APOGEO SPATIAL

ELEVATING GLOBAL AWARENESS

NEW SERIES:

GEOSPATIAL ANALYTICS-as-a-SERVICE

p. 16, 20

"Imagery analysis traditionally done in a high-end, artisanal process now moves to the cloud, at speed and scale. Uncertainty abounds, and change is hard. The U.S. government's national security and public safety missions leave little room for error."

– Kevin O'Connell, CEO, Innovative Analytics & Training *p. 16*

"AllSource Analysis is bringing a new economy for the analysts to address the human in the loop of spatial analytics."

– Chuck Herring, CEO, AllSource Analysis *p. 21*

FORMERLY Imaging NOTES

[Fall 2017 / Vol. 32 / No. 4]

Wildfires at Casita Springs in Southern California, Dec. 7, 2017. SWIR satellite image ©2017 DigitalGlobe.

REDEFINING SPACE The Vega's hot streak continues with its 11th successful launch in a row since the light lift vehicle entered service in 2012. On November 7, the Vega flawlessly orbited the MOHAMMED VI - A satellite for the Kingdom of Morocco, from Europe's Spaceport. The satellite was developed by Thales Alenia Space and Airbus. It's no surprise that institutional and commercial customers have rallied to the Vega, making it one of the most sought after systems in the industry. Already the Vega C, a new, more powerful and flexible variant set to debut in 2019, is attracting interest with Arianespace signing three contracts for this next generation player. With a combined backlog of nine missions, Vega and Vega C are positively redefining access to space.

#missionto**success**

APOGEO SPATIAL

[Fall 2017 / Vol. 32 / No. 4]

Columns

Features

COVER IMAGE

Los Angeles, California Wildfires

AS THIS ISSUE GOES TO PRESS, THESE wildfires near Los Angeles, California still burn.

DigitalGlobe is making critical imagery and data available through their Open Data Program in order to support efforts to combat these fires. DigitalGlobe is publicly releasing satellite imagery for Ventura, California, and surrounding communities and is expanding coverage based on the fire's activity.

DigitalGlobe partnered with Mapbox to update their fire tracking map, which allows users to search addresses and zoom in on specific areas, and it includes the latest fire perimeters provided by first responders on the ground (https://www.mapbox.com/labs/norcal-fire-2017/).

DigitalGlobe's Shortwave Infrared (SWIR) sensor pierces through the smoke to show where the fires are burning on the ground. This December 7 image of Casitas Springs shows fires burning in the mountains east of San Fernando.

APOGEO SPATIAL

Formerly Imaging NOTES

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MISSION

Apogeo Spatial communicates the power of geospatial tools and technologies in managing the world's environment and scarce resources, so that the global population has the security of water, food, and energy.

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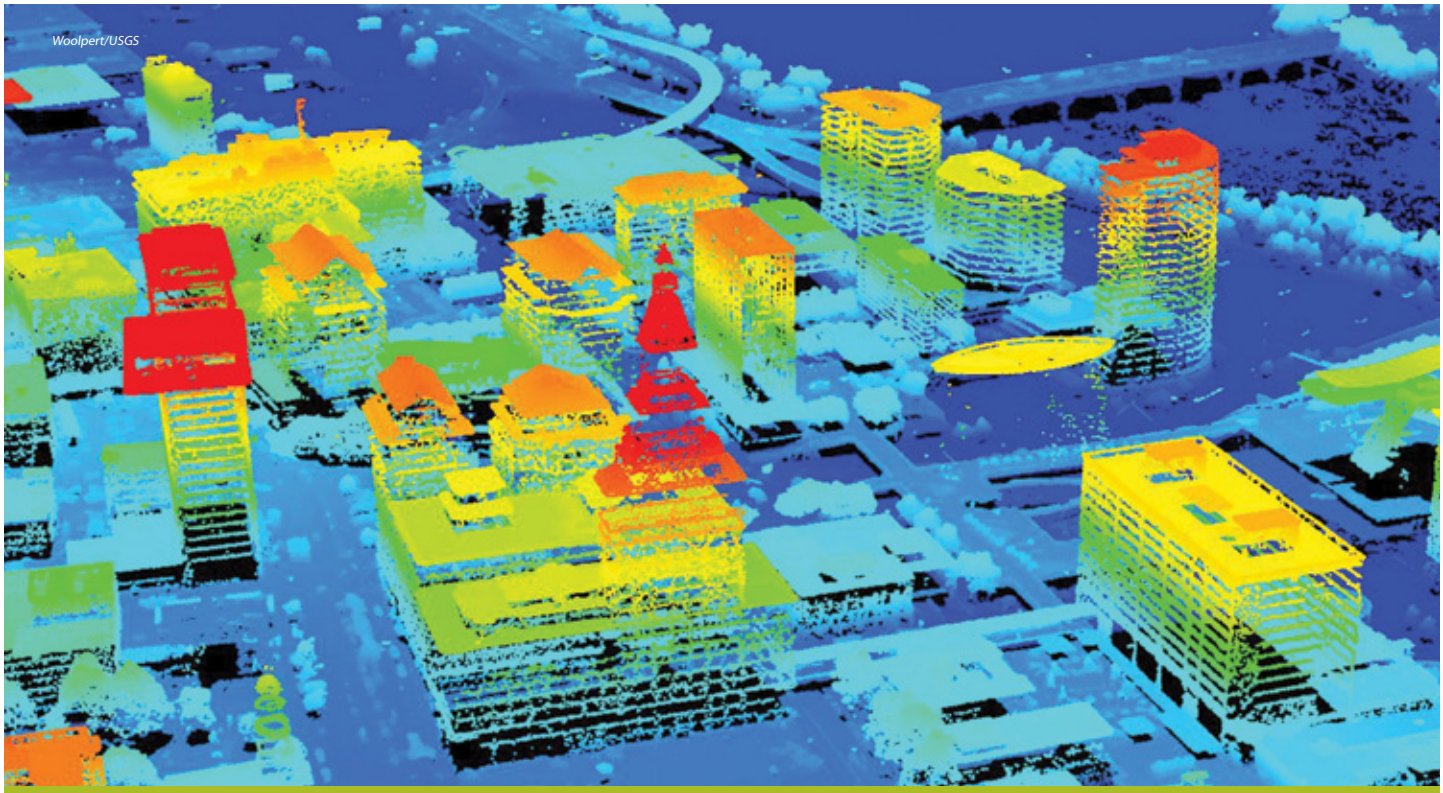
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March 8, 2017 | Hyatt Regency Colorado Convention Center

Morning Panel Discussion
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Open to the public

Women in Space featuring:

- Alires Almon – *100 Year Starship*
- Allison Barto – *Ball Aerospace*
- Laura Delgado Lopez – *Harris Corporation*
- Maureen O'Brien – *Oakman Aerospace*
- Victoria Samson – *Secure World Foundation*
- Cynda Collins Arsenault – *Moderator*

Lunch Program
12:00–1:30
Corporate Tables Available

Honoring Cynda Collins Arsenault, President and Co-founder of Secure World Foundation

Featuring keynote speaker Dr. Mae Jemison, the first African American Woman in Space

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INTERNATIONAL WOMEN'S DAY

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The Power of Imagery Insights and The Overview Effect

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DEAR READERS,

In this issue, we begin our new series on the emerging imagery insights sector, or Geospatial Analytics-as-a-Service (GaaS or AaaS). On page 16, Kevin O'Connell and Marina Hague of Innovative Analytics write about this evolving field, including anticipating challenges as the companies approach the U.S. government as a customer.

We are seeing three categories of AaaS providers emerge: Those that also own and control the data by operating their own satellites, those that are building analytics platforms to leverage existing data, and those that do both. As is the case for many commercial data companies, such as weather data, competitors are often business partners as well, blurring the lines and sometimes causing confusion in the marketplace. As analytics companies continue to launch, current imagery providers will need to determine if each one is a threat or an opportunity.

On page 20 are Matteo Luccio's interviews with two executives in this field: Chuck Herring, CEO of AllSource Analysis; and Marc Fagan, CEO of Earth Observation Systems Data Analytics. We have been covering how the satellite imagery companies are now providing analytics (DigitalGlobe, Airbus, Planet, UrtheCast…). While we'll continue this coverage, in future issues also watch for interviews of executives from companies like Descartes Labs, TellusLabs, Astro Digital, SpaceKnow, Vinsight, and Orbital Insight.

Some of these companies originally were planning to launch their own satellites, but have determined that they did not need to do so, and now are leveraging existing data and providing the analytics only. These include Ursa Space (which was featured in our Summer issue at http://apogeospatial.com/a-killer-app-for-sats) and OmniEarth (acquired by EagleView).

Astro Digital plans to launch their own medium-resolution satellites via dedicated launch partner Vector, a NewSpace company founded by original members of SpaceX. They are also developing their software platform, which streams imagery to clients' applications via API, initially primarily for agriculture. BlackSky (SpaceFlight Industries) plans to launch a constellation of 60 high-resolution satellites by 2019, and also use data from other commercial providers for their analytics.

Confirming the high level of importance on this topic is Dylan Taylor, founder of Space Angels. He recently stated, "Transforming Earth observation and space-based data from telling me what's going on to telling me what's going to happen – predictive analytics – is a multitrillion-dollar opportunity."

Dylan is also founder of Space for Humanity (www.SpaceForHumanity.org), a nonprofit that is "granting the gift of perspective" to non-astronauts to travel to the edge of space – elevating consciousness by elevating people. The objective is for more people to experience the change in perception that is experienced by those who see the Earth from space, called The Overview Effect; it changes the brain in the same way that a religious experience does. The point is similar, as well – perceiving that we are one, all connected, unified on this vulnerable tiny planet. No national boundaries are visible from space – only oneness.

The idea is that the more people can experience The Overview Effect for themselves, the more peace and unity will occur here on Earth. While SpaceX, Virgin Galactic, and Blue Origin plan to provide access to space on commercial suborbital flights for paying customers, Space for Humanity will sponsor the rides for their participants, who will become Ambassadors, sharing their experiences and epiphanies. Participants will be chosen based on their 3-minute videos.

International Women's Day is March 8, 2018; the theme is "Celebrating Women in Space!" *Apogeo Spatial* is thrilled to sponsor this event in Denver, Colorado, which will honor Cynda Collins Arsenault, President/Co-founder of Secure World Foundation (a long-time partner of *Apogeo Spatial*), and feature astronaut Dr. Mae Jemison, first African-American Woman in Space. The event includes a morning panel discussion open to the public, followed by the luncheon and keynote. For more info: www.worlddenver.org/international-womens-day. Join us!

Sincerely, Myrna

ON THE EDGE

Interpreting What We See

DISTANCE IMPACTS OUR PERCEPTIONS

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OUR PERCEPTION OF AN OBJECT CHANGES DEPENDING on how far or close we are and on how accustomed we are with it. During a recent visit to St. Petersburg, Florida, I spent several hours at the Dali Museum there. For some of Salvador Dali's paintings, the distance to the painting determines what we see. Approaching the painting, "Slave Market with the Disappearing Bust of Voltaire" (http://bit.ly/2z2mZmU) from the distance, Voltaire's bust is the most obvious feature in the center of the painting. The choice of using Voltaire's bust in the painting is notable: Voltaire was a dedicated and outspoken advocate of civil liberties, not afraid of putting himself at risk by arguing for the freedom of thoughts under the strict censorship of his time. He also showed a great respect for science and the work of Sir Isaac Newton. Moving closer to the painting, the bust of Voltaire slowly disappears, and with it, what Voltaire stands for, giving way to two nuns within the slave market, emphasizing the cruelty of the slave market.

Amazingly, our brain is able to interpret complex visual stimuli extremely fast and the meaning of a scene like the one in Dali's painting is interpreted in fractions of a second. However, the visual stimulus of this particular painting is open to interpretation. Recent research using filtered versions of this painting showed that participants overwhelmingly saw the bust of Voltaire when the finer details of the painting were obscured, and saw the nuns when large-scale features were obscured.[1]

These findings underlined the importance of scale information in perception. Large-scale features that change little over a given distance are more visible with low spatial resolution, while small-scale features that change much more over the same distance require much higher spatial resolution to be recognized. In a second experiment in the same study, the participants in two groups were shown random-noise patterns before they saw a grey-scale version of Dali's painting. The group that was shown a random pattern with a high spatial resolution reported seeing the bust of Voltaire, and the group that saw patterns with low spatial resolution reported seeing the nuns. This showed that previous experience is an important factor in perception, and adapting vision to the spatial scale in the random pattern led the participants to selectively perceive the opposite spatial scale in the grey-scale painting.

"A generic problem in vision is to know which information drives the perception of a stimulus."[1] This generic problem can be extended to knowing which information drives the perception of a specific situation, a problem or a threat. Many of the problems and threats we face as individuals, groups, communities, and as a global species are open to interpretation. Here, too, the distance that we have determines what we see.

In the same way as the perception of Dali's painting changes with our distance to the painting, looking at the planet from different distances and at different spatial and temporal resolutions changes the perception. Looking from space, we see the beauty of the Earth as

Editor's Note:
Due to copyright laws, we cannot publish the Salvador Dali paintings referenced in the article. Please visit them here:

Slave Market with the Disappearing Bust of Voltaire: http://bit.ly/2z2mZmU

The Broken Bridge and the Dream: http://bit.ly/2BaAgvz

a dynamic planetary life-support system, but getting closer we discover the cruelties of humanity on its path of exploiting the wealth of the planetary system for the benefit of a few.

Twenty-five years ago, 1,700 independent scientists sent a warning to humanity pointing out that "human beings and the natural world are on a collision course" and that if environmental damage was not stopped, our future was at risk.[2] On the twenty-fifth anniversary of this call, William J. Ripple et al. look back at this warning. Evaluating the human response to the dire warning by exploring available time-series data, they found alarming trends, including increasing dead zones, deforestation, CO2 emissions, temperature, and population growth; and decreasing invertebrate species, and freshwater resources. This led them to formulate a second warning,[3] this time supported by 15,364 scientist signatories from 184 countries, which was published on November 13, 2017: "Humanity is now being given a second notice, as illustrated by these alarming trends. We are jeopardizing our future by not reining in our intense but geographically and demographically uneven material consumption and by not perceiving continued rapid population growth as a primary driver behind many ecological and even societal threats."

The 1992 warning had little immediate impact on the perception of most of us to the threat humanity poses to the Earth's life-support system and to our own future. In 2015, there were signs that the international community was realizing the threat in global trends and the urgency of building a basis for a significant change in the trajectory of the Earth's life-support system on which all human and non-human animals depend. For example, the United Nations agreed on seventeen Sustainable Development Goals (SDGs) as part of the 2030 Agenda for Sustainable Development, and the world came together in Paris to agree on actions to mitigate climate change.

But the principle perception of the state of humanity and the role we play as part of Earth's life-support system is not changing. We don't see the "slave market" that our current global society has created with an economy that is high consumption-based. Enslaved by an economy designed to serve the hoarding of unlimited wealth by a few, our vision is focused on the small-scale needs for infinite growth of production and consumption and we are largely incapable of perceiving the large-scale threats of degrading our life-support system and crossing thresholds that will forever change the ability of this system to sustain our lives.

> "In the same way as the perception of Dali's painting changes with our distance to the painting, looking at the planet from different distances and at different spatial and temporal resolutions changes the perception. Looking from space, we see the beauty of the Earth as a dynamic planetary life-support system, but getting closer we discover the cruelties of humanity on its path of exploiting the wealth of the planetary system for the benefit of a few."

Many scientists, who are trying to describe the threats we are facing and identify their origin, are like a physician dealing with an undiagnosed patient exhibiting many symptoms but with no specific sickness diagnosed, as I've previously referenced in this column. At the recent Future in Review (FiRe) conference held in Park City, Utah, diagnosing the undiagnosed was one of the focus topics. Tens of millions are undiagnosed patients in the U.S., and one reason for that is that diagnosis is still not based on data. Examples showed that using large amounts of data and artificial intelligence, the undiagnosed could be diagnosed.

SDG 0: Responsible Procreation: Reduce population growth to -2% by 2025.

TARGETS

- **0.1:** by 2020 make a global effort to educate young women and men about the importance of responsible procreation for humanity's future.
- **0.2:** by 2020 introduce incentives for those who voluntarily give up their rights to have own children.
- **0.3:** by 2020 introduce incentives for those who adopt or foster children.
- **0.4:** by 2020 make available free support for family planning to all.
- **0.5:** by 2020 remove all incentives for having more than 1 child per couple.
- **0.6:** by 2025 introduce a tax (negative incentive) for those who have more than one own child.

Listening to those discussing the cases of undiagnosed patients, I realized that one "undiagnosed patient" is the Earth, suffering from a large number of increasingly severe symptoms. Looking at the rapidly degrading planet, I think of a father watching his undiagnosed child slowly die. Many of us scientists look at specific symptoms (such as climate change, extinction, pollution, land use) in isolation without fully accounting for the systemic connections between all of these symptoms. As a result, the very extensive Earth observation and research efforts have not resulted in an agreed-upon diagnosis of the deep cause of the rapid degradation all data is clearly showing, no matter whether looking at high spatial and temporal resolution or aggregated in space and time.

I asked myself whether an approach similar to the one used to diagnose the undiagnosed human patients could actually diagnose patient Earth. Integrating all available data on the planetary system and humanity and using artificial intelligence on this really big data might help us to identify the cause, the sickness. The need for datasets that are integrated across all domains has been emphasized particularly in the discussion of implementing the SDGs. Also, organizations like the World Bank, the Global Partnership for Sustainable Development Data and the Group on Earth Observations are making efforts towards data integration.

There is a proliferation of collaborative platforms for the integration of geospatial, environmental and statistical data, and combining the integrated datasets with algorithms based on artificial intelligence may soon allow us to reach a diagnosis. And if so, what would be a likely candidate for the "sickness" we would diagnose?

> "We are jeopardizing our future by not reining in our intense but geographically and demographically uneven material consumption and by not perceiving continued rapid population growth as a primary driver behind many ecological and even societal threats."

The sole purpose of today's economy is to generate unlimited human wealth, and this purpose was defined 250 years ago in the white-male dominated European countries. From there, this parasitic approach to our interactions with the Earth's life-support system has spread across the world as part of the white male's imperialistic enterprise and has contaminated

almost all societies in a very short time. Thus, diagnosing the Earth might point towards what I like to call the "white male syndrome," which has transformed humanity from a species much like other animals into a potentially terminal virus in the Earth's life-support system.

We are too close to, and too much inside the planetary system and therefore don't see the "disappearing bust" of Earth's life-support system. The many micro-organisms that live in our bodies are incapable of perceiving the macro human body, but both the micro-organisms and the macro organism are mutually interdependent and cannot exist without each other. Can art help us to change our perception and put us at the right distance to truly see the Earth's life-support system and the peril our current way of being in this system and interacting with it is causing?

Walking through the museum and seeing the amazing collection of Dali's work conquering irrationality, there was another Dali painting that caught my special attention: "The Broken Bridge and the Dream" (http://bit.ly/2BaAgvz). In a dream, crossing a bridge signifies a critical junction in life and an important transition to new conditions. Envisioning a broken bridge that is uncrossable makes the transition impossible and the bridge needs to be fixed before we can move on. Seeing Dali's broken bridge made me think of the bridge humanity needs to cross: the bridge that leads us from exploiting the planet for the short-term benefits of a few to being the planetary caretakers safeguarding the Earth's life-support system for all human and non-human animals. But this bridge appears more and more to be a broken bridge. We actually are running with increasing speed toward the end of the broken bridge, and this end appears to be hidden in fog.

Some of us are dreaming of terraforming Mars – turning it into an Earth-like planet. We don't want to acknowledge that we are operating Earth's planetary system and determining its future. Making mistakes has global consequences, and the data we have are documenting many of the mistakes we have made and the consequences are occurring now. We have started to call our time the Anthropocene, the epoch of our making, but we are not acting accordingly. We are using more than 50% of the ice-free land surface, and we have touched 100% of the life-support system. Pollution caused by us is everywhere and impacting the health of the life-support system. Flows have changed, and some have increased by several orders of magnitude. We are taking the planet on an uncharted trajectory; we have no plan for where we want to take our home planet, and we have no design process to come up with such a plan. Do we want a planet where, for example, currently 65 million humans are searching for a new home because the one they had is gone or uninhabitable? Do we want a planet where one species takes all and leaves nothing for other species?

It seems like we are Mars-forming Earth. Is this the future planet we want? Instead of striving for innovations that would increase the carrying capacity of the planet, we might want to strive for ways to live within the boundaries and constrain ourselves to fit in. A restoration lab would be better than innovation lab.

It also strikes me that humans are easily ready to control the population size for other animals, but have great difficulties to act on the need to control our own population size. Looking at the SDGs, this difficulty is strikingly obvious. The most important goal that would lay the foundation for all other goals was not included in the global goals – a goal I want to describe as "SDG 0: Responsible Procreation." For me this would be the most important goal in order to adhere to the warnings that scientists sent to humanity in 1992 and now again. ∧♂

Endnotes:

1. Bonnar, L. et al. (2002). Understanding Dali's Slave Market with the Disappearing Bust of Voltaire: A case study in the scale information driving perception. *Perception*, DOI: 10.1068/p3276.
2. Union of Concerned Scientists, 1992. World Scientists' Warning to Humanity. Accessed on November 16, 2017 at http://www.ucsusa.org/sites/default/files/attach/2017/11/World%20Scientists%27%20Warning%20to%20Humanity%201992.pdf.
3. Ripple, William J., Christopher Wolf, Thomas M. Newsome, Mauro Galetti, Mohammed Alamgir, Eileen Crist, Mahmoud I. Mahmoud, William F. Laurance; World Scientists' Warning to Humanity: A Second Notice, *BioScience*, bix125, https://doi.org/10.1093/biosci/bix125.

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Geospatial Data Act Exposes Geospatial Community Division

LEGISLATION IN CONGRESS HAS EXPOSED A CHASM in the geospatial community that could jeopardize chances to reform and improve the coordination and use of geospatial data.

Earlier this year, Senator Orrin Hatch (R-UT) introduced the Geospatial Data Act S. 1253, while a companion bill, H.R. 3522 was offered in the House by Representative Bruce Westerman (R-AR). Each was joined by bipartisan cosponsors.

According to an analysis by the Congressional Research Service (CRS) of the Library of Congress, the bills are intended for "the development, implementation, and review of policies, practices, and standards relating to geospatial data" and to "ensure that geospatial data (National Spatial Data Infrastructure, or NSDI) from multiple sources is available and easily integrated to enhance the understanding of the physical and cultural world."

Provisions in the legislation seek to improve the governance of geospatial activities among federal agencies, as well as these entities' relationships with state and local government, universities, and the private sector. Transparency and accountability provisions affecting the Federal Geographic Data Committee (FGDC) and the National Geospatial Advisory Committee (NGAC) are also included. Most significant is a clause in the bill that designates the Director of the Office of Management and Budget as Chairperson of the FGDC, a position currently held by the Secretary of the Interior and usually delegated to a lower-level official.

"The benefits of geospatial technology are truly untold. Our federal agencies use geospatial data, but often different agencies acquire duplicative information and waste precious taxpayer resources in the process," Rep. Westerman said upon introducing his legislation. "This bill will save money, improve information accuracy, and provide a more modern system for collecting and sharing geospatial data."

"The uses and applications for geospatial technology are immense and constantly growing," Senator Hatch said. "The process in which the federal government collects geospatial data currently wastes vast amounts of taxpayer dollars and fails to provide the most accurate information. The GDA will provide the tools to create a more robust and modern system of maps and digital data with a budget that avoids redundant expenditures. We need to optimize the method in which we collect geospatial data to advance the technology for states, counties, and citizens around the nation."

The Government Accountability Office (GAO) found without management improvements, that "the vision of improving the coordination of geospatial information and reducing duplicative investments will not be fully realized." It went on to warn, "until there is effective coordination across the National Spatial Data Infrastructure, there will continue to be duplicative efforts to obtain and maintain these data at every level of government."

Unlike the Map It Once, Use It Many Times Act, introduced in 2013 by Rep. Doug Lamborn (R-CO) (H.R. 1604, 113th Congress), the Geospatial Data Act does not address several other issues related to the federal government's conduct of geospatial activities. Among these is development of a coordinated research and development agenda, the use of prison labor to provide data conversion and application services, sending work to offshore operators, or the need

Editor's Note:
The contents of this article are the opinion of the author, and may not reflect those of the publication.

for a cadastre of land owned by the federal government. Nor does the Geospatial Data Act provide for any consolidation or reorganization of the more than 40 federal agencies with geospatial activities.

An earlier version of the Geospatial Data Act, (S. 740 and H.R. 6294) was introduced in the 114th Congress, in 2015, but no action was taken due to a lack of consensus within the geospatial community.

The current bills, S. 1253 and H.R. 3522, include revisions to address concerns raised on the previous proposals. The bills now recognize the important role the private sector plays in geospatial activities. Procurement, or contracting with the private sector, is inherent to the Geospatial Data Act and its goal of making the NSDI a success. The revised legislation addresses a variety of challenges, components and stakeholders in geospatial data and the NSDI, both governmental (federal, state and local) and the private sector. Provisions that assure quality in the procurement of the collection and acquisition of geospatial data were added to achieve the overall goals and objectives of the legislation. As introduced, S. 1253 and H.R. 3522 provide that the government should not duplicate or compete with the private sector in the performance of commercially available geospatial services, but rather should utilize the free enterprise system to the maximum extent possible.

The bill also requires contracting for such geospatial data services to use the competitive process based on demonstrated competence and qualifications of competing firms, rather than contracting awards to the lowest bidder. Such quality is essential to the success of government programs and activities that are dependent on reliable, accurate, and professionally acquired data and services. Moreover, the bills include a provision to preserve and comply with existing state law for licensing of professionals in surveying that protect public health, safety and welfare.

Organizations including the American Society of Civil Engineers (ASCE), the National Society of Professional Surveyors (NSPS), and MAPPS (An Association of Photogrammetry, Mapping, and Geospatial Firms) support the Geospatial Data Act as introduced and are resisting efforts by other organizations to weaken these important provisions. These groups support the private sector utilization, contracting and licensing provisions in the bill, noting in statements that they "serve the public interest, improve the geospatial activities and move the NSDI closer to a reality in service to the Nation and its citizens."

In November of 2017, Sen. Hatch and Rep. Westerman introduced new bills, S. 2128 and H.R. 4395, that are similar to their original 2015 proposals, S. 740 and H.R. 6294. The most current bills do not have the private sector utilization, primacy of state law, or qualifications-based contracting provisions. They have the support of the American Association of Geographers (AAG).

The National States Geographic Information Council (NSGIC) has supported the bills introduced earlier this year, as well as the current proposals.

"Since the federal government does not manage the licensing of surveyors or the resulting enforcement, then there must be recognition of state licensing laws at the federal level so any federal regulations provide the public with the avenue to understand where their protection of health, safety and welfare resides," said Patrick A. Smith, RPLS, Vice President, Surveying and Mapping LLC (SAM) and Chairman of the NSPS Government Affairs Committee.

"The bill also requires contracting for such geospatial data services to use the competitive process based on demonstrated competence and qualifications of competing firms, rather than contracting awards to the lowest bidder. Such quality is essential to the success of government programs and activities that are dependent on reliable, accurate, and professionally acquired data and services."

"Too many GIS databases are built without an accurate initial base. If the initial data is not more accurate than the resulting application data, then the resultant compounding error in positions could significantly impact public health, safety and welfare in applications," Smith said.

According to Marvin Miller, PLS, RPP, CP, PPS, SP, a geospatial professional based in Zimmerman, Minn. and chair of the MAPPS forum on government and university competition, "Federally initiated and funded geospatial projects and their respective data deliverables can and do make their way into state/county/municipal agencies that may then use such data as authoritative documents without being prepared under the responsible charge of a state-licensed professional. Recognition of state licensing laws for geospatial projects by the federal government would serve to not only expand the official use of the data by state and local agencies, but also to encourage and promote regional funding participation."

"The government should not be engaged in activities that can be performed by the private sector," Miller said. "That is supported by numerous independent studies conducted by the government."

In fact, as early as 1973 an OMB (White House Office of Management and Budget) study found that mapping is a commercial activity and recommended that more of it be contracted. The Report of the Federal Mapping Task Force on Mapping, Charting, Geodesy and Surveying, OMB, July 1973 said, "Private cartographic contract capability is not being used sufficiently. We found this capacity to be broad and varied and capable of rendering skilled support to federal MC&G (mapping, charting and geodesy) programs. Contract capability is a viable management alternative, and using it would be consistent with the President's desire to limit the size of the federal payroll. Its use should be encouraged in lieu of continued in-house build-up."

Duplication can take two forms. Some data are collected multiple times by federal, state, and local government, resulting in duplication in effort and resources; and government also duplicates and at times competes with the data and services of private geospatial firms. S. 1253 and H.R. 3522 establish that the government will not compete with private enterprise, but rather will utilize the private sector to the maximum extent possible. Consistent with current federal law and the code in most states, the bill assures that contracts will be awarded to qualified and competent firms, subject to negotiation of a price that is fair and reasonable to the government. Moreover, the provision to protect the primacy of state law will prevent the unintended consequence of the federal government condoning unlicensed practice that jeopardizes public health, safety, and welfare.

"As one small step toward more effective and efficient government, the Geospatial Data Act must address all forms of duplication as well as preserve and uphold professionalism in the geospatial field by recognizing licensure and qualifications in government activities and the procurement process."

Reforming federal geospatial activities may not earn the same attention as health care, immigration, or tax reform, but this duplication and lack of coordination is illustrative of the swamp in Washington, D.C. that needs to be drained. There are dedicated federal employees who do the best they can while trapped in an inefficient system. As one small step toward more effective and efficient government, the Geospatial Data Act must address all forms of duplication as well as preserve and uphold professionalism in the geospatial field by recognizing licensure and qualifications in government activities and the procurement process.

It is commonly recognized that Congress is loath to get in the middle of disputes with a specific industry or profession. Until there is "peace in the valley," as one state lawmaker noted, legislation like the Geospatial Data Act is not likely to be acted upon in Congress.

What's Next for Imagery Insights Providers?

Value Creation for the U.S. Government Customer

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As the U.S. commercial remote sensing (CRS) industry continues to evolve, there is a secondary, related industry emerging alongside the traditional imagery data providers; we refer to this as the imagery insights industry. A cluster of young companies, such as Orbital Insight, Descartes Labs, SpaceKnow, OGSystems, Ursa Space Systems, TellusLabs, and others, is experimenting with new business models that create insights derived from remotely sensed imagery data.

Consistent with broader analytic- and service-oriented trends in the market, these companies are selling information derived analytically from pixels, instead of simply selling those pixels. This shift from data to analysis is revolutionizing the CRS industry and allowing firms to provide advanced, tailored analysis to customers across a wide range of commercial sectors and industries. Further, this increasingly customizable analysis in support of real-time decision-making is a growing segment of an even larger field called Geospatial Analytics-as-a-Service (GaaS, or sometimes called AaaS).

There is considerable overlap between the two industry segments. If any distinction exists between the imagery insights industry and the broader GaaS industry, it is the extent to which the former emphasizes imagery data as the foundation of analysis, versus companies in GaaS, which predominantly leverage other sources like social media and traffic camera data as the core of their analysis. The imagery insights industry owes its inception to the recent abundance of cheap, easily accessible, and readily disseminated remote sensing data from both satellites and aerial platforms. In addition, the adoption of cloud computing provides these companies with a platform in which to quickly develop, test, and offer new, machine- and expert-based analytic applications to customers.

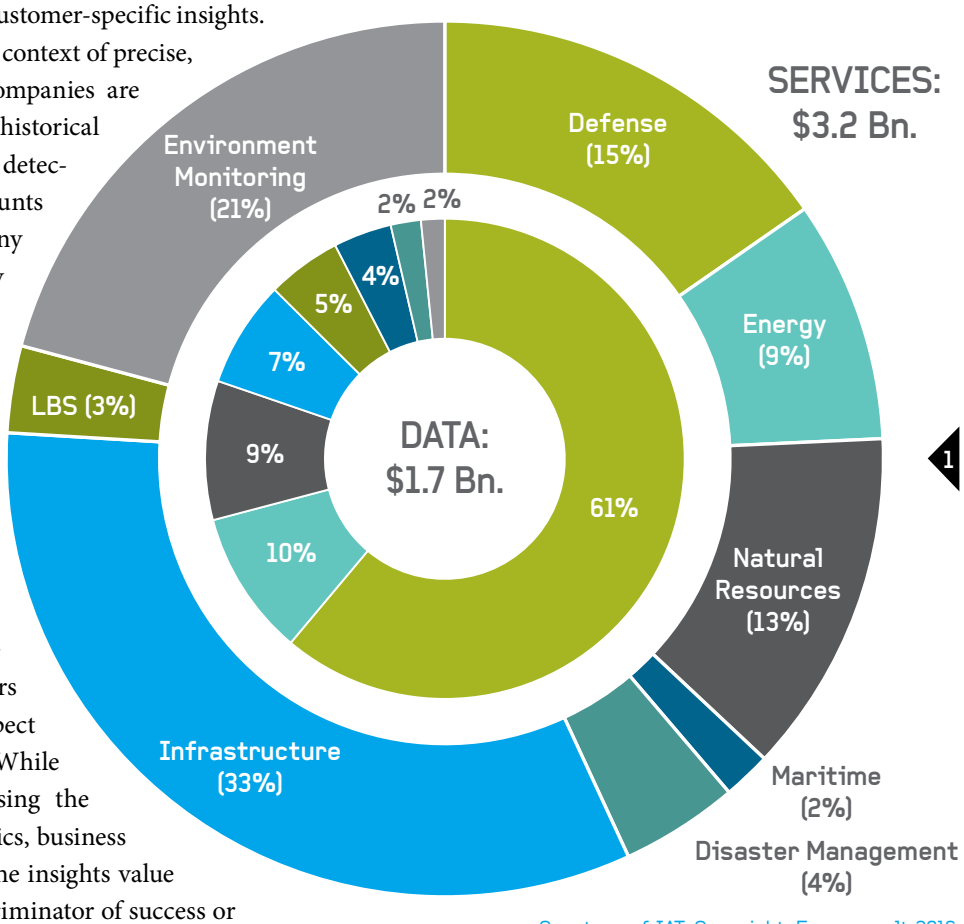
Editor's Note:
In this article, the term Geospatial Analytics-as-a-Service (GaaS) is used to specify an Analytics-as-a-Service (AaaS) model where the primary or majority of data is geospatial. This term, and several variations including Imagery-as-a-Service (IaaS), has been used in a number of publications including the 2017 USGIF "State of GEOINT Report" to refer to similar concepts. The terms have subtle differences and are evolving over time.

Companies operating within this sphere rely on proprietary software and algorithms to create tailored analytic products. Advances in big data collection, storage, and query allow imagery insight providers to comb through massive amounts of sensed data in minutes or hours instead of weeks. Technologies such as machine learning and artificial intelligence (AI) can rapidly identify relevant data points and non-obvious connections and turn them into actionable intelligence.

Data source and platform agnosticism gives GaaS providers considerable business latitude, and allows them to target specific industries by creating tailored, customer-specific insights. While value is often described in the context of precise, high-speed, current information, companies are also assessing the added value of historical data, for time-series reviews, change detection, and trend analysis. Large amounts of sensed data are amassed in company archives, and are now increasingly placed into the cloud for ease of collaboration and experimentation, in platforms such as AWS (Amazon Web Services) Earth.

The addition of temporal aspects creates a powerful new dimension that potentially drives wholly new value to customers, whether traditional national security customers or any of a wide range of emerging commercial customers for whom speed is an essential aspect of competition or market value. While the opportunities are many, choosing the right combination of sensors, analytics, business models, and markets – in essence, the insights value chain – has and will be the key discriminator of success or failure in the market.

Generally, governments – especially their national security sectors – prefer to purchase data and conduct their own analysis. But the shift in market size and growth for both the remote sensing data and insights markets has been underway for a while. Euroconsult assessed that the global value of remote sensing analytic services surpassed data sales in the past few years; while both segments are growing, the services sector growth continues at an explosive rate, and is expected to continue to grow quickly. The combination of rapid revisit, large-scale data management, and advanced analytics offers tremendous potential, both commercially, and to inform key government policies. See ***Figure 1***.



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Courtesy of IAT. Copyright: Euroconsult 2016.

UNDERSTANDING MARKET TRENDS

Broader geospatial market trends continue to change historical paradigms for thinking about imagery and imagery analysis. Many potentially disruptive trends are well-known, and portend rapid change:

- the emergence of smallsat architectures,
- proposed commercialization of new phenomenology (e.g., radar and hyperspectral data), and
- commercial launch trends.

Less understood is the tectonic shift emerging in the artificial intelligence world. Estimates of artificial intelligence firms globally range from 1000-3500, with heavy concentrations in the U.S. and Europe. Dramatic change and disruption is bound to happen in such an ecosystem, given the sheer amount and diversity of investment. Aside from purely commercial activities, governments are also placing increased investment in the connection between geospatial intelligence and AI, such as NGA's

public-private partnership initiative, the U.K.'s early 2017 announcement of plans to invest in AI development, and France's "AI France" plan designed to establish leadership in the industry. Other countries are beginning to awaken to the opportunity to benefit from the geospatial-AI link.

WHICH ADDRESSABLE MARKETS?

Traditional national security users are highly savvy about remote sensing, and a growing set of new commercial customers is increasingly knowledgeable. In order to be successful, however, imagery insights firms will need to understand different nuances of addressable markets, and how they are changing. They will also need to understand the comparative value of what they are providing relative to complements and substitutes in the market. This involves understanding the unique needs of customers, the value of information to them, and especially the price sensitivities to other sources in the market. While some customer knowledge is still necessary, however, a true commercial market will emerge only when the need to understand remote sensing is a mere artifact, just as the cell phone user cares little about the fact that their call home transits terrestrial, undersea and space channels. Trust will also be important.

GOVERNMENT USE

Both government and commercial users potentially benefit from full engagement with the remote sensing industry. Let's start with government. The U.S. government has been leveraging commercial imagery data for over a decade, and it continues to increase its commercial data consumption. The National Geospatial-Intelligence Agency (NGA), for example, pioneered the NextView and EnhancedView contracts since the advent of U.S. commercial imagery; more recently, NGA awarded a $14 million contract to Planet for commercial imagery data over 25 select areas of the globe. NGA's Commercial Initiative to Buy Operationally Responsive GEOINT (CIBORG), with the support of the General Services Administration (GSA), is further designed to enable a steady flow of commercial, unclassified data and products into the Intelligence Community (IC).

Similarly, unconventional is the U.S. government's interest in increasingly automated analytic products: DoD's Algorithmic Warfare Cross-Functional Team (Project Maven) is working in concert with NGA to incorporate machine learning and AI much deeper into combat and other operations. While Project Maven is beginning to work with commercial analytics providers, the majority of other U.S. government activities have been focused on acquisition of data.

The GaaS providers have not yet found a substantial role in satisfying government analytic needs. Why? First of all, some of them may not be emphasizing government needs as a matter of business strategy. Within government, however, some impediments exist as functions traditionally done inside the government, based on new business approaches and technology, emerge in the commercial world. The answer may also have to do with additional misperceptions or mistrust of the analytic processes used to derive imagery insights. Imagery analysis traditionally done as a high-end, artisanal process now moves to the cloud, at speed and scale. Uncertainty abounds, and change is hard. The U.S. government's national security and public safety missions leave little room for error.

COMMERCIAL USE

Commercial customers also have unique needs, especially in fast-paced areas like transportation or slower functions like insurance or mining. What are the addressable markets here? These potentially include, but are not restricted to, sectors like agriculture, insurance, mining, oil and gas, global asset management, and others. Accuracy and accuracy-at-speed will be important for assessing trends, and risk, and other factors around which those customers create their own business value for individuals or other companies.

DESCRIBING CLEARLY HOW ANALYSIS IS DONE

If customers are going to value and use commercially-driven insights, they are going to understand and have confidence in how the process is done. Increasingly, the imagery insights companies are moving beyond using software simply as an analytic tool to view and decipher imagery. Software allows preliminary analysis beyond the labelling of sensed objects, recognizing trend lines through historical and current data, and even beyond short-term predictions. Sophisticated functions like mapping, discovery, change detection, 3D analysis, and others are now possible. However, high-value, advanced analysis provides an understanding that goes beyond the "what," "where," and "how," and sometimes adds the "why," and the "so what." It provides an in-depth assessment of an issue, and often includes a level of forecasting stretching beyond the immediate future.

The AI software and machine learning algorithms used by the imagery insights industry have not yet achieved this more advanced level of analysis, except in narrowly defined areas. However, rapid advances can be expected given the intensity

of effort, both within this industry but also because of the broader base of AI development. But this will be insufficient unless the analytic tradecraft underlying the analysis is explicit, whether to government analyst or commercial consumer.

What aspects of tradecraft might they need to know? Let's look again at the government and commercial market segments. A vision of commercial success for the imagery insights industry with U.S. government clients would involve seamless incorporation of commercial insights into government analytic products. That will require that the analyst understand the provenance and quality of the data, the tradecraft associated with analysis, and at least a conceptual understanding of the entire commercial process. Government analysts will not check someone else's work, and may either discount it or discard it as part of their own analytic process. Integrating commercial insights into NGA or other U.S. government organizations will necessitate a significant level of trust in the analytic products coming out of the commercial sector.

In order to ensure that the U.S. government can rely on its industry partners, a system will need to be developed to validate the quality of analysis being produced by the commercial sector. This system can be produced through a combination of U.S. government and industry best practices, and can be executed either within government or within the emerging GEOINT broker concept. Participating companies would need to be certified as trusted providers of imagery analysis, which would allow their processed data and insights to be seamlessly integrated into existing defense and intelligence systems. This system would include rules for certification and reevaluation, including those required by business model changes.

Specific tradecraft standards would need to be developed and tailored to specific types of capabilities. For example, standards for synthetic aperture radar (SAR) would be different than those for standard multispectral imagery. Standards for night-time imagery (NTI) and non-Earth imagery (NEI) would likely be the most flexible due to the fledgling nature of those technologies and the limits on commercial resolution. Standards would need to be regularly updated to stay abreast of technological and regulatory developments.

"Integrating commercial insights into NGA or other U.S. government organizations will necessitate a significant level of trust in the analytic products coming out of the commercial sector."

For commercial customers, analytic tradecraft and standards are equally important, albeit in different ways. Historically, the search for the "killer app" for commercial remote sensing has gone unanswered, other than vague or anecdotal generalizations about why commercial clients might find value in these data and the insights they provide. Commercial customers of the imagery insights industry are already making key decisions using these analytic products, so they will need ways to maintain and increase confidence in how to use them.

UNDERSTANDING THE NEW VALUE CHAINS FOR IMAGERY INSIGHTS AND GAAS

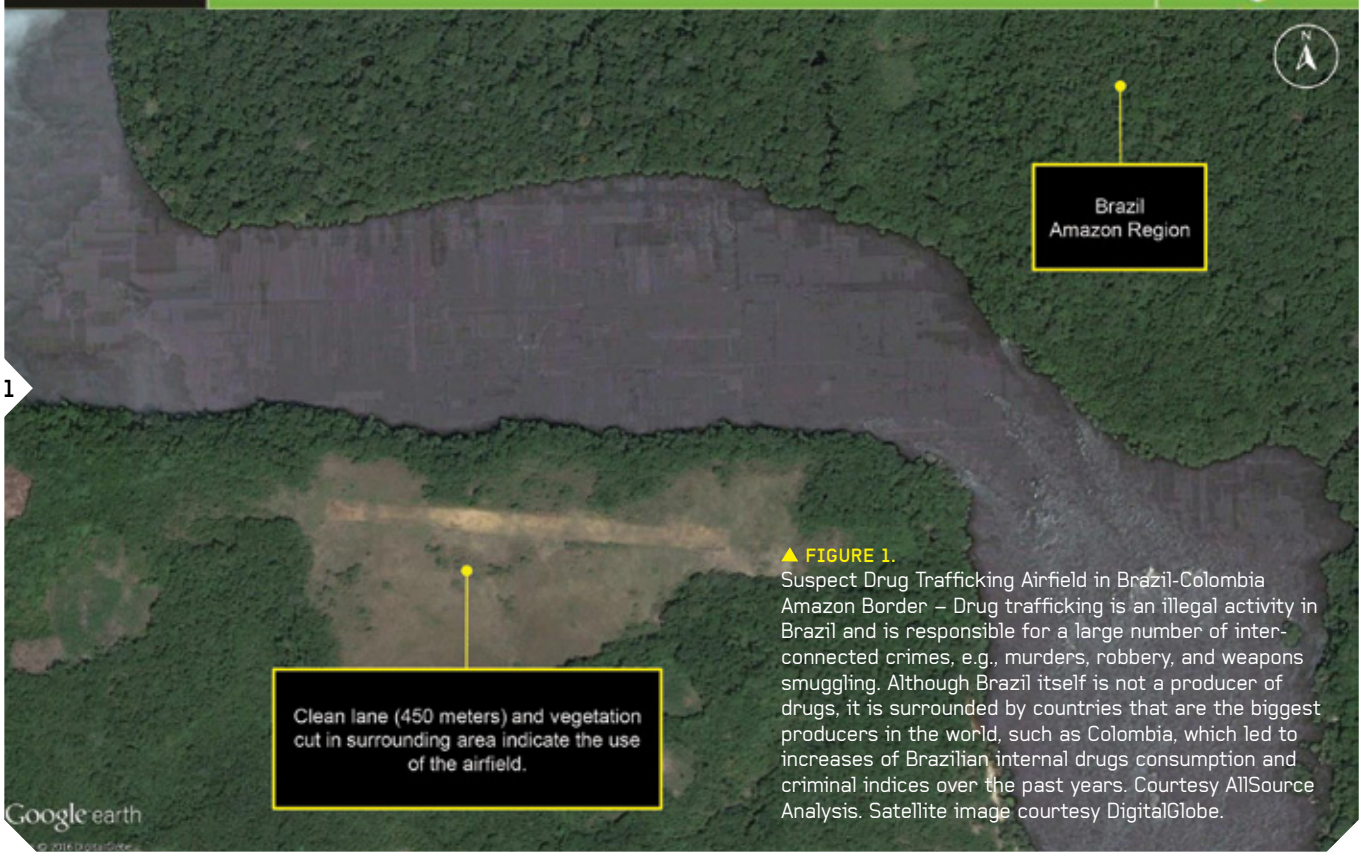
Selecting and satisfying specific market sectors, which we refer to as analytic verticals, remains tricky for the imagery insights industry. In order to drive commercial success, there has to be a sophisticated understanding of customer need throughout the value chain from sensed data to exploitation methods, to analytic tradecraft, to price and service models.

There is the question of which data combinations – whether from remote sensing or elsewhere – will drive the highest potential commercial value. There may be tradeoffs associated with satisfying one vertical that might preclude satisfaction of another. Other types of geospatial information, such as data from drones or terrestrial collection systems, serve both to complement and compete, depending on the business model. Which combinations will prevail? Understanding these issues will be an essential part of expanding this industry's ultimate contribution to GaaS.

It is in both the U.S. economic and national security interest to remain the international leader in commercial remote sensing and in imagery insights, both of which serve as foundational elements of GaaS. Beyond the CRS data providers, who are themselves reassessing their roles in this market, the imagery insights industry represents an important and growing segment of the commercial geospatial ecosystem. Addressing market opportunities in both government and a wide range of commercial applications will require experimentation and adaptation as clear value propositions emerge. There will be winners and losers. But careful attention to the analytic

ANALYSIS

Suspect Drug Trafficking Airfield in Brazil-Colombia Amazon Border



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▲ **FIGURE 1.**
Suspect Drug Trafficking Airfield in Brazil-Colombia Amazon Border – Drug trafficking is an illegal activity in Brazil and is responsible for a large number of inter-connected crimes, e.g., murders, robbery, and weapons smuggling. Although Brazil itself is not a producer of drugs, it is surrounded by countries that are the biggest producers in the world, such as Colombia, which led to increases of Brazilian internal drugs consumption and criminal indices over the past years. Courtesy AllSource Analysis. Satellite image courtesy DigitalGlobe.

ANALYSIS

Oil Spill in the Saronic Gulf

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▲ **FIGURE 2.**
Oil Spill in the Saronic Gulf – On early Sunday morning, September 10th, 2017, the oil tanker Agia Zoni II sank in the waters between Piraeus and the island of Salamis. The vessel was carrying approximately 2,200 metric tons of fuel oil and several hundred tons of marine gas oil, which reportedly leaked from the hull into the Saronic Gulf near Ataláṇti and Psyttáleia Islands upon sinking. Courtesy AllSource Analysis. Satellite image courtesy Planet.

AaaS ■ IaaS ■ GaaS

Geospatial Analytics-as-a-Service & Platforms

The Next Value Proposition Matures

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The field of Earth Observation (EO) has seen two big changes in recent years: first, the massive increase in the number and variety of space-based sensors and, hence, the proportional increase in the amount and refresh rate (cadence) of EO data and falling prices for them; second, the shift by EO companies from selling pixels to selling finished intelligence products that answer specific questions—in other words, from data to analytics. This first article in this new series presents the perspectives of two long-time players in this industry:

- Chuck Herring, CEO and Co-Founder of AllSource Analysis;
- Marc Fagan, CEO of Earth Observation Systems (EOS) Data Analytics.

ORIGINS

Herring grew up hearing about all kinds of space missions. His father was a senior leader at Ball Aerospace for about 25 years and his older brother has been at Lockheed-Martin for almost 30 years. When Ball Aerospace became the major owner of EarthWatch, the predecessor to DigitalGlobe, his father was the founding CEO. "I was working at IBM. He brought me over for lunch and I was very interested, so I switched to EarthWatch." His passion for the field has kept him in it since. "It is exciting, interesting, and fun to be involved in the birth of a new industry and watch it take off."

In his early days at DigitalGlobe, as Herring understood his customers' questions and problems, he began to think of what later became AllSource Analysis. While many of his customers were savvy about the technology, others did not fully understand it. He and his colleagues began using subject matter experts and image and geospatial analysts to extract information out of the imagery, so as to provide their customers with answers, rather than just pixels. The savvy customers – generally, governments and large corporations that were already using aerial imagery – often needed help extracting the information that was most relevant to them, especially in real time. Toward the end of his time at DigitalGlobe, Herring and a few of his colleagues including Stephen Wood, formed a group called the Analysis Center, then decided to found AllSource Analysis outside of DigitalGlobe, because they felt that they needed to be "agile and small" and able to adjust their offering and their business model to their customers' needs. Stephen was a co-founder who has stepped away from day to day, and is still involved and on the board.

Before joining EOS Data Analytics, Fagan was part of another venture-backed startup that had an exclusive partnership with Google, which was then launching Google Maps Engine, an imagery analytics program. "We were investigating the opportunity for commercial applications of Earth Engine analytics," he recalls. "Part of the consideration included identifying go-to-market strategies, and the technical and product requirements

for commercialization." Jointly, the two companies developed a series of pilots with such companies as Pacific Gas & Electric, Chevron, and water utilities. Ultimately, Google deprecated Google Maps Engine, which was to be the vehicle for the commercial implementation of Google Earth Engine. "By this time however, we understood the potential and value of EO imagery analytics for commercial as well as non-commercial applications."

EOS Data Analytics is backed by Noosphere Ventures, a Silicon Valley, California-based VC managed by Max Polyakov.

Noosphere, Fagan recalls, approached him to start a company to develop a cloud-based EO analytics platform, utilizing software engineers and EO research scientists largely resident in Ukraine. "I spent a fair amount of time investigating the talent of the team there and the opportunity, and ultimately decided that the talent was excellent and started the company as the CEO in 2015." Presently, Fagan says, EOS has 103 employees, including four professors, nine additional PhDs, and 60 people with master's degrees in mathematics, EO, analytics, and GIS. The management and product management teams are in Menlo Park, California, and the engineers and scientists are in three cities in Ukraine: Dnipro, Kharkiv, and Kiev.

CHANGES IN THE EO DATA MARKET

"When the high-res commercial imagery first started, you had just a couple of satellites from DigitalGlobe and Space Imaging," Herring recalls. Now, in addition to the enormous amount of imagery being collected by DigitalGlobe (and all the predecessors that are now part of DigitalGlobe), there are new players, such as the European Space Agency, Planet, and UrtheCast, and many others keep emerging, including some that are talking about launching SAR satellites. "You are looking at spectral enhancements, you are looking at getting into radar."

Most commercial customers, however, are not able to fully understand and interpret these data, Herring points out. Therefore, in addition to the technology, the EO industry provides expertise, including AI and machine learning, to expedite getting the answers that their customers require. Increasingly, government customers want to acquire finished intelligence, as opposed to just pixels. "There are many different companies solving many different imagery and geospatial problems," Herring says. Nevertheless, the more savvy customers often also want the source imagery, to use for basemap purposes.

Additionally, Fagan points out, the advent of open source and very inexpensive methods to convert imagery into point clouds using photogrammetry has given a new boost to aerial imaging, including UAVs. One use case he cites is the use of aircraft and UAVs for the detection of structural changes along gas transmission pipelines for safety measures. Nadir high resolution satellite imagery, he

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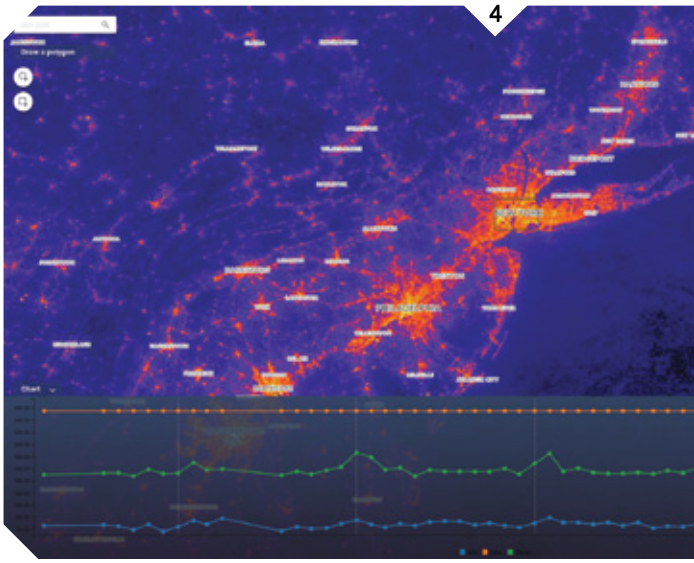
▼ FIGURE 3. LandViewer is an on-the-fly imagery browser that allows the public to explore potential scientific, social and business applications of earth observation data, in this case, Landsat 8 imagery of Stanage, Queensland, Australia.



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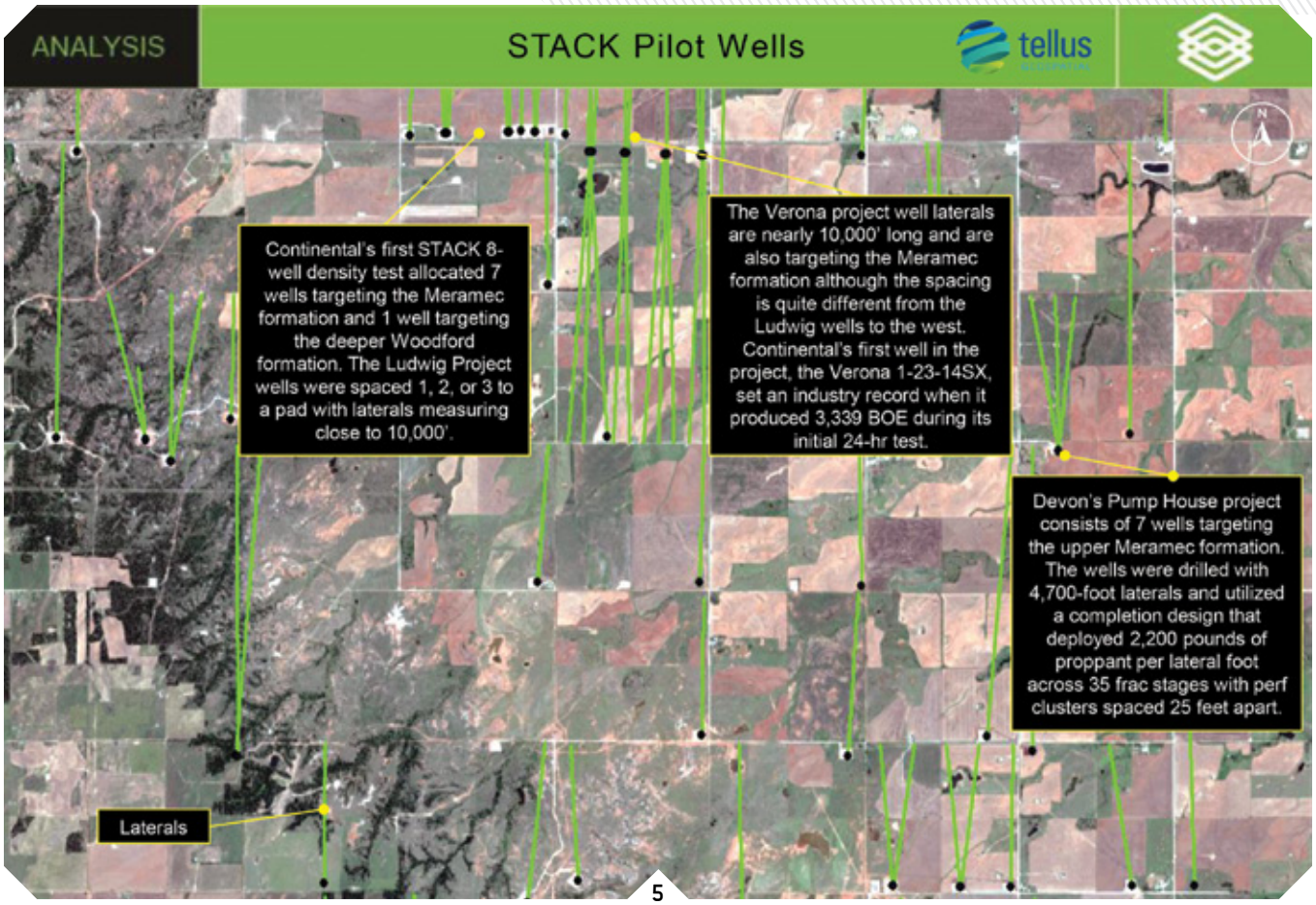
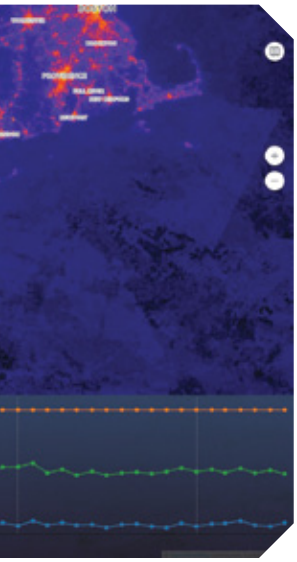
▶ FIGURE 4. GDP Analysis - Night lights change detection (worldwide) for gross domestic product (GDP) analyses utilizing NOAA Visible Infrared Imaging Radiometer Suite (VIIRS) of New York and Philadelphia regions, U.S.A.



▲ FIGURE 5. STACK Pilot Well Programs in Oklahoma – Newfield Exploration Company announced the discovery of Oklahoma's STACK play in November of 2013. The Sooner Trend Anadarko Basin Canadian and Kingfisher counties (STACK) play was so named due to the stacked nature of the play's production zones. Courtesy AllSource Analysis. Satellite image courtesy DigitalGlobe.

explains, was unable to properly register multiple image sets and made it difficult to correct for distortion along sloped surfaces. These issues, he says, made it impossible to detect changes of less than 300 square feet. Now, by converting digital imagery sets using photogrammetry, it is possible to develop very high-resolution point clouds and apply change detection methods that have nearly perfect registration between images and obviate the issue of the distortion of sloped surfaces, Fagan says. This, he adds, can now be done at very competitive pricing and with verifiable accuracy.



BUSINESS MODELS

AllSource Analysis' business model, Herring says, is a combination of selling imagery and providing more automated analytics. "So, being able to do large areas, across continents, across regions, doing change detection, object identification, those types of things…" Their analytic services range from classic use cases, such as counting cars in parking lots to monitor sales, to volumetric analyses of oil facilities.

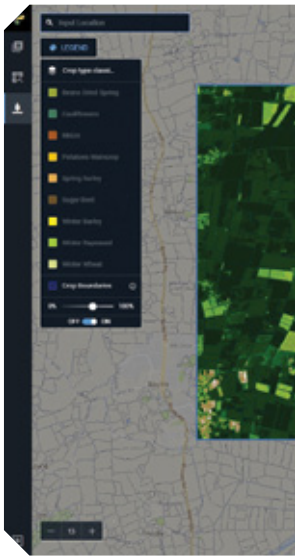
"Also, DigitalGlobe and Planet are building many of those tools for their partners." This "first phase analytics," Herring explains, can accelerate what his analysts do. AllSource Analysis has created a network of analysts and, early on, signed a strategic partnership with BAE Systems' GXP group, which has a secure, cloud-based platform that analysts can use from anywhere. "It is an amazing platform that is essentially that advanced tool kit that an expert analyst needs to use."

Some of the analysts that AllSource Analysis employs were trained in the intelligence community or academia and are now between jobs or retired. "This is something for which they have a passion." Additionally, they have an expertise in a particular area, such as Middle Eastern security, Asian economic development, or energy. Many of the more savvy commercial customers, such as energy companies, have in-house mapping capabilities but may lack the capability to view and analyze imagery. "We have the software,

the content, and the experts," Herring says. "We provide the finished intelligence product. We take all that complexity away and we can do it in a very cost-effective way, because we do not have a building filled with a thousand full-time analysts. We are able to scale and bring on analysts as we bring on customers."

EOS' core technology is EOS Engine, a platform-as-a-service for building, developing, presenting, and imaging processing and analytics, Fagan says. It includes a "work bench," consisting of workflow, sequential processing steps, business rules, and a suite of GIS functions and features, which allows EOS to rapidly configure use cases by simply pointing to its repository of datasets in the cloud, he says. Once configured, the use case automatically creates, accesses, and processes EO data. "Our goal is to be the market-leading EO analytics platform in any and all industry verticals." EOS plans to sell this platform as an OEM product to customers that already have relationships with end users.

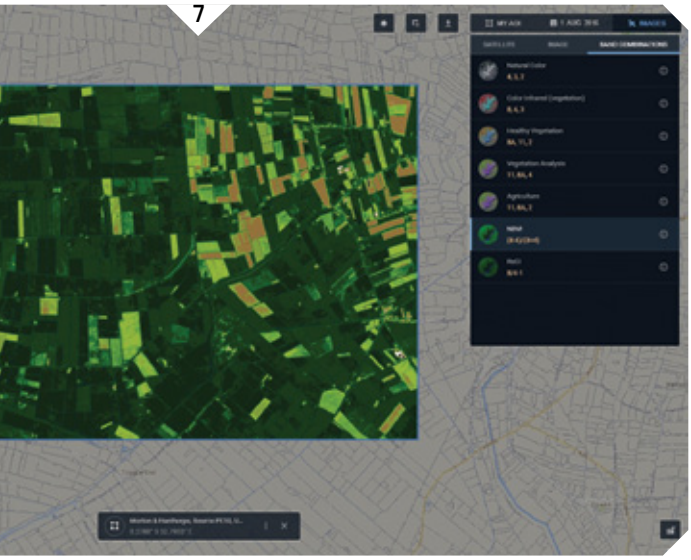
EOS has also developed a free cloud-based platform, called "LandViewer" that enables non-EO experts to peruse datasets and derive spectral indices, such as NDVI, NDWI, and atmospheric penetration. The company is currently working, in partnership with Amazon, with Landsat, MODIS, and Sentinel 2 data and plans to soon add data from Sentinel 1 and NASA's Suomi National Polar-orbiting Partnership (NPP), Fagan says.



It recently released a premium version of LandViewer that provides more expert analytics and will soon provide commercial datasets from additional satellites as well as from aerial imagery providers. The company has developed proprietary methods of automatically indexing, stitching, tiling, and mosaicking raw imagery scenes and is providing these services to multiple satellite and aerial data providers, Fagan says. LandViewer, by educating potential end users as to new EO datasets, coupled with derivative data and analytics, has been a great lead source for all of OES's products, he adds.

Pricing of EOS Engine, which is primarily focused on

▼ FIGURE 6. Attack on Dayr az Zawr Airbase – Analysis of GEOINT reveals that the infiltrators were able to travel approximately 600 meters through checkpoints, security fences, and defensive fighting positions to reach L-39 aircraft on the main operational apron. Courtesy AllSource Analysis. Satellite image courtesy Airbus.



◀ FIGURE 7. Crop Monitoring - Crop production monitoring and yield forecasting utilizing neural nets, high-cadence satellite imagery, and InSAR (Interferometric Synthetic Aperture Radar) with ESA's Sentinel 1, including spectral health monitoring indices relevant to agriculture, including grain trading and crop insurance, in Bourne, U.K.

enterprise applications, is based on per square kilometer by use case, because each use case consists of a different combination of processing and data type, Fagan explains. With LandViewer products, EOS charges a base monthly price for the analytics and open source datasets and will add commercial datasets and more sophisticated analytics for a flat monthly fee.

AI AND MACHINE LEARNING

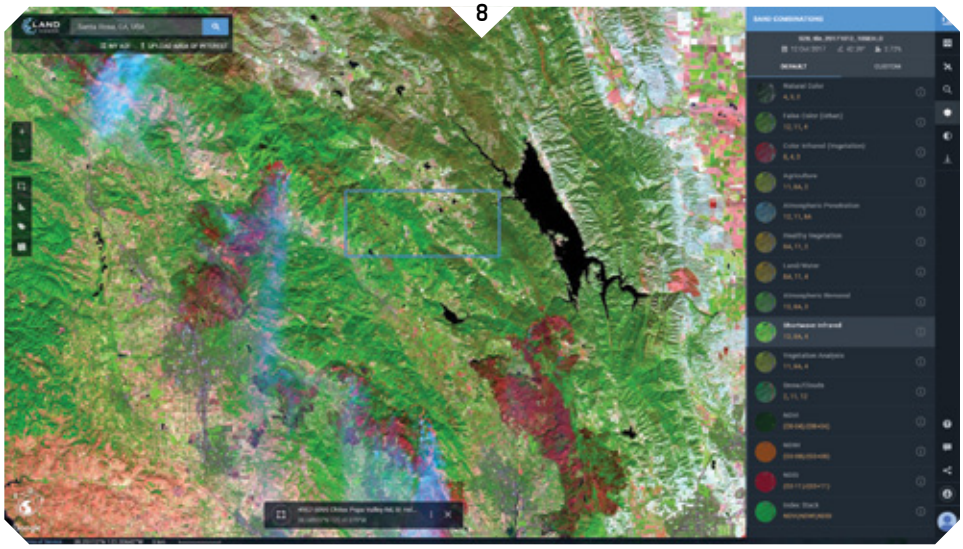
While AllSource Analysis is not building AI or machine learning, it is leveraging its partners' resources in those fields. "Not only can our analysts do the Phase 2 and Phase 3 finished analytic product, they can also help those AI machine learning developments refine their capabilities, essentially train and help," says Herring. While companies such as DigitalGlobe, Orbital Insight, and Planet are automating image analysis, AllSource Analysis is focused on the human imagery intelligence experts.

EOS has a large staff of EO scientists with expertise in the traditional mathematics of pixel analysis, Fagan says. However, since its founding, EOS has largely converted to AI methods primarily using convolutional neural networks, which, he says, greatly extends its range of capabilities and is required by the land mass covered by its analytics. Its methods include land cover classification, feature recognition, and InSAR. "We have extensive 'training' programs and continue to improve on our results and the more refined indexing of results."

As examples, Fagan cites analyses of tiered water pricing rates by classifying ground cover and applying evapotranspiration rates to identify target water consumption rates by properties; a crop production monitoring analytic utilizing SAR data to discern the production rate of crops by type; and multiple applications replacing nadir imagery sets with rapid and less expensive photogrammetry processing of point clouds. Use cases also include asset management and construction monitoring and the identification of the lifecycle stage of upstream oil and gas wellheads, based on identifying the types of equipment present. "This is a very exact indicator of the production rates of oil and gas for the commodities and futures markets that provides such insights way before any other methods in the industry," Fagan says. EOS also applies the same methodologies to LIDAR datasets, he adds.

PARTNERSHIPS

"There is a huge ecosystem out there built on geospatial analytics and intelligence," Herring points out. For example, DigitalGlobe continues to build out its capabilities with regards to high-res and very high-res imagery, Planet is combining its "doves" with the SkySat constellation of seven satellites that it acquired from Google, other companies are deploying radar satellites, and still many more satellites are coming. To be true to its name, AllSource Analysis partners with several imaging companies and technology providers "because that accelerates what our analysts can do," Herring says. The company also started



▼ FIGURE 8. LandViewer showing on-the-fly shortwave infrared spectral analysis with Sentinel 2 imagery of St. Helena, California, U.S.A.

▲ FIGURE 9. WaterCloud - Ground cover classification utilizing convolutional neural networks (AI) and aerial imagery and evapotranspiration rates for water conservation analytics in N. California, U.S.A.

partnerships with companies that provide real-time alerting such as Stratfor and PlanetRisk. This allows their customers to geofence an area – say, where a company executive is traveling – and get alerts about events in that area that might raise security concerns before seeing them on the news, as well as additional relevant information.

AllSource Analysis has a "symbiotic customer relationship" with Stratfor, which specializes in geopolitical intelligence and has experts around the world watching issues from elections to terrorism. "They don't have an imagery intelligence capability, nor, because of our partnership, do they want to build that internally. So, they are telling us what they are working on and can request intelligence from us." The company is also developing partnerships with companies that are doing ground intelligence in areas of the world where it is harder to get ground intelligence due to lack of security. "They have a product that is complemented by our product."

Among EOS's partners, Fagan cites Airbus, DigitalGlobe, Planet, TerrAvion, and DroneBase. "We are also in negotiations with satellite entities from China, Kazakhstan, the UAE, and Korea and we continue to work diligently with Amazon and their partners for open source datasets such as NOAA, NASA, and the European Space Agency."

CUSTOMERS AND USE CASES

Most of AllSource Analysis' current customers are in the fields of government and commercial security, energy, and finance, though Herring also mentions Uber and Lyft. While the applications across these fields are generally of the same type, the company's success hinges on the ability of its subject matter experts to answer its customers' specialized needs and questions. Unlike companies that do very project-based analytics, as consultants, Herring explains, AllSource Analytics is putting together a subscription program, with three levels of product: a 5-10 page "discovery" report, a 10-20 page "analysis" report, and an "insight" report of more than 20 pages. The exact mix and frequency of these reports is customized to each customer's needs. "We are priced in a way that makes it very easy to understand," Herring says. "It makes it predictable for the customer. We are not selling them a multi-million dollar project."

"We are bringing a new economy for the analysts to address the human in the loop of spatial analytics." As an example of AllSource Analysis' work, Herring cites research for the U.S. government and U.S.-friendly foreign governments on geopolitical issues that may affect their national security, such as refugees, food security, or oil. "This is all open source, it is commercial, it is the same as what we talked about when imagery first started coming on line. It is stuff that we can help them with that they can share across agencies and with other governments."

Another example he cites is corporate security. For example, an energy company or a large manufacturing company that has multi-billion dollar facilities in dangerous regions throughout the world, where things can change very quickly, wants to understand its potential vulnerabilities or threats in real time. A third example concerns competitive intelligence, for example in the energy industry, in which a company might want to know not just what the industry volume is but what quarterly profits a competitor is likely to report.

EOS, Fagan says, has developed a large knowledge base regarding the numerous EO data types that, coupled with the appropriate analytics methods, support the myriad of use cases across industries. "Our development road map," he says, "has been dictated by first identifying from industry experts the most valuable use cases and testing and verifying the correct data type and analytics to support those use cases."

"One of the tenets of our company is being data agnostic," Fagan says. Companies that rely on just one or a few sensors, typically because those are the ones they own, need to develop analytical capabilities to augment the value of their data, he explains. However,

the myriad of use cases in both the commercial and nonprofit sectors require many different sensor types, with different resolution, spectral bands, cadence, and costs. "Presently, EOS is doing an awful lot with SAR, primarily with ESA's Sentinel 1A and Sentinel 1B, but also with Airbus's TerraSAR products."

Another use case that demonstrates the need for being agnostic with regards to data sources, Fagan says, is the detection and modeling of change in the signature of night lights worldwide as a proxy for changes in GDP, a project for which EOS utilizes the NPP sensors. Another example is the identification of the production rates of specialized refineries, called crackers, using SWIR (shortwave infrared) to detect their thermal signatures.

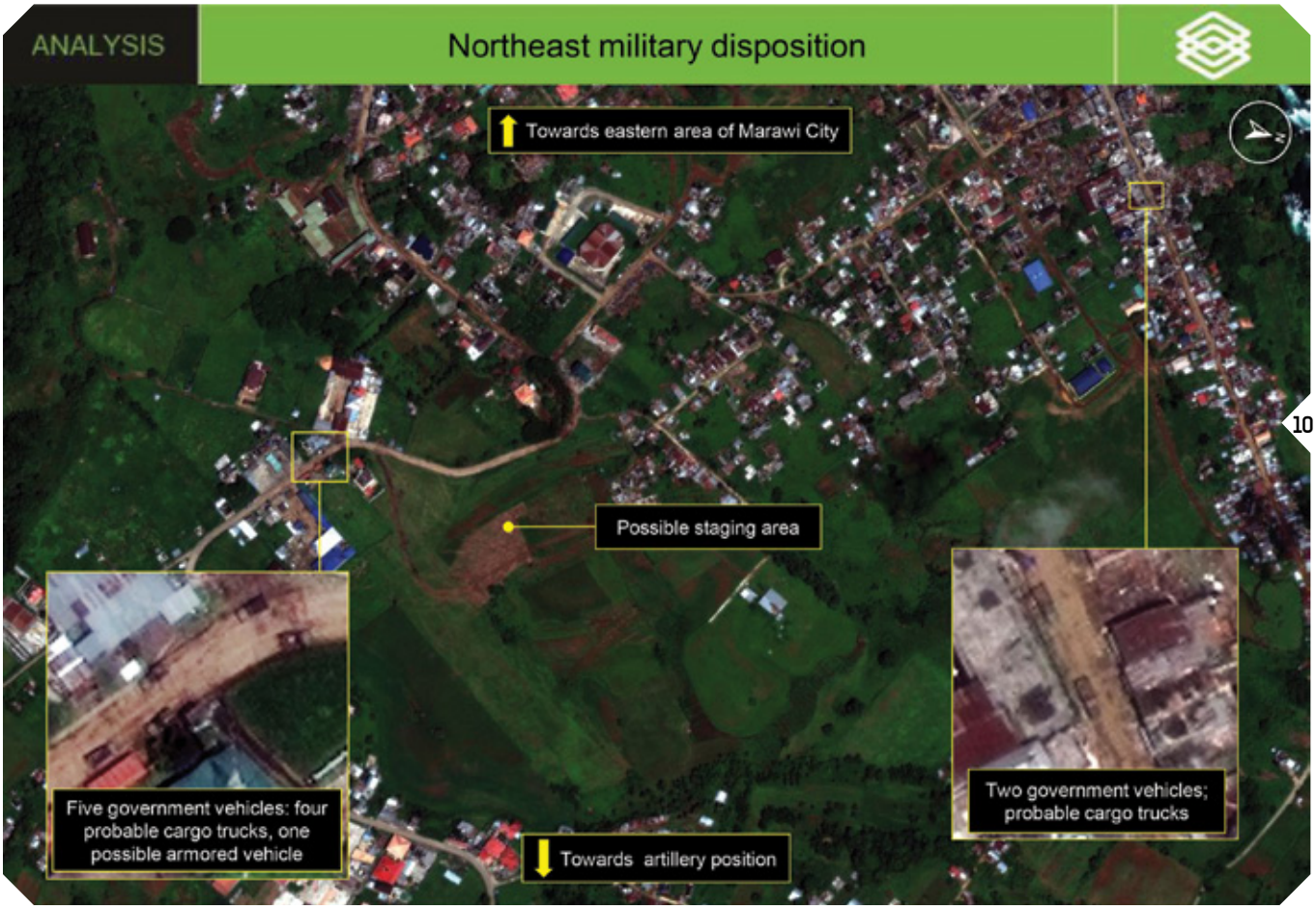
"Our present focus is in the financial, agriculture, and energy industries," Fagan says. "In the financial markets, we have more than 12 distinct products ranging from oil and gas futures, GDP economic indicators, disaster impact analyses, reinsurance risk analyses, and agriculture commodities and futures analytics. In agriculture, the products include crop production rate monitoring, crop heath analyses, disaster damage, and economic assessment." EOS has also developed analytics to support the agriculture supply chain where its data is utilized by seed producers, pesticide and fertilizer providers, processing plants and transportation logistics, he adds.

EOS is also working with nonprofit entities, especially regarding environmental issues. Examples include Blue Planet, a consortium of the United Nations that focuses on such things as oil spill detection, nitrates runoff pollution, and the status of coral reef deterioration; and the World Ocean Council, which brings together nonprofit research work and commercial enterprises to improve the environmental health of oceans, Fagan says.

CONCLUSIONS

When the U.S. Air Force was developing GPS, who knew that it would one day be used by consumers to find the nearest coffee shop, by shipping companies to track their trucks, or by seismologists to track the movements of the Earth's crust after large earthquakes? Likewise, the explosion in the amount and varieties of EO data will generate innumerable and yet unforeseen new use cases and business opportunities. ∧♂

▼ **FIGURE 10.** The Philippine Government Regains Control of Marawi City – According to AllSource analysis of GEOINT from 28 June 2017, eastern areas of Marawi City sustained widespread damage, and the Philippine government most likely occupies key civil, political, and military areas in the city's west and northeast areas. Courtesy AllSource Analysis. Satellite image courtesy DigitalGlobe.



10

An Essential Part of IoT

Imagery as Basemaps for Smart Facilities

FRED WOODS / VP MARKETING / GEONEO
SAN DIEGO, CALIF. / WWW.GEONEO.COM

Energy conservation and sustainability are priorities for governments and businesses in regions throughout the Americas, Europe, Middle East and Asia. Most existing infrastructure is old and obsolete. This is an obstacle to meet the rising expectations of government officials, employees and citizens. Governments are leading large-scale transformational projects to address this issue.

Buildings, facilities, campuses and installations account for the most energy consumption within these regions. To reduce energy use and create sustainable facilities, governments worldwide are taking action. Whether through governmental orders, regional mandates or city plans, governance is driving conservation and sustainability. This is leading to the rise of smart buildings, facilities, installations and campuses. Facility managers, installation commanders and campus administrators are purchasing and implementing modern, efficient and connected equipment that can make these facilities smarter and energy efficient.

"Energy is a valuable resource that is critical for Marine Corps readiness and success. To be effective, we cannot afford to use more than we need. To maintain our expeditionary edge, we will use energy wisely, from 'Bases to Battlefield.'"

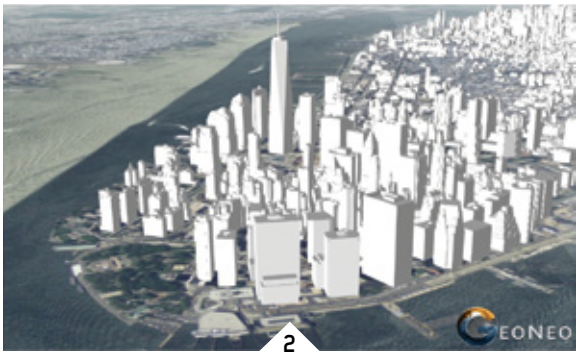
J. A. Kessler, Major General, U.S. Marine Corps,
Commander, Marine Corps Installations Command

In the United States (U.S.), the goal is to maintain building and facility sustainability while reducing greenhouse gas emissions. Reducing facility energy consumption, and creating 25 percent renewable energy by 2015 are specific goals set by the U.S. government. The European Union (E.U.) mandates include building energy savings of 20 percent by 2020. And Latin America and the Caribbean aim for net-zero energy consumption in buildings. But where to start?

Transforming existing buildings, facilities, installations and campuses into smarter and more efficient infrastructure to meet mandates and energy goals, using the Internet of Things (IoT), is the future today. IoT enables building and facility managers to understanding better how to use sensors and connected devices to monitor and improve the performance. The challenge is where to start the process of creating efficient facilities and buildings.

Before transforming a building to a smart facility, a complete and precise inventory of assets, indoors and out, including an energy audit, needs to be completed. Dewberry, a Fairfax, Va.-based professional services firm, uses various types of imagery to create a precise basemap to map these assets. The volume of information to be collected and the time needed is daunting. However, using remotely sensed imagery from drones, aircraft and satellites, including LiDAR and image-based point clouds, is an economical and time-saving method to create the precise basemap for planning and auditing.

Traditional energy audits of buildings are manual. Field workers use manual thermographic, infrared (IR) cameras and visual inspection techniques to collect building and facility information. For a large facility or government installation, with tens or hundreds of buildings, this is a time consuming and man-hour intensive exercise. This forgoes other influences such as the surrounding land surface temperature.



◀ **FIGURE 1.** Point clouds are used for as-built and 3D analysis. Image © 2017 GeoNeo, Inc.

◀ **FIGURE 2.** Solar analysis using 3D models. Image © 2017 GeoNeo, Inc.

Creating basemaps using satellite, aerial and drone imagery replaces manual and time-consuming surveys. Phil Thiel, Senior Vice President at Dewberry explained, "We use oblique imagery and LiDAR of facilities and campuses all the time. We also use thermal imagery to detect and report heat loss as part of an overall energy audit for U.S. Department of Defense (DoD) facilities."

Facility and energy performance auditing using space, airborne and drone-based imagery is

time-expedient. Analysts use Landsat, Thermal Infrared Sensors (TIRS) and airborne IR sensors for a variety of applications relating to energy audits. These include establishing the baseline solar reflectance, absorbance and surface temperature calculations over a geographic area. Additionally, they map solar energy potential for locating renewable energy. Using space and airborne imagery to identify areas of high heat reflectance and absorption helps to prioritize facilities for further detailed evaluation and analysis.

Facility managers and analysts use the resulting satellite and airborne imagery to identify susceptible buildings for detailed collections using drones and handheld cameras. "Capturing imagery during construction to record the as-built status, recording where structural components are located, enables more intelligent decisions when adding smart infrastructure later," explains Chris Blakely, Senior Solutions Engineer, GISinc, a Birmingham, Alabama-based GIS and location technology company. Refining the energy audit using high resolution IR and visual imagery from drones speeds up the process. This leads to infrastructure energy performance evaluation to determine the viability of the structure for reuse, retrofitting, demolition or replacement.

Photogrammetrists use visual imagery to create high-resolution 3D models of the facility, installation or campus infrastructure for further analysis and visualization. Visualizing thermal imagery by overlaying it on 3D models aids the analysis, correlating ground with building temperatures. GISinc uses 3D-rendered models to precisely place or locate infrastructure assets, such as mapping the array of smart lighting. Using image-based 3D models for viewshed analysis ensures that lighting, security cameras and other sensors are positioned for maximum coverage, while using fewer devices.

"Imagery is a great form of reference for both interior and exteriors assets," says Thiel. "We developed an application that allows a building or facility manager to take a virtual tour of their facility, and locate equipment, such as water and steam valves."

Analysts, paired with facility and resource managers, work to identify susceptible areas for detailed explorations and IoT equipment, such as thermostats, automatic shades and on-demand lighting systems. "When I think of our IoT work, we are analyzing power, communications or cyber assets and how they work together. After analysis, imagery is used as a visual reference for the IoT and subsystem," says Thiel.

The return on investment (ROI) for imagery is manifold. Using imagery as the precision basemap of the facility, campus or installation enables multiple forms of analysis, leading to decision product generation. These products include solar reflectance, thermal radiance and 3D models. Facilities, operations and security managers, utilizing the decision products, work together, improving sustainability, workability and security of the facility while reducing operating costs. Thiel explained that realizing the total ROI occurs within two to five years, when savings makes the budget swing into a positive direction.

> "Transforming existing buildings, facilities, installations and campuses into smarter and more efficient infrastructure to meet mandates and energy goals, using the Internet of Things (IoT), is the future today. IoT enables building and facility managers to understanding better how to use sensors and connected devices to monitor and improve the performance."

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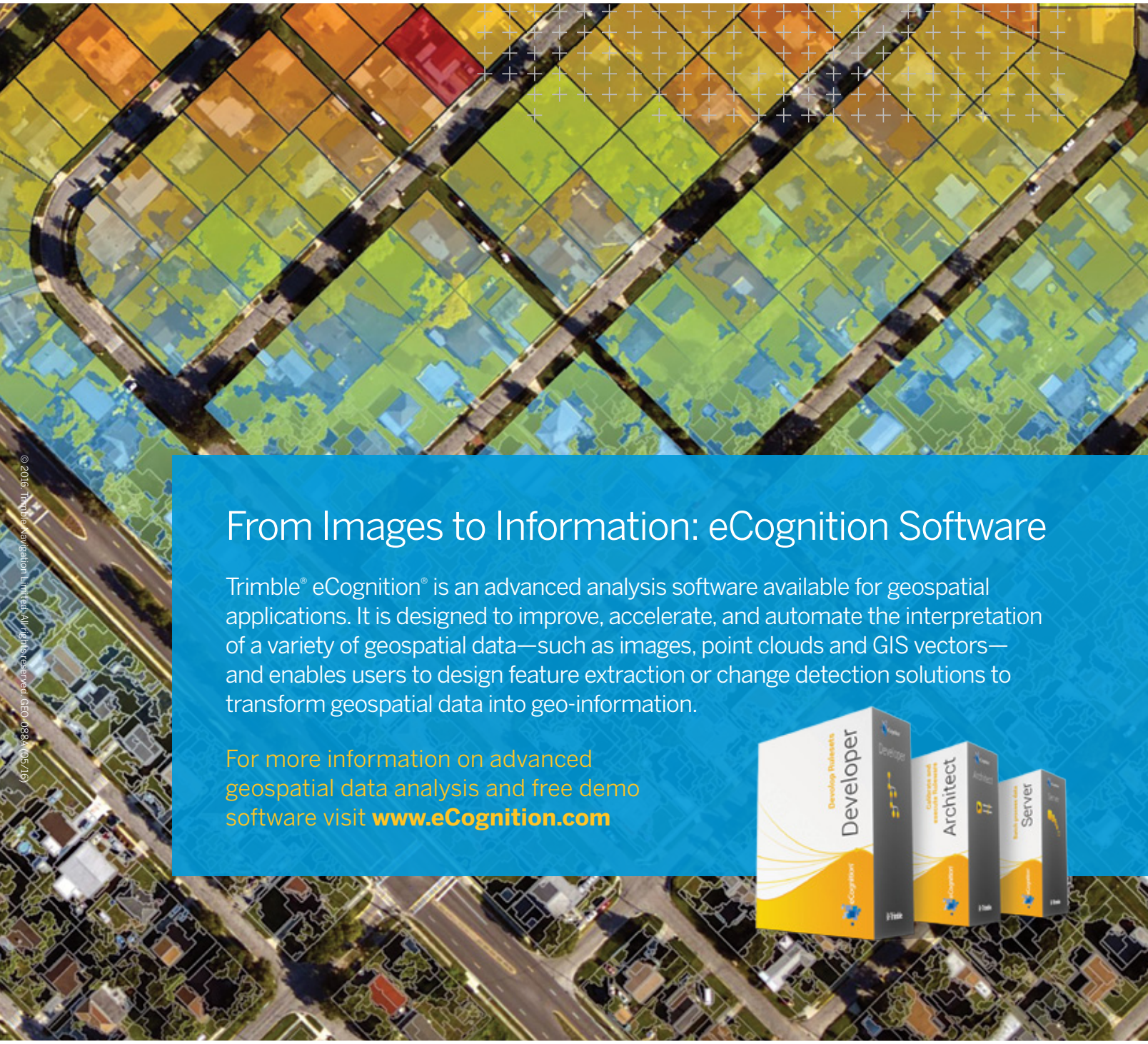

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