and research; and preservation of the rights, freedoms, and uses of the sea as reflected in international law."

In September 2015, in coincidence with President Obama's tour of the Arctic, the National Geospatial-Intelligence Agency (NGA) released its unclassified Arctic website. That same day, the President announced the agency's ambitious public-private partnership, formed to develop the first public, high-resolution, satellite-based digital elevation model (DEM) of Alaska in 2016, and of the entire Arctic by 2017.

"The public website sat there for a year with all of these great products, but the DEM piece was missing," said Brian Bates, a data scientist with NGA's Office of Strategic Operations. The resulting project, funded by the National Science

"As we monitor how changes in the Arctic influence geopolitical landscapes, we will balance our Arctic investments against the Department's responsibilities and objectives around the world, while collaborating domestically and internationally to help develop effective solutions."

—FORMER SECRETARY OF DEFENSE CHUCK HAGEL

Scientists are using Arctic DEM data of the Lena Delta at the end of a remote river in Siberia to study river systems that are otherwise inaccessible.

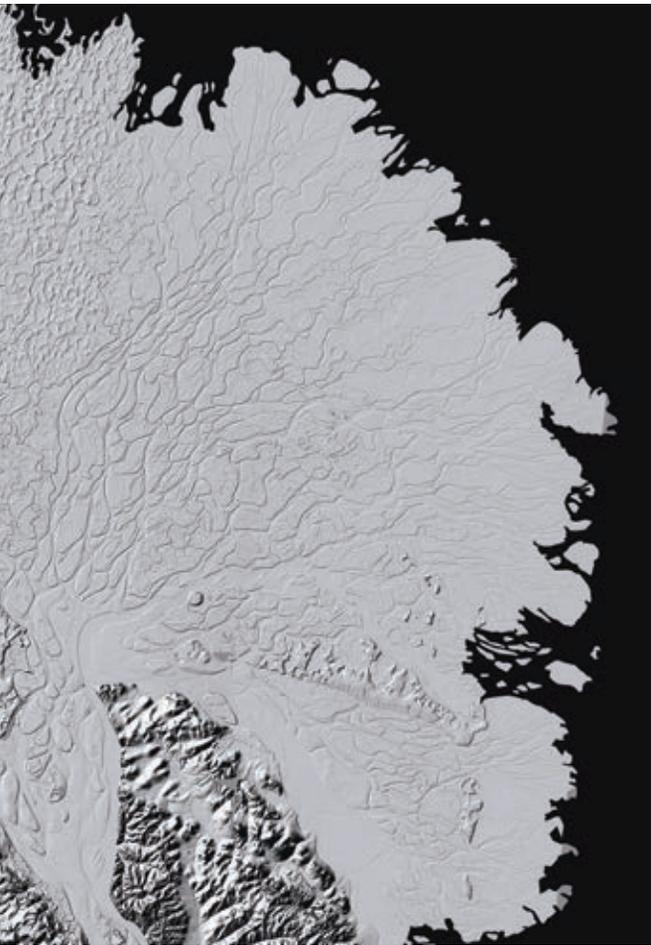


IMAGE COURTESY OF NGA

Foundation (NSF) and known as Arctic DEM, exceeded expectations and brought together a powerful coalition to produce an unprecedented geospatial product that no member could have achieved alone.

"[This project] is extremely beneficial to our community that wants to do change studies and attribution," said Dr. Kelly Faulkner, director of NSF's Office of Polar Programs, of the decision to fund Arctic DEM. "We could see the scientific benefit in addition to the operational benefit."

SPARKING INNOVATION

The common standard for global DEMs are those generated from NASA's Space Radar Topography Mission (SRTM) in 2000. The 30-meter dataset was made public in 2015, but no information was collected north or south of 60 degrees, i.e., Earth's poles.

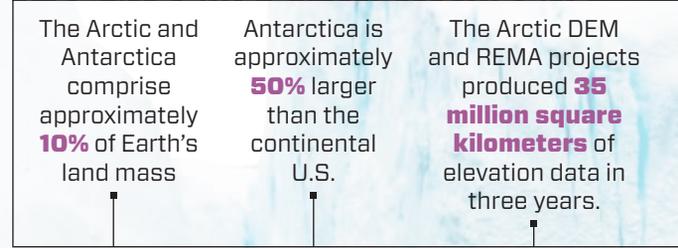
"Prior to 2010 and our partnership with the National Science Foundation, NGA did not have a lot of unclassified satellite imagery requirements in the polar regions, but in that same year, through our commercial partnership with DigitalGlobe, NGA's capacity to collect large amounts of unclassified satellite data over these areas of the Earth had increased dramatically," Bates said.

NGA began collecting stereo imagery from polar orbits in 2010 through its commercial imagery program, according to Bates. In 2015, in accordance with the President's Executive Order and with plans for Arctic DEM in the early stages, the agency redoubled its efforts, aiming to collect as many stereo pairs of Arctic and Antarctic imagery as possible.

"Our colleagues [at Ohio State] came up with an algorithm that could take stereo images and create the z-axis mapping and get DEMs produced out of electro-optical satellite images at the unclassified level," Bates said.

But at the 2015 release of NGA's public Arctic website, this algorithm was still immature.

POLAR DEMS BY THE NUMBERS



“We went through months of working closely with the scientists, making corrections, and holding test runs before we thought we could produce a product we would all be proud to put our names on,” Bates said.

Once the algorithm was ready for prime time, the team needed an unclassified, high-performance computer in order to apply it at scale. Paul Morin, director of the Polar Geospatial Center at the University of Minnesota, which served as the lead organization on the Arctic DEM project, contacted the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign. The center’s Blue Waters supercomputer is one of the world’s fastest and largest computers, according to Bill Kramer, senior associate director of the Blue Waters Project Office.

The Blue Waters office only takes on partners with substantial missions that would be nearly impossible to achieve without the use of the supercomputer.

“By concentrating the computing and analysis features of Blue Waters plus applying our special support staff we make these projects productive and decrease their time to solution,” Kramer said. “We’re not wide breadth with thousands of people using Blue Waters. It’s the people who have a frontier scientific challenging in front of them, and in this case the DEM work far exceeded those expectations.”

Blue Waters’ vast computing, data storage, data movement, and wide area networking capabilities enabled the Arctic DEM team to deliver its first data release ahead of schedule, and to eventually go on to produce the Reference Elevation Model of Antarctica (REMA), a similar project for Earth’s southern pole.

Once the DEMs were generated using Blue Waters, the next step was to make the massive data trove publicly available. Esri’s ArcGIS Image Server is designed to manage extensive volumes of imagery and to process the data on the fly, according to Peter Becker, the company’s senior product manager for imagery.

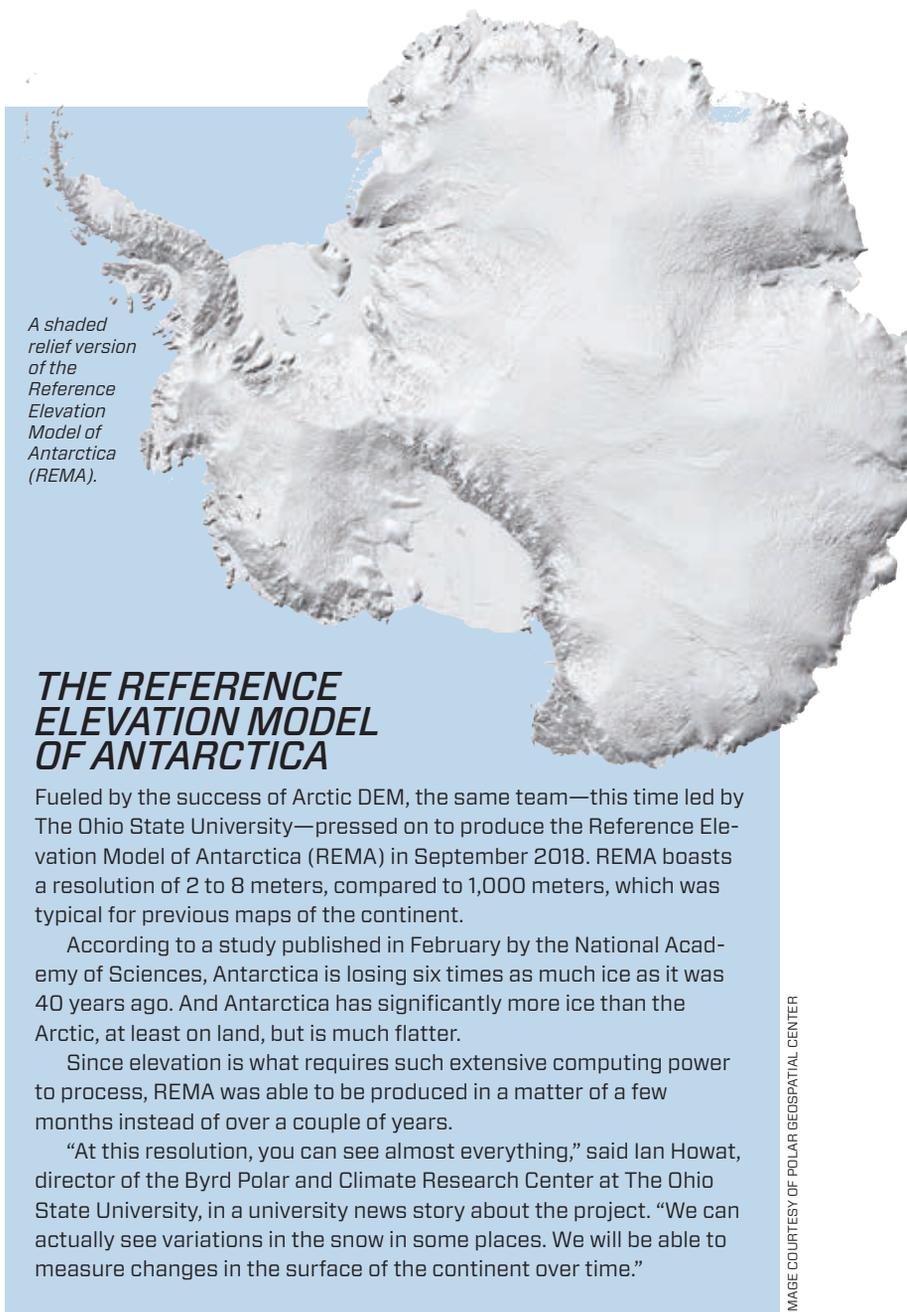
“On the fly means the data is processed as you access it instead of pre-processing,” Becker said, adding that this means users can actually take measurements of the data and study change rather than simply panning and zooming across cached web files.

“Users can say they want to see the difference between two different dates,” Becker continued. “The server will find those dates, subtract between one and the other, and send that difference back to the user.”

Today, following its seventh data release in September 2018 at 2-meter resolution, visitors to the Arctic DEM website can draw a line to designate a desired area of study and view the DEMs covering that area—in some cases as many as 40 to 60. Users can calculate the volumetric loss of elevation

The creation of Arctic DEM and REMA required more than **1.5 billion core hours** of compute time—the equivalent of running the fastest desktop computer money can buy for **50,000** years.

Arctic DEM and REMA include **400 terabytes** of terrain data and nearly **200,000** individual DEMs.



A shaded relief version of the Reference Elevation Model of Antarctica (REMA).

THE REFERENCE ELEVATION MODEL OF ANTARCTICA

Fueled by the success of Arctic DEM, the same team—this time led by The Ohio State University—pressed on to produce the Reference Elevation Model of Antarctica (REMA) in September 2018. REMA boasts a resolution of 2 to 8 meters, compared to 1,000 meters, which was typical for previous maps of the continent.

According to a study published in February by the National Academy of Sciences, Antarctica is losing six times as much ice as it was 40 years ago. And Antarctica has significantly more ice than the Arctic, at least on land, but is much flatter.

Since elevation is what requires such extensive computing power to process, REMA was able to be produced in a matter of a few months instead of over a couple of years.

“At this resolution, you can see almost everything,” said Ian Howat, director of the Byrd Polar and Climate Research Center at The Ohio State University, in a university news story about the project. “We can actually see variations in the snow in some places. We will be able to measure changes in the surface of the continent over time.”

(often ice) or conduct time series plotting with results that are accurate within a couple of meters.

As a result, environmentalists, policymakers, and national security leaders alike are able to observe quickly and in detail information related to changes in navigation routes, deforestation, glacial retreat, coastal erosion, the construction of new roads and buildings, and much more. The information has been a treasure trove for scientific research and is also highly useful for planning operations in the north without the need for expensive, risky, or near-impossible reconnaissance flights.

“This is a component of Arctic situational awareness,” Morin said. “We’re talking about denied airspace, in a form that it’s not denied by an air force or government, but simply because of geography.”

As the U.S., other Arctic nations, and interested observers work to create a global framework for the modernization and expansion of commercial and government activities in the Arctic, the ability to quickly and accurately monitor change will become increasingly useful.

A POWERFUL PRODUCTION CHAIN

The National Science Foundation (NSF) provides funding for high-risk, high-reward science, including the Arctic Digital Elevation Model (DEM) and the Reference Elevation Model of Antarctica (REMA) as well as the Ohio State algorithms and University of Illinois supercomputer that made both models possible.



The University of Minnesota's Polar Geospatial Center (PGC) requested and stored imagery from NGA and served as the lead organization for the Arctic DEM project.



elevation models. Ohio State was the lead organization for the REMA project.

The University of Illinois at Urbana-Champaign's Blue Waters supercomputer is one of the largest in the world and provided the computing power necessary to efficiently convert vast quantities of stereo electro-optical images into 3D DEMs.



The National Geospatial-Intelligence Agency (NGA) provided commercial imagery for Arctic DEM and REMA through its contract with Maxar's DigitalGlobe in addition to subject matter expertise in DEM production.



The Ohio State University Byrd Polar and Climate Research Center developed the open-source Surface Extraction from TIN-based Searchspace Minimization (SETSM) algorithm that makes it possible to convert commercial, electro-optical imagery to digital

Esri provides the image servers to host and process the DEMs for both projects on the fly.



"We're talking about elevation as a standard derived product from remote sensing at this point—just something that's produced as a matter of course," Morin said. "Before, people were doing change detection, but from pictures. That's very different than change detection from surfaces."

Faulkner emphasized NSF's long history with mapping agencies such as the U.S. Geological Survey (USGS) that have a vested interest in mapping the Arctic. The Arctic Spatial

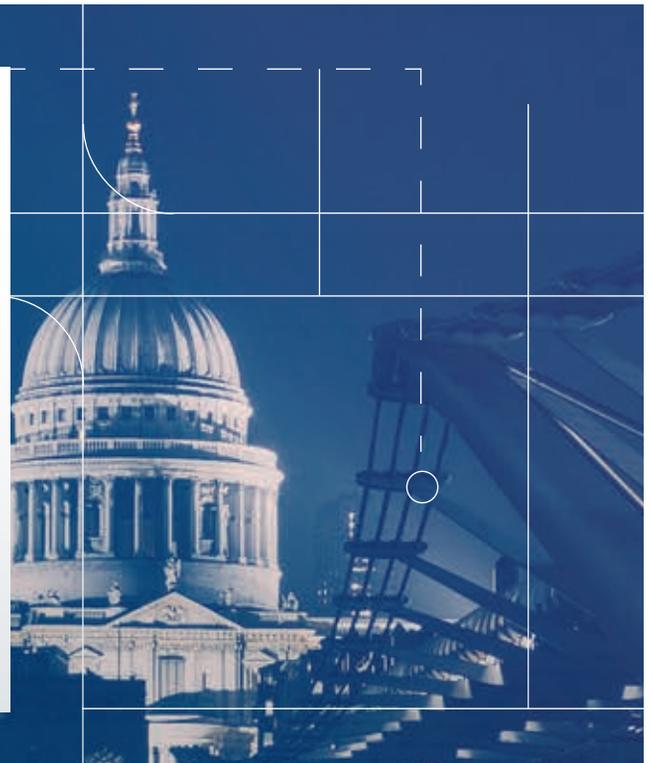
Data Infrastructure group, born under the Atlantic Council and led by USGS, takes a more GIS-based approach to understanding the region and unifies the mapping agencies of all Arctic nations for data sharing.

"USGS has very strong standards for mapping and there was some skepticism initially," Faulkner said in reference to Arctic DEM. "But as they began to see the products coming out they evolved their thinking. I think we sparked the innovation and others are starting to pick up on it."



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A MULTI-DISCIPLINARY FEAT

The interdisciplinary, highly collaborative Arctic DEM project created an entirely new way of developing accurate surface maps—one that likely couldn't be achieved by any other country, said Kramer, pointing to all of the physical and intellectual resources that came together to make this possible.

Faulkner hailed the collaboration across government, industry, and academia as "extraordinary" and added, "I can't tell you how beautiful this is if you're a scientist."

Morin noted the significance of taking a scientific approach to the daunting task.

"What we did was revolutionary—and when we did it there wasn't a spec written," Morin said. "We didn't know what the accuracy, repeat, or precision would be. That was all written after it was produced. It wasn't the government way, but the scientific way. In science, we write the paper after the dataset is produced. In government, it is the other way around—the government writes the [RFP] and then vendors have to meet that."

Bates said by partnering with civil federal agencies and universities, NGA was able to achieve much more than its individual budget and capabilities would have allowed.

Now, the polar science and geospatial communities are rallying around how to analyze the DEM.

"Even here where we built this stuff we have a hard time dealing with how to analyze this much," Morin said. "What do you do with 400 terabytes of data? And that number is never going to get any smaller. ... We've already burned piles of computing time producing this, now we need more time to figure out what's in it."

NGA is already experiencing a steady stream of requests for unclassified 2-meter data of Alaska, Greenland, and Russia, according to Chuck Crittenden, an applied scientist

with the agency. In an effort to perform automated quality assurance work on Arctic DEM data and expand upon those efforts, NGA awarded a five-year, \$15 million contract to GeoNorth Information Systems (GNIS) in August 2018.

Anchorage-based GNIS, in partnership with Lockheed Martin and the University of Alaska Fairbanks, will provide NGA with access to scalable geospatial data processing tools to produce specified foundation products and services.

"NGA has extensive capabilities and very refined and detailed data products," said Jonathan Heinsius, general manager and director of geospatial programs at GNIS. "They are very interested in having data products and services that are readily shareable and open for a place like the Arctic, which is very much about international collaboration."

Part of this effort will include scouring Arctic DEM to automatically correct for any data artifacts, according to Crittenden.

"There's a lot of land to go through," Crittenden said. "For us to do that in our standard production would take a long time."

The innovative Arctic DEM project has shown the value and potential of time-dependent terrain, and many geospatial experts are now interested in applying the method for other areas of the globe.

Crittenden added he would like to see a process similar to Arctic DEM used for coastal areas around the world.

"In the event of a disaster or emergency we would have unclassified data we could share immediately to help first responders," he said.

Morin concluded that Arctic DEM has ushered in a "golden age of topography," and said, "Between this and LiDAR we can know the structure of the Earth's surface like we've never known before and we can watch it change."

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AS THE PHYSICAL AND GEOPOLITICAL landscape in the Arctic continues to evolve, the U.S. Coast Guard is going to be present in the region more often and in increasing numbers, according to two Coast Guard analysts working at the National Geospatial-Intelligence Agency: Jason Tucker, a civilian, and IS1 Rob Wright, who is active duty.

“GEOINT is of utmost importance to the Arctic,” Wright said.

Tucker and Wright both said they are experiencing significantly more requests for Arctic-related work compared with four or five years ago. They provide the Coast Guard’s Intelligence Coordination Center with visual representations of changing ice coverage, increasing vessel activity, regional infrastructure, and predictions such as the potential for mineral consumption or anticipated ice melt.

In addition to illustrating polar ice transformation, the analysts are also able to reveal navigable waters and how vessels transit these waters at times they haven’t been able to in the past, according to Tucker.

Doing so helps the Coast Guard gauge its preparedness for more frequent search-and-rescue missions in the Arctic.

“The Crystal Serenity cruise ship went through in 2016 with thousands of people on it and there’s really not any search-and-rescue infrastructure up there,” Wright said. “What if the ship had hit a rock? We’re showing there’s a lot more people in the Arctic, a lot more vessel activity.”

Recently, the duo’s analysis helped inform Congress’ decision to fund six Polar Security Cutters to replace the Coast Guard’s two legacy ships. At press time in April, the service was said to be close to awarding a contract for the first icebreaker.

Wright and Tucker created a graphic that visualized Arctic maritime domain awareness, including SAR agreements and available infrastructure such as airfields, airports, and port areas.

“[Decision-makers] could see all at once, this is what the operating environment looks like currently, this is what we think the operating environment is going to look like in the

“The [cubesat sensors] will be able to detect the [EPIRB] stress beacon, geo-locate it, and send that information to the MC3 ground station.”

—HOLLY WENDLIN,
U.S. COAST GUARD
RDT&E PROGRAM



IMAGE COURTESY OF DEPARTMENT OF HOMELAND SECURITY

A digital rendering of a cubesat that will be part of the Coast Guard’s Polar Scout project.

next 20 to 50 years, and take that environment into account to realize there is a need for a new Polar Security Cutter,” Wright said.

Looking ahead, Wright and Tucker predict the demand for Arctic GEOINT products will continue to grow as new cutter capabilities enable the Coast Guard to have a stronger presence in the far north.

CUBESATS FOR SEARCH & RESCUE

The Coast Guard Research, Development, Test, and Evaluation (RDT&E) Program is testing two cubesats with the Department of Homeland Security (DHS) Science & Technology Directorate to evaluate the use of space-based sensors in support of Arctic search-and-rescue missions.

In December two cubesats, dubbed Yukon and Kodiak, were launched into low-Earth polar orbit on a rideshare mission from Vandenberg Air Force Base in California. The Polar Scout project will be used to inform satellite technology recommendations for many potential applications within the Coast Guard and across DHS.

In addition to the cubesats, the program includes two Mobile CubeSat Command and Control (MC3) ground stations, one at the Coast Guard Academy in New London, Conn., and one at University of Alaska Fairbanks. The team will use a civilian icebreaker to take out Emergency Position Indicating Radio Beacons (EPIRBs) for testing this summer.

“The [cubesat sensors] will be able to detect the [EPIRB] stress beacon, geo-locate it, and send that information to the MC3 ground station,” said Holly Wendlin, C4ISR Domain Lead for RDT&E.

Wendlin said the Polar Scout team aims to conclude its final report by the end of the year.

The U.S. Coast Guard Cutter Healy carries around 100 crew members and 30 scientists to deploy sensors and semi-autonomous submarines to study how environmental factors affect the water below the ice surface for the Office of Naval Research.



PHOTO BY NYXOLYNO CANGEMI/U.S. COAST GUARD

IMAGE COURTESY OF NASA



ICESat-2 will use six laser beams to measure the height of ice, as illustrated in this not-to-scale artist's rendering.

THE LATEST GENERATION of remote sensing satellite technology offers more ways than ever for humans to learn about the Earth's changing poles.

NASA'S NEWEST ICESAT

In September 2018, NASA launched its ICESat-2 photon-counting LiDAR satellite to characterize Earth's polar ice sheets and sea ice.

ICESat-2's laser pulses 10,000 times per second, sending light to the ground, collecting the returning photon in its telescope, and recording the photon travel time. Because the speed of light is constant, travel time can be converted to distance traveled. But doing so requires precise knowledge of the satellite's location using GPS and star trackers.

According to Tom Wagner, NASA's ICESat-2 program scientist, the original ICESat, launched in 2003 and de-orbited in 2010, had 170 meters between footprints (spots illuminated), but ICESat-2 has only 70 centimeters in between. Wagner used a football field analogy to quantify the advance.

"The original ICESat put one footprint in each end zone, and ICESat-2 gives us a footprint on every yard line," he said.

To "bridge the gap" between the two ICESats, NASA's IceBridge airborne survey mission mapped each polar region once a year, flying over the Arctic from March to May and over Antarctica from October to November. The new satellite mission will decrease the need for costly, risky, and technologically limited flights, according to Wagner. And so far, ICESat-2 is exceeding expectations.

"We're getting a far greater signal from the ground than expected, and with the photon-counting mission, we're going to be able to see through the clouds in most areas," Wagner said. "ICESat-2, we're hoping, is going to give us a new look at what goes on, especially during the warmest periods."

This will lead to new insights, considering planes aren't able to fly below cloud cover, and clouds are more frequent during warmer seasons. The advanced ICESat-2 technique also appears to be able to see through water, mapping heights in streams or reservoirs and in some cases seeing depths down to 30 meters.

"A lot of people will be interested in this data," Wagner said, adding that groups such as NOAA and the Army Corps of Engineers have already taken notice.

The first ICESat-2 data release is expected to take place in the first half of 2019.

FINLAND'S ICEYE STARTUP

One of the first use cases Finland-based ICEYE explored for its commercial synthetic aperture radar (SAR) satellite constellation was monitoring Arctic conditions in real time, according to company chief scientific officer and co-founder Pekka Laurila.



IMAGE COURTESY OF ICEYE

This ICEYE-X2 radar satellite image from Prince William Sound in Alaska shows ice flowing to the sea.

“A key thing in the Arctic is literally half of the year it’s dark and a majority of the time it’s cloudy,” Laurila said, highlighting why Arctic surveillance is an ideal application for SAR technology, which can “see” through clouds and darkness.

Now that ICEYE has successfully demonstrated the size, cost, and operational formats of its technology with its ICEYE-X1 and ICEYE-X2 satellites, both launched in 2018, the company has set the ambitious goal to multiply its fleet and create “the world’s largest constellation of SAR satellites,” according to Laurila.

Currently, many operations in the Arctic, such as those underway by the oil and gas industry, require 24/7 aircraft monitoring to track sea ice and ensure other safety measures—but flying the aircraft itself can be dangerous.

As the company’s constellation expands and its revisit rates increase, Laurila predicts ICEYE’s technology can

begin to replace aircraft-level monitoring within a couple of years.

“Getting the revisit rates to increase to more than once per day starts to bring the majority of these operational use cases into the commercially interesting range,” Laurila said, adding the company aims to “very quickly get to a point where we are talking about mere hours between imaging opportunities.”

CANADA’S GRAY JAY PATHFINDER PROJECT

In February, Canada’s Department of National Defence (DND) awarded a C\$15 million contract to Space Flight Laboratory (SFL) at the University of Toronto Institute for Aerospace Studies to develop multipurpose microsattellites in support of Arctic surveillance.

As ice melts in the Arctic, new routes are being created that could enable encroachment by maritime vessels, said Dr. Robert Zee, director of SFL.

“Maintaining Canadian sovereignty and continental security has become increasingly more challenging in the 21st century,” Zee said.

DND’s “Strong, Secure, Engaged” policy outlines various initiatives aimed at enhancing the Canadian Armed Forces’ ability to operate in the Arctic and adapt to a changed security environment, including the development of new technologies to improve surveillance and control.

Following testing of a prototype, SFL will build two additional microsattellites to create a small formation. The microsat constellation will include multiple sensors—primarily imaging and radio frequency—operating in close formation in low-Earth orbit to allow for quick detection and identification of surface or airborne targets.

According to Zee, the Gray Jay Pathfinder project, named after the unofficial bird of Canada, will track

commercial airliners and vessels in the far north to demonstrate basic hardware and algorithms that if successful could be enhanced for future operational purposes.

“An operational mission would require bigger, better sensors, equipped to detect high-speed, highly maneuverable weapons,” Zee said, adding that increased intercontinental ballistic missile range and cruise missile maneuverability are growing potential threats.

In May 2018, DND expanded the Canadian Air Defence Identification Zone to cover “the entirety of Canada’s Arctic Archipelago and its approaches,” according to a DND spokesperson.

“Countries like Russia and China may be developing defense systems and technology that will challenge those of NORAD,” Zee continued. “Newer technologies are needed to counter those threats and provide sufficient deterrence.” 🌐

“Maintaining Canadian sovereignty and continental security has become increasingly more challenging in the 21st century.”

—DR. ROBERT ZEE, SFL



IMAGE COURTESY OF DND-MDND CANADA

Canada’s Department of National Defence is investing in research and development to produce innovative solutions to surveillance challenges facing the Canadian Armed Forces, particularly in Canada’s North.



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THE WORLD IS BUZZING ABOUT BLOCKCHAIN.

To understand what it actually is, one must start with bitcoin, for which the bubble burst in 2018. Or so suggest the numbers. When the first-ever bitcoin exchange stood up in 2010, online traders valued the controversial coin at just \$0.003—less than a penny. Seven years later, in December 2017, bitcoin escalated when its value reached an all-time high of nearly \$20,000 per coin. Then, suddenly, what went up came crashing down. By January 2018, bitcoin had lost 30 percent of its value, and a year later it was down 80 percent. Millions were made, then lost. Observers wondered: Was cryptocurrency a tidal wave in the global economy, or just a drop in some huckster's bucket?

Although bitcoin's future is ambiguous, so is its past. Established in 2008, its creator is an anonymous party known only by the pseudonym Satoshi Nakamoto, who in August 2008 registered the bitcoin.org domain and two months later published a whitepaper that laid the foundation of the bitcoin universe. Nakamoto outlined and subsequently launched a digital currency consisting of virtual tokens that are "mined" from bitcoin's software by computers that solve complicated mathematical problems in exchange for rewards. Because users can anonymously trade and transact extracted tokens without intermediaries like governments and banks, the system is entirely decentralized.

If this sounds complicated, that's because it is. But complexity isn't what drove cryptocurrencies into a bear market. Instead, it was higher stakes and scrutiny; the more valuable bitcoin became, the more attention it attracted from hackers and regulators, which undermined user confidence.

Whether bitcoin lives or dies, the blockchain concept on which it relies has a promising future. Because with the same basic logic, architecture, and algorithms, one can securely transact information just as easily as one can transact currency—including location information, whose potential coupling with blockchains is inspiring a wave of innovation that promises new benefits for the geospatial intelligence (GEOINT) community.



UNDERSTANDING BLOCKCHAIN THROUGH BITCOIN

Bitcoin relies on an **international community** of devotees who have agreed to run special software on their computers, forming a global network of machines that is bitcoin's infrastructure. When



users transact with bitcoin, they do so using two unique alphanumeric codes. One, called a **private key**, is secret. The other, a **public key**, is exposed. The former is akin to a password and the latter to an account number. To send a payment,

users initiate a transaction from a **digital wallet** and "sign" it with their private key. Along with basic transaction data—how much bitcoin one is sending, for example, and to whom—the private key is encrypted using a dedicated algorithm whose alphanumeric output is known as a signature.



Signatures subsequently are broadcast to the aforementioned network of computers, some of which are tasked with validating transactions. By matching signatures to public keys, the computers can confirm—without ever knowing the sender's identity—that the bitcoin being transacted belongs to the sender and is actually available to send.



For expediency, transactions are verified and recorded in chunks known as blocks, each of which has its own alphanumeric code called a "**hash**" that represents the transactions inside it while also referencing the block before it. In that way, each block connects to the next,



forming a "blockchain." The **blockchain** is considered immutable because a single change to a single block will generate a new hash that no longer aligns with the rest of the chain behind it, causing a cryptographic domino effect that "breaks" the chain.



Furthermore, each computer in the bitcoin network stores its own copy of the blockchain, the result of which is a **distributed**

architecture that builds trust by



consensus. Which is to say: One computer can't change the blockchain unless a majority of other computers on the network agree with it. The pairing of immutability

with consensus **makes fraud and falsification improbable**, if not impossible.

SCHOOL OF BLOCK

To understand how the GEOINT Community might leverage blockchain, one must first understand what it is.

"Blockchain is not bitcoin," said Ali Husain, director of SparkCognition Labs, the research and development group within SparkCognition, an Austin-based AI company that uses blockchain. "There's a widespread misunderstanding that they are one and the same. Blockchain is the technology, and bitcoin is one of its many applications."

In that way, a blockchain is like an operating system. Similar to iOS or Android on a smartphone, blockchain is invisible to users but delivers features and benefits through an infinite number of potential software applications.

Arie Trouw likens blockchain to a QuickBooks register. "It's a series of entries in a ledger," explained Trouw, founder and CEO of XYO, a San Diego-based company on a mission to decentralize location data. "What makes it so special is that each entry is linked to the previous entry with cryptography in such a way that it can't be changed."

Blockchains can be public—anyone, anywhere can join the network—or private: only permissioned parties may join the network. In both cases, the ledger is copied and stored on each machine in the network for the purpose of consensus.

"Blockchains by nature are distributed," said Mark Barber, former head of product enablement at BTL, a Vancouver-based company with its own blockchain platform. "That means instead of doing any storage or compute of information in a single place, it's done in a number of places concurrently. So if one machine that operates the blockchain fails, the blockchain will continue to operate because it has built-in redundancy."

The benefits are numerous—starting with cybersecurity. "There's not one centralized database a bad actor can go into and compromise," Husain explained. "In fact, if something like this happens in a blockchain-based system, it's very apparent that something has been tampered with."

A related benefit is transparency, according to Barber, who once heard someone describe blockchain as taking systems from "what you see is what you get" to "what you see is what I see." "Instead of you seeing your data and me seeing my data, what we see is our data because we're looking at the same computing platform," he said.

Transparency enables truth, and from truth comes trust. "In my mind, blockchain fundamentally is a novel way for computers—and therefore people—to agree," said Robert Keenan, product lead at ConsenSys Solutions, the consulting practice of New York-based blockchain company ConsenSys. "Now we can have a global system where computers trust each other, and where people can trust the data that comes from those computers. That unlocks opportunities for individual agency where you no longer need to rely on third parties for certain tasks."

CATALYZING COLLABORATION

In the GEOINT Community, blockchain can help solve real challenges. For instance, that of open governance. "Our clients' biggest need is to enable a kind of data sharing that doesn't exist today," said Matthew Nelson, a blockchain consultant at IBM. "You have a business network of different participants ... but you don't necessarily have a singular or consolidated way to enable a business process across those members without using a technology like blockchain."

Private blockchains, in particular, give entities operating on disparate systems—the Intelligence Community, for example—a shared mechanism through which to achieve a common operating picture; when they contribute to the blockchain, their contribution is broadcast across the entire network and recorded permanently on a shared ledger.

"If you have multiple participants on the blockchain network, and one of those participants needs to be removed from the process, you still have a record of what that participant has been doing and provenance of all their actions," Nelson said.

Although the agency told *trajectory* it's not yet prepared to discuss blockchain, the National Geospatial-Intelligence Agency (NGA) is an ideal candidate for blockchain-based data sharing, according to Nelson. "NGA has been struggling with the provenance of data ... because its business network is so broad," he explained. "If you use a blockchain to consolidate those network members around a single source of truth, you'll see that brokered data is easier to manage

because you can track it from the time you receive it all the way through to the time the end user gets it, which allows you to maintain its integrity.”

The nonprofit Radiant Earth Foundation, which aggregates open Earth imagery for use by global aid organizations, recently executed a proof-of-concept in precisely this domain. After a disaster, NGOs often need commercial satellite imagery to inform response and recovery efforts. Although it’s useful, such imagery is expensive. What many don’t realize, however, is that the licenses NGOs obtain from commercial imagery providers often allow them to share data with others in their mission space. By moving licensing governance to a blockchain, Radiant Earth Foundation theorized, it could increase access to commercial imagery and improve humanitarian outcomes.

“For instance, the Bill & Melinda Gates Foundation has over 10 terabytes of commercially licensed data, most of it from DigitalGlobe and most of it of the continent of Africa,” said Radiant Earth Foundation founder and CEO Anne Hale Miglarese. “When they negotiated the license, they negotiated that it could be shared with other nonprofit people and organizations working in the global development community. But because that data sits on a drive in their GIS expert’s office, nobody knows they have it. The main driver of our project was to get all that imagery from the philanthropic organizations that have it and make it more broadly available.”

Imagine, for example, relief workers engaged in a humanitarian project in Ghana. When they log onto the Radiant Earth Foundation’s platform, they see DigitalGlobe imagery from the Gates Foundation’s repository, which they can access. Behind the scenes, the blockchain confirms identities and creates records.

“It assures commercial providers that we are taking care and respect their license, but it also shows them that their data is being used,” continued Miglarese, who concluded the pilot project in September. “Going from proof-of-concept to full-scale implementation this early in the landscape feels too risky to me, but I do believe there is real possibility to increase the spread of data and people sharing it.”

Echoed Keenan of ConsenSys, Radiant’s partner on the project, “It’s a nascent technology, but what we’re building is a longer-term vision for improving interoperability across the entire ecosystem.”

TOKENS OF APPRECIATION

Radiant Earth Foundation isn’t the only organization that has noticed the potential of underutilized GEOINT data. So has Soar, an Australian startup that wants to build what it calls “the world’s first fully decentralized global super-map.”

Built on blockchain technology, Soar’s map resembles Google Maps in spirit. Instead of static, low-resolution satellite imagery, however, it features dynamic space- and airborne-based imagery. Continuously updated, the imagery spans resolutions and spectrums, encompassing natural and false color, multispectral, thermal, and even LiDAR. The map—the beta version of which launched in October—is searchable at the pixel level; is “multi-scale,” meaning users can seamlessly zoom from a faraway satellite view to a close-up drone view; and contains image histories so users can witness pixel-level changes over time.

“Our goal is to build a massive repository of every single type of remotely sensed data,” explained Soar founder and CEO Amir Farhand.

To build the dynamic global map it envisions, Soar needs imagery, 80 percent of which it says is underutilized. In particular, it needs drone imagery, the vast majority of which is captured by individual operators who take images they never share.

“You’ve got data providers all over the world, including everyday people with drones. What happens to their data?” Farhand asked. “In most cases, it’s siloed and never sees the light of day. What we encourage people to do is put that data onto Soar.”

And so emerges another promising outgrowth of the “geoblockchain:” incentivized mapping.

Although the imagery itself is stored in the cloud, Soar stores drone imagery metadata—including location, altitude, time, and equipment used—on a public blockchain, where a proprietary algorithm validates the authenticity of the footage to ensure its integrity for users who might include anyone from cable news producers to intelligence analysts. Meanwhile, it also uses the blockchain

“Blockchain is not bitcoin. There’s a widespread misunderstanding that they are one and the same. Blockchain is the technology, and bitcoin is one of its many applications.”

—ALI HUSAIN, SPARKCOGNITION LABS

to support its own micro-economy, the centerpiece of which is a bitcoin-like token called the SkyMap (SKYM). Although it’s not a currency, SKYM functions like one within the Soar platform: When their imagery is validated and uploaded to Soar, drone operators are automatically compensated with tokens they can use to purchase or sponsor other Soar content. Those who wish to sponsor content can do so through Soar’s SkyBounty system, wherein users can incentivize fellow operators to gather and share imagery of particular locations.

“If we were going to incentivize [drone operators] via [government-backed] currency, it would cost us millions of dollars we don’t have,” explained Farhand, who said SKYM gives Soar a means to scale quickly, affordably, and securely.

The potential of incentives is further evident in another blockchain-based platform, New York-based StreetCred, whose goal is to create a global dataset of “points of interest” (POI) data for use by small businesses and software developers. Such data—the hours of a store, whether a restaurant is wheelchair-accessible, the location of a popular swimming hole—often is inaccessible and incomplete, according to StreetCred CEO Randy Meech. At one end of the POI ecosystem, he said, are solutions like Google Maps, whose data generally is available only to developers who can afford a hefty fee for the Google Places API. At the other end are organizations like OpenStreetMap, whose crowdsourced datasets are open source, but often unfinished. While a fitness company might want to know the locations of all parks and gyms in a given city, for example, there’s no guarantee the OpenStreetMap community has mapped them.

To fill the gap between Google Maps and OpenStreetMap, StreetCred is building a blockchain-based POI marketplace through which developers

who need place data in specific geographies or verticals can incentivize citizen mappers to generate it in exchange for digital tokens that can be used within the platform or converted into fiat currency.

Because blockchains are consensus-driven, data can only be added to a map when other users verify it; users who post accurate data receive tokens as a reward and users who post inaccurate data lose them as a penalty. And because blockchains are decentralized, the StreetCred community and the data it generates can live on, even if their creators do not.

“It can’t be shut down. Bitcoin is a good example. Because there’s no central authority to bitcoin, it’s permanent infrastructure. As long as there are people who want to [participate in the system], it exists,” Meech said.

Encompassing everything from doctor’s offices in Manhattan to restaurants in Mumbai, the resulting data could be a catalyst for future GEOINT transformation. “We’ve seen it with open data before: When you make this stuff available, really interesting innovations come about that you couldn’t have even imagined before,” Meech said. “You can see a lot of monetizable use cases for [POI data] today, but we’ve likely seen just the tip of the iceberg.”

PROOF OF LOCATION

Two other companies utilizing crypto-incentives are XYO and FOAM, each of which is focused on proof of location.

“We started thinking about all the use cases people are excited about when it comes to blockchain, and we realized: All of them involved the real world, but so far we’ve really only seen blockchain applications that work on the internet,” said FOAM co-founder and CEO Ryan King, who recognized that in order to interact with the real world, blockchains need

mechanisms to record and verify location. “So, we started building tools ... to bring geodata to the blockchain.”

FOAM’s system relies on radio beacons that network participants operate in their homes or businesses in exchange for FOAM tokens. When a beacon is installed, it locates three other beacons in its vicinity and forms a “zone” with them. Beacons have atomic clocks inside that synchronize with each other when a zone is formed, at which point customers can enter the zone and request a “presence claim,” which is essentially a receipt of their location. The zone’s beacons use triangulated timing signals to calculate the customer’s position, which is subsequently verified and recorded on a public blockchain. Finally, the customer receives a verified presence claim that could serve them in a variety of diverse applications.

A rideshare customer, for instance, might use proof of location to ensure the car she ordered is the one in front of her and not the one down the street. A plumber, meanwhile, might use it to prove to his employer that he actually showed up to a customer’s house. Disaster victims could use it to prove they live in a disaster zone in exchange for relief. And reporters could use it to combat fake news by proving they actually witnessed an event they’re covering.

Although the system is similar to GPS, it’s different by design. “With GPS you don’t have proof of location because it’s a one-directional system. You can receive your location but you can’t talk back to the system, so there is no history of your location that allows you to prove you were in a certain place at a certain time,” explains King, who said other flaws with GPS include: it’s easily spoofed; it doesn’t work well indoors, underground, or in urban environments; and it’s a single point of failure, which leaves it vulnerable to attack. “Because there’s no way to generate a receipt with GPS, you can easily change your GPS data and share it with someone else. That’s not going to cut it in a decentralized economy.”

XYO takes a different approach. Its solution, the XYO Network, leverages small, low-cost electronic devices called “Sentinels.” Sentinels can be carried on one’s person or attached to virtually any object one wants to track. As they move through the world, they communicate with each other while cryptographically collecting and storing GPS coordinates. One Sentinel “shakes hands” with another and makes a location-based record of the interaction on a digital ledger that is later uploaded to a public blockchain. There, anonymized data can be parsed and cross-referenced to answer location-based queries.

The handshake is how the XYO Network achieves the consensus for which blockchains are known. Here’s an example XYO often uses: Imagine someone shipping a birthday gift to a loved one. Because they want to ensure the package arrives safely, they ship it with a Sentinel in the box. When the package arrives, the Sentinel inside the box communicates with a Sentinel located in or near the recipient’s home. The sender can then query the XYO Network to ask if the package arrived and determine that it did. While present-day package tracking tells you what city your package is in on what day, the XYO Network offers street-level detail in real time.

Again, tokens fuel the process: When someone queries the network, they must pay XYO tokens to get an answer. In return, anyone whose Sentinel helps produce the answer receives some of those tokens, thereby incentivizing people and businesses to participate in the network.

“Our goal is to instrument the world with these devices and build a massive network of data that does not require a central owner to be trusted,” said Trouw, who hopes Sentinels eventually will be embedded in everything from smartphones to shipping labels.

BLOCKCHAIN OR BUST

Startups aren’t the only ones who see proof-of-location potential. Traditional GEOINT enterprises also are staking claims, suggesting blockchain might soon reach its tipping point. In November, for example, Boeing announced a joint venture with SparkCognition. Called SkyGrid, it’s creating an aerial operating system that will apply AI and blockchain to air traffic control for drones.

“Blockchain is an integral part of SkyGrid because it allows us to maintain high standards of safety and auditability,” explained SparkCognition’s Husain, who also serves as SkyGrid’s chief software architect. Every drone in the system, he said, will have a unique ID that will be used to identify it

“You’ll see that brokered data is easier to manage because you can track it from the time you receive it all the way through to the time the end user gets it, which allows you to maintain its integrity.”

—MATTHEW NELSON, IBM

in the blockchain, where everything from its flight path to its maintenance history will be recorded. “This data, once written, cannot be tampered with. And in the case of a regulatory authority such as the [Federal Aviation Administration] needing access to flight records, they can be sure of the data integrity.”

IBM is pursuing similar ends of safety and auditability. In 2018, it launched the IBM Food Trust, a blockchain developed in partnership with Walmart and other grocers to create transparency across the global food supply chain.

“They’re tracking the lifecycle of food items from farm to distributor to store to end consumer,” IBM’s Nelson said. “And the reason they’re doing that is, when there’s a foodborne illness outbreak like there was with romaine lettuce in 2018, they don’t want to have to throw out all the lettuce. They want to target the individual farm or distributor [where the outbreak originated] and pull only those items.”

Walmart’s former VP of food safety, who helped develop and test the blockchain, now works for the U.S. Food & Drug Administration, which has expressed interest in a food-safety blockchain of its own. In February, it launched a pilot project to test a blockchain for tracing pharmaceutical supply chains.

Other federal agencies that have dipped their toes in blockchain waters include:

- The U.S. State Department, which launched a pilot project in 2018 to establish a blockchain registry for international workers and their contracts, the goal of which was to prevent forced labor;
- The Centers for Disease Control and Prevention, which in 2018 tested a blockchain-based system for tracking public health issues like the opioid crisis;
- And the Department of Homeland Security, which is exploring how blockchains could help it prevent counterfeiting and forgery, track cross-border oil imports, and trace the origin of other raw material imports.

THE WEAKEST LINK

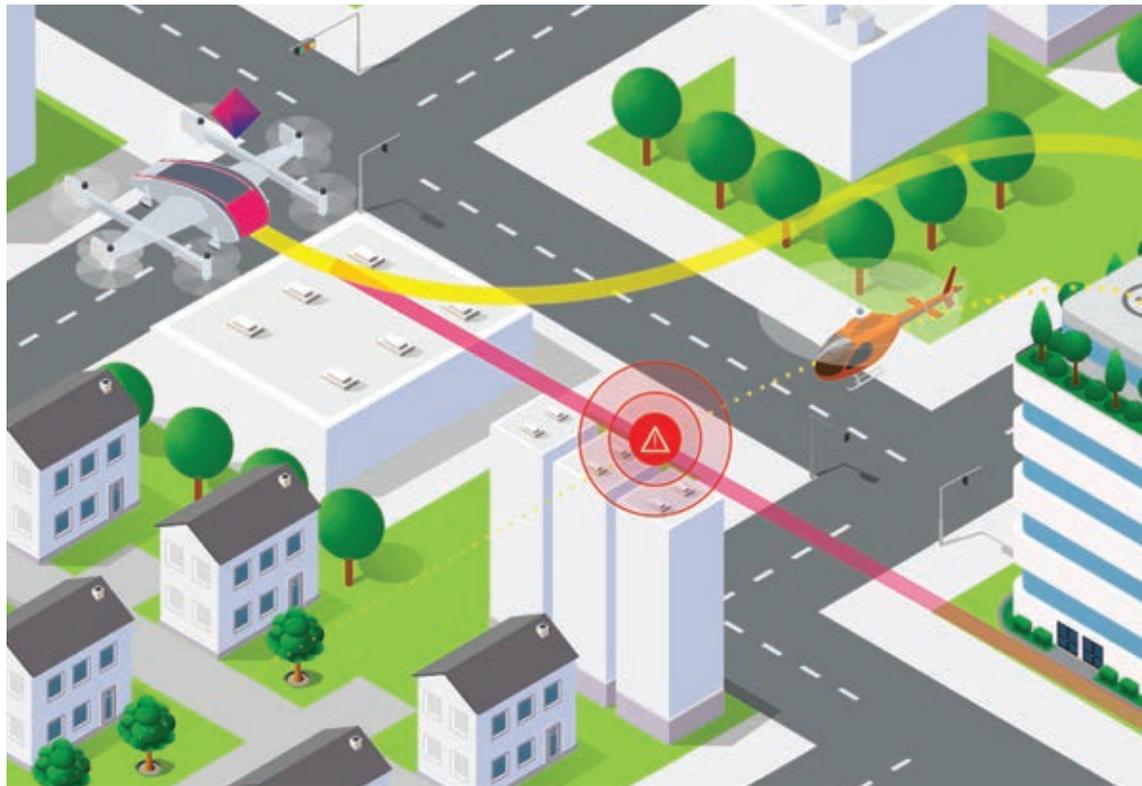
Blockchain presents major opportunities, but also major challenges. And despite its complexity, the challenges have more to do with people than technology.

“Blockchain theoretically is a great concept, and what we can do with it has a lot of benefits to a lot of organizations. What has to happen for us to realize those benefits, though, is a large-scale adoption of it across multiple agencies,” said Kevin Bolger, practice lead for AI and machine learning at Esri, which is helping companies like XYO spatially enable blockchains. “For example, blockchain could benefit the question of sales tax within the U.S. because when we do online sales we have to track where a sale was done and what municipality or state gets credit for that sales tax. We can use blockchain to track that, but in order to do that we have to have mass adoption of blockchain not only across state and local governments, but also among retailers.”

Echoed Nelson, “The problem lies not with building out the technology, but with governance of the network, which requires getting different groups into one room to sit down and decide how they want to do data sharing.”

Indeed, the move from centralized to decentralized business processes is as cultural as it is technological.

“You have big issues and questions as far as where the world of data is going,”

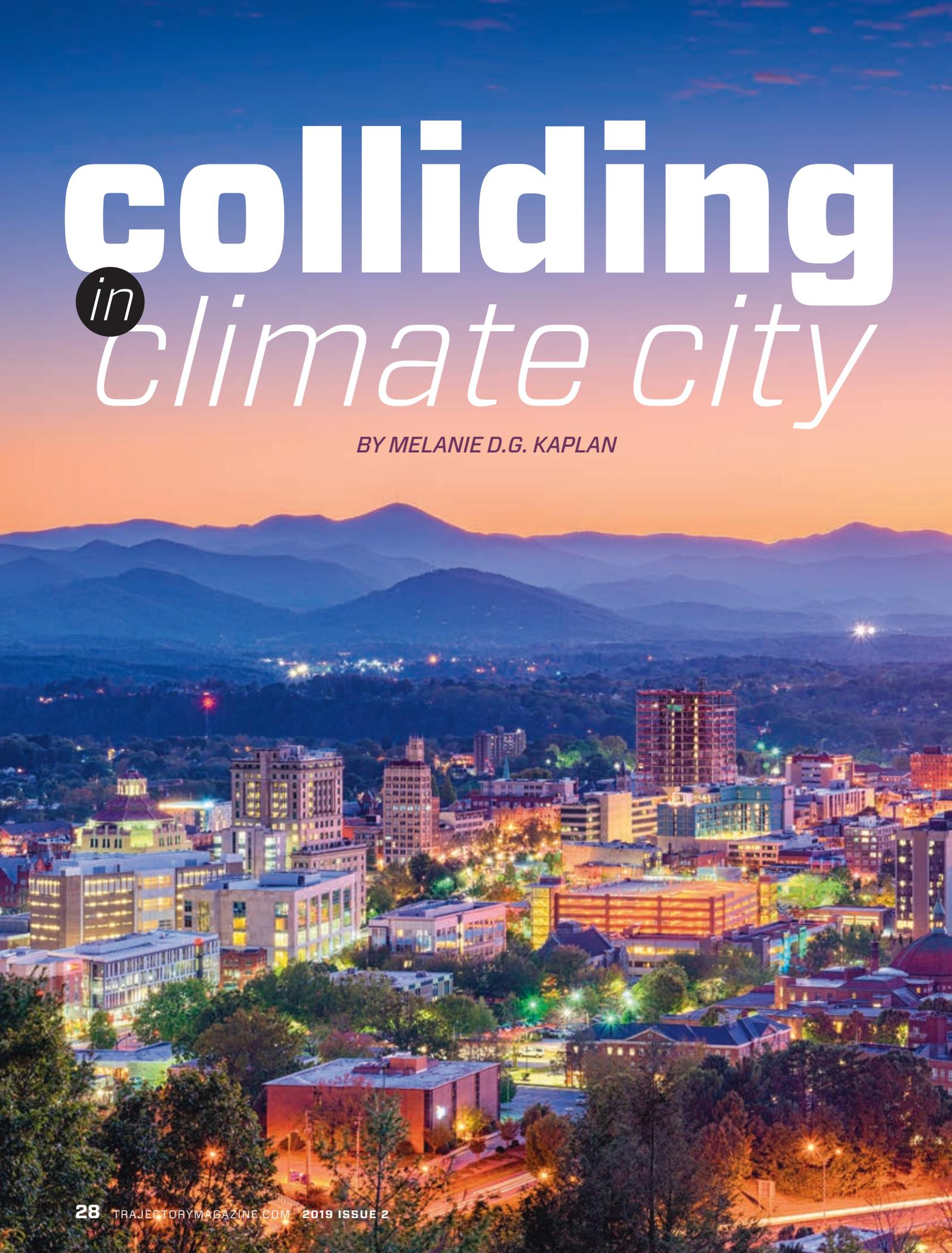


explained Trouw, who said entities must answer a host of legal and regulatory questions before blockchain goes mainstream. “What defines data ownership? How do I use my own data? Can I control it? Those more esoteric questions are very important, because if data is being shared in a public view, it can be used for good and for evil.”

It’s a reputational problem as much as anything else. “[Solutions like StreetCred] need people to believe in the value of cryptocurrency and have a positive perception of it,” Meech said. “Because of the hype, and because there have been some scams, the trustworthiness of the industry in general is a challenge.”

Speaking of hype: You have to cut through it in order to see blockchain’s true potential. “If you think about all the tech products you use right now, how many of them could benefit from being on the blockchain? I’d argue not many,” concluded Farhand, who added blockchain’s limitations—it’s notoriously slow at data processing, for example, and remains too technical for everyday consumers to grasp—might preclude it from ubiquitous use. “But in a siloed fashion—defense applications, mapping applications, insurance, logistics, health care—all of a sudden it becomes very, very palatable and genuinely game-changing.” 🌐

SkyGrid plans to develop a platform that will facilitate the smooth integration of autonomous cargo craft and passenger air vehicles in the global airspace.

An aerial night photograph of a city, likely Asheville, North Carolina, showing a dense urban area with various buildings, some brightly lit, and a prominent mountain range in the background under a twilight sky. The city lights create a warm glow against the cool blue and purple tones of the evening sky.

colliding *in* *climate city*

BY MELANIE D.G. KAPLAN

In Asheville, N.C., an entrepreneurship and innovation center is the new kid on the block, joining the city's powerhouse of government, military, and academic climate experts.

 **AFTER WORLD WAR II**, at the start of the Cold War, the U.S. government decided that its paper weather records, stored in New Orleans, would be better off warehoused in a city with slightly less volatile and wet weather. Asheville, at the southern end of the Blue Ridge Parkway in western North Carolina, not only enjoyed a milder climate with fewer perilous forecasts but was also within a day's drive of the nation's capital, and—unlike Washington, D.C.—was not a Soviet target. Plus, the federal government had recently acquired a building there, one of the largest in the Southeast, which came with a trained workforce. >>



PHOTO BY BRENDAN ALMAND/THE COLLIDER

Jeff Hicks, CEO of NEMAC+Fernleaf, presents in 2018 at 1 Million Cups, a free program designed by the Ewing Marion Kauffman Foundation to educate and inspire entrepreneurs.

Nearly seven decades later, Asheville—a hippie mountain town better known for its Biltmore estate, craft breweries, and popular “Shindig on the Green” summer music gathering—remains home to the world’s largest repository of climatological data.

Downtown Asheville is home to:

- The National Centers for Environmental Information (NCEI) headquarters, which falls under the National Oceanic and Atmospheric Administration (NOAA);
- The U.S. Air Force’s 14th Weather Squadron, which provides climate services to the defense and intelligence communities;
- The North Carolina Institute for Climate Studies (NCICS), a center of excellence that operates the Cooperative Institute for Climate and Satellites—North Carolina; and
- The University of North Carolina Asheville’s National Environmental Modeling and Analysis Center (NEMAC), which worked with NOAA to build the U.S. Climate Resilience Toolkit during the Obama administration.

But perhaps nothing has helped secure Asheville’s “Climate City” nickname as much as an entrepreneurship and innovation center established in 2016 known as “The Collider.”

Founded by local businessman and philanthropist Mack Pearsall, The Collider is a nonprofit organization dedicated to incubating startups that use data to work toward climate change solutions. Located in a sunny, 25,000-square-foot

space across the street from the park that hosts Asheville’s famous drum circle, and just a few blocks from the federal building that houses NCEI, NCICS, and the 14th Squadron, The Collider provides space for co-working, collaboration, meetings, and presentations. Its 65 member companies include climate tech startups (some founded by retired NCEI climate experts), consultancies, nonprofits, and entrepreneurial support businesses.

“I do think there’s something special about what’s being built here that can serve the world by exporting climate change solutions,” said The Collider CEO Josh Dorfman.

Given Asheville’s remarkable concentration of climate scientists and researchers in government, academia, and business, Dorfman said he anticipates The Collider will be at the forefront of creating an industry. “If you have the big brains and the big data, you can do important things in the world.”

In October, The Collider hosted its first climate data hackathon, and in March, it announced its first Climate Tech Challenge—a global search for the best emerging idea in climate tech, with a \$5,000 cash prize. In April, The Collider hosted its second annual climate change conference, with speakers such as author and inventor Bill Nye, NERDette podcast’s Greta Johnsen, and venture capital fund In-Q-Tel’s Tom Gillespie, among others.

This fall, the organization will launch a virtual, mentored incubator program open to climate analytics startups around the world. Among the focus areas: climate-smart

agriculture, resilient infrastructure, and climate data and analytics. The Collider’s goal is to work with more than 60 companies in its first five years.

While activating the science community to engage with the entrepreneurial community has been challenging at times—“The personalities are different,” Dorfman said—The Collider has succeeded in becoming a rich space for networking. It is a place where academics, government scientists, and entrepreneurs who might not typically cross paths can literally collide to share ideas and brainstorm solutions.

For instance, the 14th Weather Squadron—which ingests nearly 3.8 million weather observations each day and supports hundreds of intelligence agencies, combatant commands, and coalition partners—has consulted with NEMAC+FernLeaf, a public-private partnership and The Collider’s anchor tenant, to start modernizing its data capabilities.

“We are in the early stages of transforming the way we deliver geospatial datasets to customers, including the Air Force or Intelligence Community,” said Raymond Kiess, a senior climate scientist with the 14th, who explained that currently, the squadron relies on sorely outdated desktop capabilities. “We reached out to NEMAC+FernLeaf, our partners at The Collider, who have experience in geospatial data, and we asked them how to do it. Our desire is to be able to meet OGC (Open Geospatial Consortium) standards for sharing GIS data over the web.”

The private side of the NEMAC+FernLeaf partnership, FernLeaf Interactive, has a proprietary software dubbed AccelAdapt that uses tax, climate, and socioeconomic data to help local governments assess climate risks, propose



The Collider office in Asheville provides space for co-working, collaboration, meetings, and presentations.

“I do think there’s something special about what’s being built here that can serve the world by exporting climate change solutions.”

—JOSH DORFMAN, THE COLLIDER



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PHOTO BY NATIONAL CLIMATIC DATA CENTER

This photo from the 1960s shows National Climatic Data Center employees at the federal building in Asheville.

NCEI, formerly the National Climatic Data Center, stores climate information dating back to 1743 on tens of millions of pieces of paper as well as in the cloud at a volume of nearly 40 petabytes.

targeted actions, and communicate those plans to the public. The company is one of Esri's emerging business partners and is also working on incorporating climate change resilience into the Esri Hub, a framework that focuses on citizen engagement.

"The Hub helps get data into the hands of people who may not even know what GIS is," said FernLeaf CEO Jeff Hicks. "We want people to be able to type in their address, and it'll say, 'Hey, you live in an area that is susceptible to wildfires. Here's what you can do to be more resilient.'"

Hicks, who founded FernLeaf out of his home, described The Collider as a "center of gravity" for people working on climate change solutions. While the data is important, he said, it's more important to be able to show up at happy hour and run into someone responsible for a particular dataset he's using. "I'm not walking over to NCEI to pick up a hard drive," he said. "It's the people. There's a brain trust here."

NCEI, formerly the National Climatic Data Center, stores climate

information dating back to 1743 on tens of millions of pieces of paper as well as in the cloud at a volume of nearly 40 petabytes. The center is responsible for issuing weather watches and warnings in addition to generating statistical information such as weather norms, averages, and anomalies. It also produces datasets for nearly every sector of the economy, but not for individual businesses. The challenge is getting that data into the hands of decision-makers and market drivers.

"The Collider's the next step," said meteorologist Scott Stevens at NCEI's Center for Weather and Climate, adding that the decades-old collaboration between NCEI and the 14th set the stage for Asheville to be known for its climate data expertise. "What do we do with all this data?"

The Collider's COO, Megan Robinson, formerly of NCEI, said it's beneficial for government employees to meet with those from the private sector and academia. "The government sometimes has a hard time understanding what impact their data has on society, what formats are needed, how to improve their data streams," she said. "By convening at The Collider, those from the federal side are able to understand the intersections that they don't normally see in their day-to-day jobs."

Collider member Innovim works primarily with the Department of Defense, NOAA's National Weather Service, and NOAA's National Environmental Satellite, Data, and Information Service. It provides sub-seasonal to seasonal weather and climate monitoring, as well as forecasting up to weeks or months in advance. The Maryland-based company has 14 computer scientists and systems engineers working out of Asheville's federal building.

Philip Ardanuy, Innovim's chief science officer, said The Collider offers staff a place to network, recruit new employees, and learn about other areas of the industry. More than anything, he said, it's a community in which professors, civil servants, technicians, researchers, and academics can share information as equals.

"The work we do is typically driven by our customers' missions and the function we support, so it doesn't necessarily cover the entire enterprise of climate change," Ardanuy said. "By interacting across the diversity of The Collider, we can understand all aspects of how climate affects society. The conversations are diverse, and as a consequence, they broaden my perspective and help me see the big picture."

Climate change as a national security threat—with potential to wreak havoc on coastal and urban communities, agriculture, and food and water supplies—has been discussed at various Collider events. Ardanuy predicts The Collider's future role as perhaps helping to prepare a "climate-ready nation," not unlike NOAA's Weather-Ready Nation program, for which Innovim is an ambassador. To that end, The Collider would help the public understand the causes and likely impacts of climate change, prepare for the worst, and mitigate when possible.

"Regardless of how climate is changing, and regardless of what portion is manmade, society will have to be agile enough to adapt to climate change as—and before—it happens," Ardanuy said. "The interactions that The Collider facilitates will promote the flow of information across different organizations that normally might not even know of each other. At the end of the day, it will help America be more climate resilient." 🌍



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Amazon Web Services (AWS): Taking GEOINT to the Cloud

Q&A with Tom Lash, manager, AWS Federal Delivery Organization

Q What challenges does AWS help its customers solve?

Today, many enterprise and government customers use AWS Cloud to transform their organizations and businesses. AWS offers the broadest and deepest platform of services and features, and allows our customers to be more agile while reducing their computing costs. Geospatial customers benefit from the elasticity, scalability, and cost-effectiveness of our services, which frees them from having to purchase, maintain, and operate their own servers and data centers, enabling them to focus on differentiated solutions.



Q Why is the cloud so important to today's GEOINT Community?

National security depends on our nation's ability to stay a step ahead of adversaries by modernizing aging infrastructure and adopting the latest security technologies, which are available in the cloud. The GEOINT Community can move much faster when members embrace a cloud-based architecture and take advantage of new capabilities as soon as they are launched. The cloud allows mission owners to experiment on-the-fly for very little investment, and iterate nearly instantly.

Q What are some things federal agencies can do to ensure successful cloud adoption?

AWS uses the Well-Architected Framework as an exemplar for how customers should design their own systems and workloads. The framework helps cloud architects build secure, high-performing, resilient, and efficient infrastructure for their applications. Based on five pillars—operational excellence, security, reliability, performance efficiency, and cost optimization—the framework provides a consistent approach for customers and partners to evaluate architectures and implement designs that will scale over time.

Q How is AWS contributing to the current revolution in Earth imaging technology?

The Earth imaging revolution is going to produce an incredible amount of

raw data that requires ground processing and efficient data management and dissemination. One of the reasons we developed AWS Ground Station was to support small satellite advancements. Prior to AWS Ground Station, organizations could launch collection platforms, but were faced with millions of dollars on ground collection and processing.

AWS Ground Station eliminates this problem by delivering a global ground station-as-a-service. We provide direct access to AWS services and the AWS Global Infrastructure. This allows users to easily control satellite communications, quickly ingest and process satellite data, and rapidly integrate that data with applications and other services running in the AWS Cloud.

Q What sorts of AI and machine learning tools does AWS offer?

We provide a wide range of machine learning (ML) services. Amazon SageMaker gives every developer and data scientist the ability to build, train, and deploy ML models quickly. This fully-managed service covers the entire ML workflow to label and prepare data, choose an algorithm, train the algorithm, tune and optimize it for deployment, make predictions, and take action.

We also have Amazon Comprehend, a natural language processing service that uses machine learning to discover insights and relationships in text. Comprehend is often used as a companion to GEOINT data to provide textual content to imagery from ancillary sources.

Q What excites you most about the future of GEOINT?

Interest in AI/ML has driven the widespread adoption of new computing methods, including capabilities like AWS Inferentia, a machine learning inference chip designed to deliver high performance at low cost. AWS Inferentia will support the TensorFlow, Apache MXNet, and PyTorch deep learning frameworks.

AI/ML technologies allow users to interact with geospatial data more naturally, opening GEOINT to a much wider range of users. Complex GIS queries can be replaced by asking simple key intelligence questions, enabling analysts to get answers and make decisions faster.

I am excited to see customers consolidate and migrate their GEOINT

holdings to the cloud to share and collaborate more easily. Recently, I migrated a very large data holding that I helped develop almost a decade ago, and the cloud makes the data more usable and discoverable to a wider range of users.

Q How has participating in organizations like USGIF helped AWS achieve its goals?

USGIF is a great way to interact with the entire GEOINT Community, including government, industry, and academia. Most AWS services are developed to address direct customer needs and requests; therefore, we benefit tremendously from listening to our customers and understanding how to make challenging problems solvable.

We enjoy working with our integration partners to understand how they are applying our technologies in new and creative ways. This helps us respond with features and services to help them deliver functionality to their customers faster. USGIF does a great job of focusing on the heart of what makes GEOINT unique, and that is the richness and diversity of data in this community.

Q What are you most looking forward to about GEOINT 2019?

I have been lucky enough to participate in every GEOINT Symposium since 2004, and it really is the highlight of my year. Last year, we celebrated the launch of WorkSpaces in our Top Secret Region, and this year we will similarly celebrate the launch of AWS Lambda in that region. Lambda is our primary serverless compute service that helps users migrate from traditional servers and virtual machines to simply running code without provisioning or managing servers. It is groundbreaking for GEOINT customers because it allows them to simply run, and perhaps even more importantly, accredit, their code versus virtual infrastructure.

This photo of a port in Macau, China, shows plane detection.



IMAGE COURTESY OF DIGITALGLOBE/ORBITAL INSIGHT

Orbital Insight: Enabling Global Transparency

Q&A with Chris Bollinger, VP, Public Sector

Q Who are the main customers and industries that Orbital Insight serves?

The mission of our company is to increase transparency of what's happening on and to the Earth. We support a variety of customers. At the highest level, it's about providing actionable analytic insights generated from geospatial data to decision-makers, key stakeholders, and policymakers. Our core users are analysts at commercial companies, NGOs, and federal defense, intelligence, and law enforcement agencies. We support our commercial clients by providing increased transparency into global energy supply, U.S. retail market demand, U.S. housing supply, and the dynamics within integrated global supply chains.

Q What distinguishes Orbital Insight from other geospatial analytics companies?

The key issue is the depth and breadth of the technical capabilities we've developed to date. It starts with the data. We have strategic supplier relationships with all the major geospatial data firms in the world—Maxar, Airbus, Planet, e-Geos, and so on—and this allows us to provide the full spectrum of geospatial data. We leverage space, aerial, terrestrial, and maritime-based sensors to give the best analytic signal to our clients. We also have a broad portfolio of AI and machine learning algorithms we can



Chris Bollinger

then apply against that data in our platform, which supports analysis at near-global scale. As an In-Q-Tel and Defense Innovation Unit portfolio company, we operate both in the commercial unclassified realm as well as in the classified domain to meet the needs of defense and intelligence users.

Q What are some innovative ways your company is applying advanced analytics in the public sector?

At the highest level, we empower human geospatial analysts to know where to look and when. Our technology takes multi-source data from all commercial providers as well as U.S. government-owned and -operated sensors and automates the identification of anomalies and change detection. All of this supports the generation of indications and warnings by government analysts. We also help automate the generation, curation, and maintenance of foundation data.

Another innovative thing we do is automated tipping and cueing. We take lower cost, higher revisit, lower resolution commercial sensors and, with our algorithms, automate anomaly and change detection. That creates a cue of tips the government can take into command-and-control and tasking architectures to optimize the collection through U.S. government sensors or higher cost, higher resolution commercial sensors.

Q What are the primary challenges you face?

There's so much data out there—the amount and different types, especially for geospatial, is increasing exponentially every day. The first thing we do is validate whether the data can add more analytical insight to the signal we're providing to our clients. A strong vetting and validation process up front is essential to determine if there is value to be gleaned from the data.

Depending on the mission, the time it takes to get data from collection down into some architecture where we can order, ingest, and process it can also be a challenge. That speed can go from hours to days or weeks. We have to take all of that into account in terms of bringing data to bear and whatever the timely window is to provide these insights to our analysts and consumers.

Q How are next-generation technologies like AI and the cloud shaping Orbital Insight's offerings?

Advances in AI, machine learning, and deep learning are a big part of our computer vision algorithms because a bulk of the data we consume is imagery based. Distributed computing environments like AWS (C2S for the U.S. government), Google Cloud Platform, and Microsoft Azure allow us to apply this rapidly at scale. Beyond AI, other sources of geospatial data, like mobile geolocation information, provide enormous opportunities to push the boundaries of cloud storage and distributed computing. Fortunately, we're now able to ingest, interpret, and analyze even larger volumes of multiple datasets—including satellite imagery and geolocation data—to derive meaningful signals for our customers.

Q What excites you most about the future of GEOINT?

As a former Marine officer, I've always been fascinated by the geospatial world. Thanks to technological advances, we're able to help our clients have timely and actionable

understanding about what is happening on and to the Earth. The full spectrum of policy- and decision-makers and operational commanders are able to have much more visibility in real time about what is happening around the world. It's also exciting to increase transparency in areas of the world where there hasn't been much access. For example, helping underserved populations become more resilient to natural disasters or helping NGOs deploy resources in new ways.

Q What has USGIF Membership meant to Orbital Insight?

USGIF is the community leader in representing the whole ecosystem of government, industry, and academia. What we're doing has never been done before. Governments and our clients, both commercial and public sector, haven't applied AI and machine learning to these types of things at enterprise scale, so we're learning together as we go.

Being involved with USGIF allows us to be a part of the conversation and bring our subject matter expertise in how this technology works, and, more importantly, how it currently doesn't work. We're involved in those discussions about the future so we can apply AI in ethical ways to make the world a better place.

Bringing GIS to the General Public

A conversation with Angela Hamilton, program lead, Mixed Emerging Technology Integration Lab, Institute for Simulation and Training, UCF

Angela Hamilton first joined the University of Central Florida (UCF) as an undergraduate student, earning her bachelor's degree in digital media with a specialization in technical writing. She then went on to become a member of the research faculty at UCF's Institute for Simulation and Training while pursuing a master's degree in technical communication and more recently earning a graduate certificate in GIS.

For the past 12 years, she has worked in the Institute's Mixed Emerging Technology Integration Lab (METIL). Hamilton became a USGIF Individual Member in 2018 and aims to apply her lifelong passion for geography to explore how METIL can integrate geospatial technology into some of its initiatives.

Q How would you describe the work of the Institute and METIL?

We are a research arm of the university, and partner with industry and government on human-centric simulation (as opposed to machine-centric) to improve training and education outcomes. Within METIL, we do a subset of that, focused on taking off-the-shelf and other emerging technologies and integrating them for novel applications rather than building new technologies from scratch. Instead of reinventing the wheel, we look for new applications of existing technologies like IoT, AI, AR/VR, cybersecurity, and blockchain paired with advanced simulation that we can integrate in a creative way to solve real-world problems.

Q What are some examples of this?

A lot of our military work is in health care simulation. In WWII, special decks of cards service members used to play poker served a dual training purpose that helped them memorize the silhouettes of different aircraft profiles. Something similar was done during the wars in the Middle East to memorize the most wanted terrorists. This reinforces training content while soldiers are having fun.

We created a similar training card framework for Army combat medics, incorporating golden hour procedures for tactical combat casualty care and other sequential steps medics go through. We did physical cards with an augmented reality layer to



Angela Hamilton

visualize the procedures and a mobile app based on cognitive spacing algorithms for reinforcement. Based on the flexibility of the framework, we also made rapid response versions for Ebola and cybersecurity, and more recently have done versions for Navy recruits. A lot of what we do is geared toward taking academic research and development done in the lab for the military and transitioning it to broader applications and audiences.

Q How does this work connect to geography?

Hurricanes have been on our minds in Florida a lot the last couple of years with three direct hits in the last two hurricane seasons. It really made an impact on me looking at some of the GIS tools that are available. So many are for first responders, but some might be for the general public where you can go on and find out what flood zone you are in, for example.

Everything is done in silos and all of these different data streams aren't integrated. We've created portal dashboards that can link out to all of that disparate information. We actually did it in real time, starting the project during Hurricane Harvey and then dealing with Irma and Maria. The dashboards were built from a GIS perspective as far as where supplies are located, which gas stations are open, and so on, because GIS is such a critical need during and after natural disasters.

Q Who used these tools?

During Hurricanes Harvey, Maria, and Irma we worked with an outside group through a public-private partnership, with our students and faculty supporting Kant Consulting to leverage a generous donation of the use of SitScape. Through that outlet, the dashboard was shared with first responders and government agencies to merge a lot of the different portals and resources those groups use. Some popular modules and tools had more than 20,000 users, with an average of 5,000 users during each disaster. The same architectures and principals we developed for the portal could be applied anywhere.

Q What are you working on currently?

We've been integrating a lot of these data feeds, taking it one step further so we're prepared and not doing so in the midst of a crisis. Instead, we want to plan the architecture and get the data feeds before a crisis so it's not quite so time-critical and ad hoc. For example, getting data on where supplies are located to reduce congestion on roads before and after a disaster, so people aren't blindly looking for what they need. Another area we are involved in is the integration of GIS and blockchain into our smart city initiatives and ecosystems.

Q Why did you join USGIF and how has it helped you reach your goals?

For the last few years, I've been looking into ways to integrate GIS into our research and development agenda. In the past, GIS tended to be a feature in a lot of the apps we developed, and I'm trying to shift toward doing GIS-focused projects where that is the main platform or interface. Our goal is to take the GIS applications beyond the primary domains they're in right now—government agencies,

Prototype 3D visualization of Hurricane Maria flood data in Puerto Rico.



IMAGE COURTESY OF UCF/IST

first responders, emergency planners—and bring novel GIS applications to the general public. Last year, at the GEOINT Symposium, I was able to see what the technological landscape is and hear directly from experts and users about what their visions are in these areas. 🌐

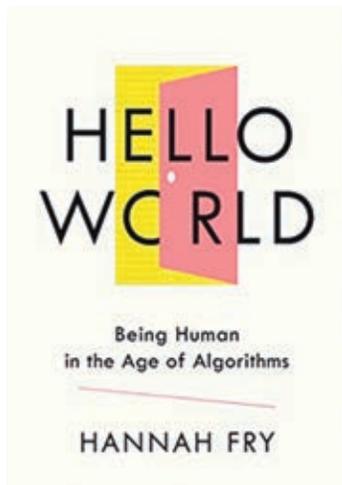
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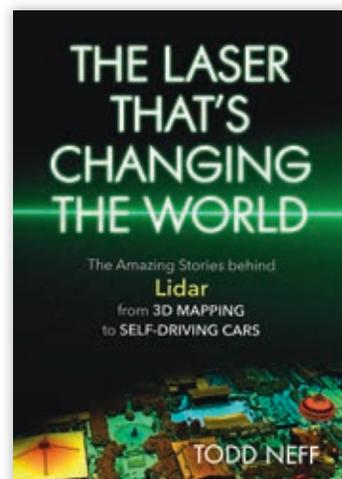
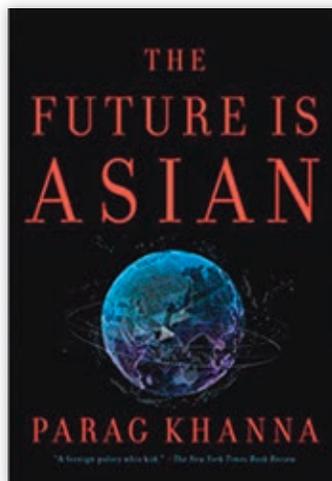
By Hannah Fry

This book, shortlisted for the 2018 Royal Society Investment Science Book Prize, offers a look inside the algorithms that are shaping our lives and the moral dilemmas accompanying them. Automation is revolutionizing criminal justice, medicine, transportation, finance, and beyond, but at what cost? Is mathematical efficiency now valued over personal privacy and human compassion? The author investigates how AI codes are written, applied, and biased, posing how human life will change in the age of the algorithm.

The Future is Asian

By Parag Khanna

Author Parag Khanna believes if the 19th century brought the “Europeanization” of the world, and the 20th century its “Americanization,” then the 21st century is the time of “Asianization.” With global tech dependent on Asian talent and politicians praising the continent’s glittering cities and efficient governments, Asia’s growth in the coming years will have a major impact on the world’s future. This book estimates what that growth—and its effects—might look like.



The Laser That's Changing the World: The Amazing Stories behind LiDAR, from 3D Mapping to Self-Driving Cars

By Todd Neff

LiDAR technology will change the world in more ways than one. Award-winning science writer Todd Neff introduces readers to the great innovators who explored and expanded LiDAR’s use cases, setting the stage for modern applications such as coastal mapping, damage assessments, and autonomous vehicles. The book looks ahead to a future that could bring LiDAR to unpiloted air taxis, to the contaminated pipes of the U.S. nuclear weapons complex, and to satellites capable of pinpointing greenhouse gas sources from orbit.

USGIF EVENTS CALENDAR

MAY 14

GEOINteraction

Tuesday

Northern Virginia

JUNE 2-5

GEOINT 2019

Symposium

San Antonio, Texas

JULY 23

GEOINteraction

Tuesday

Northern Virginia

SEPTEMBER 26-27

GEOINtegration

Summit

Herndon, Va.

OCTOBER 7-9

Geospatial Gateway

Forum

St. Louis, Mo.

NOVEMBER 16

GEOGala

Northern Virginia

NOVEMBER 18-22

GEOINT Community

Week

Northern Virginia

DR. NADINE ALAMEH returned to the Open Geospatial Consortium (OGC) in March to serve as CEO. Alameh was a member of the OGC staff from 2009 to 2014, serving initially as a director, then executive director, of OGC's Interoperability Program.

THE HONORABLE JAMES R. CLAPPER was named a senior advisor to StellarPeak Corp. In this position, Clapper will improve corporate strategic planning, business development, and market intelligence to drive StellarPeak's growth within the Intelligence Community.

MAJ. GEN. CHARLES CLEVELAND, vice director for intelligence, joint staff with the Defense Intelligence Agency, moved to NGA to serve as director of operations and military deputy.

PAUL E. DAMPHOUSSE joined Spire Global to lead national security business development for Spire Federal in Washington, D.C. Damphousse's last assignment was chief of advanced concepts for the Pentagon's National Security Space Office and the DoD Executive Agent for Space.

Native appointed **CHRIS INCARDONA** VP for the public sector. Incardona has more than 25 years of experience with companies such as Airbus, Boeing, GeoEye, DigitalGlobe (Maxar), and, most recently, as VP for strategic program development at Orbital Insight.

Maxar Technologies appointed **DANIEL JABLONSKY** president and CEO. Jablonsky, who most recently served as president of DigitalGlobe, will also join Maxar's board of directors.

Continental Mapping hired **JEREMIAH JOHNSON** as deputy general manager and Janus program manager. Johnson brings more than 13 years of experience from Leidos, Hexagon U.S. Federal, and Perspecta, where he directly supported the NGA Foundation mission.

SAIC announced CEO **TONY MORACO** will retire effective July 31. Moraco will be succeeded by COO **NAZZIC KEENE**. Additionally, **NATHAN ROGERS** assumed the role of chief information officer at SAIC in February. Rogers succeeds **BOB FECTEAU**, who retired from the company in April.

NGA appointed **MARK MUNSELL** chief technology officer. Munsell will lead NGA's technology transformation and modernization efforts in his new role.

President Trump nominated **CHRISTOPHER SCOLESE** to be the next director of the National Reconnaissance Office. Scolese is currently the center director of NASA's Goddard Space Flight Center. Current NRO director Betty Sapp has held the post since 2012.

ICEYE announced the appointment of **STEVE YOUNG** as VP, business development and sales. Prior to joining ICEYE, Young worked at BAE Systems, most recently as campaign director, Typhoon and chief of staff. In 2015, he helped co-found Earth-i, after a previous role with Surrey Satellite Technology. ICEYE also hired **LEOLA MOSS** as VP, product delivery and operations. Prior to joining ICEYE, Moss worked as the director of pipeline operations for Planet and spent three years as a senior program manager for Google.

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GEOSPATIAL DATA AT THE TACTICAL EDGE

*A conversation with Gary Blohm,
the new Director of the
U.S. Army Geospatial Center*

Q What do you see as the major challenge in delivering geospatial information to warfighters currently and in the near future?

Geospatial data, more than ever, is critical to all Army operations. As we achieve advances, and more data becomes available, we are increasing our tactical collections. This requires a lot of work in analytics, and we need to ensure this data is available at the tactical edge where networks are not available or not as robust as they could be. The Army Geospatial Center (AGC) is working with the Army Futures Command (AFC) and its Cross-Functional Teams (CFTs) to ensure we can do so.

We are talking about a lot of data. We need the proper architecture to make our data discoverable while addressing cybersecurity needs. At the same time, we need to have interoperability among the National Geospatial-Intelligence Agency (NGA), the other military services, and coalition partners.

Q Is interoperability a challenge?

Having a standard shareable geospatial foundation is a challenge that will never be solved. The technology is constantly evolving, with new products being introduced that have to be standardized. We work hard alongside NGA and have made great strides. We help drive standardization because in the tactical world where there is less throughput, we need to have standards that allow data to get through smaller networks and “pipes.” The Army looks at us as the lead for many users. A big part of my role is to communicate and coordinate with our partners.

Q How is geospatial information being integrated by Army Futures Command?

We work with AFC on modernization across all the CFTs. Lt. Gen. James Richardson, Deputy Commanding General, AFC, visited AGC and we spoke with him about how AGC provides and synchronizes the geospatial foundation across all CFTs. We held a Geospatial Summit—a two-day event to understand their needs, and for them to understand our domain and how we work with NGA and others to provide data they need.

In this era of multidomain operations, synchronizing across domains is critical. It’s our job to make sure commanders will be able to make decisions with the most accurate geospatial intelligence possible.



Gary Blohm (far right), Director of the U.S. Army Geospatial Center, receives a demonstration on new geospatial technology following the Defense Strategies Institute’s GeoData Summit in Alexandria, Va.

For example, providing forward position navigation for next-generation vehicles that operate autonomously in places where traditional position navigation is not available. Our Geospatial Lab is working with the Assured Positioning, Navigation, and Timing CFT to navigate based on visualization and some mapping background. AGC will help augment long-range positional fires as well. The Synthetic Training Environment CFT is also asking for our help.

Q Are soldiers using advanced training environments that incorporate VR?

That depends on the training level. We supply geospatial information for training the individual soldier, the squad level, and on up to the Joint Readiness Center. The gaming industry is involved, too. At the National Training Center, units can train realistically not just in a representative environment, but in a specific environment.

We work with NGA and commercial sources to get data on the exact place a warfighter is going. We can build a session for a soldier entering a building that’s known or create a drill for a formation that is planning to cross a bridge. “Mapping” sometimes

oversimplifies what we do: we are also implementing data that we have on the bridge’s load structure. For example, will it hold both troops and tanks? Do we know if it is in good repair?

Q NGA is the repository for most geospatial data, but the Army has mountains of its own data. How do you envision the long-term sharing of geospatial data for the DoD?

We leverage NGA as the authoritative data source for this information. When we are looking at the tactical environment, and you don’t have the capability to send as much data along, what do you do? There are different approaches. One is you don’t pull all the data down, but you make it visible. We are working with NGA on GRiD, the Geospatial Repository and Data Management System—Tactical, to drive responsive data exchange into the tactical environment.

NGA is taking a lead role on architecture to take cloud technology to the edge. And industry is increasingly interested in getting cloud services to places where throughput is a challenge. Ultimately, this will probably not be based on a DoD-unique solution, but by taking commercial solutions and applying them to DoD problems. ☺



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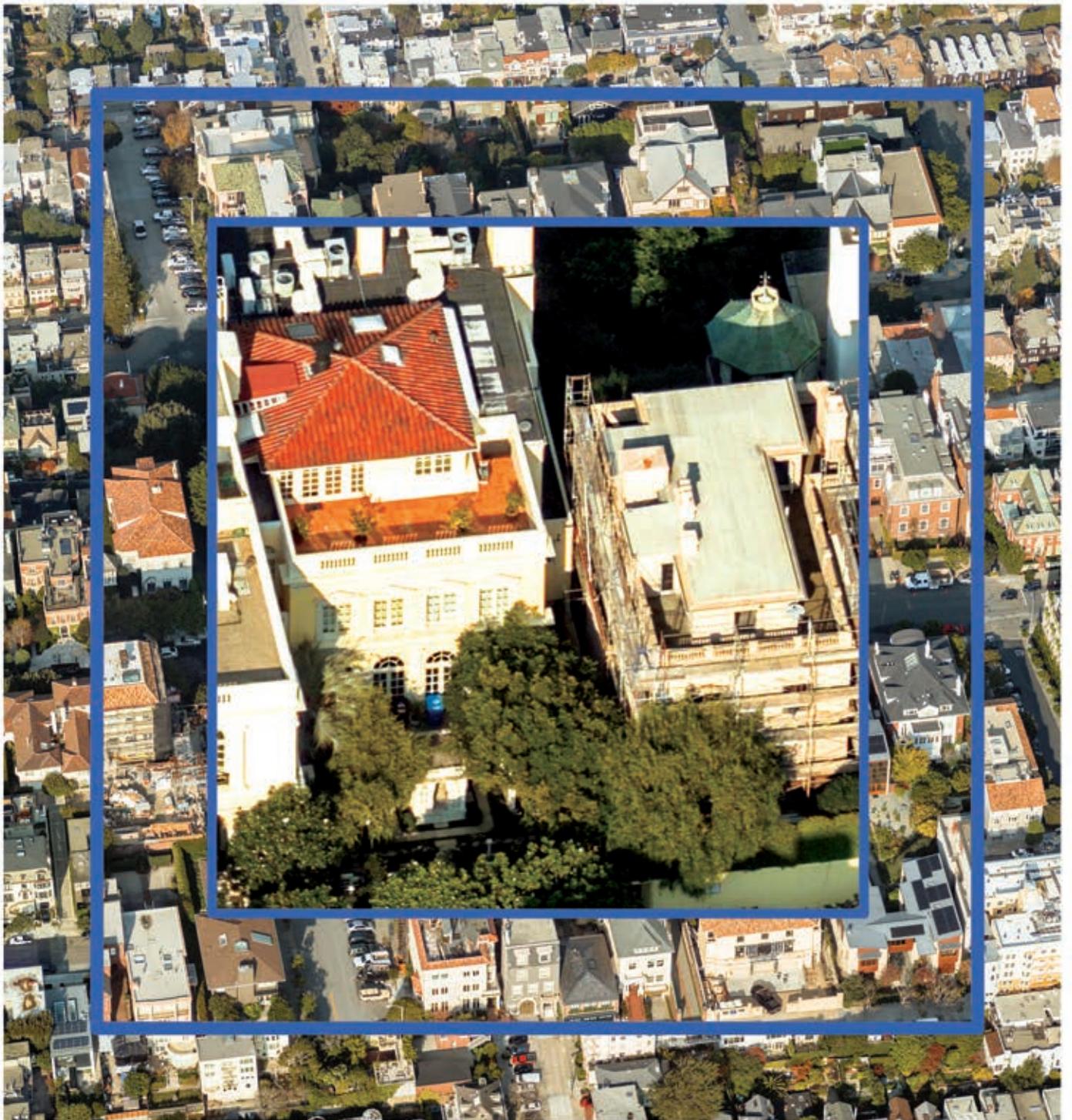


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