2015

STATE OF GEOINT REPORT

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2015 STATE OF GEOINT REPORT

What's Hot

What's Not

What's on the Horizon

2015 State of GEOINT Report

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FOREWORD

Established in 2004 as a 501(c)(3) nonprofit, non-lobbying educational foundation, the United States Geospatial Intelligence Foundation (USGIF) has provided leadership to the GEOINT discipline via the three pillars that define USGIF's goals: Build the Community | Advance the Tradecraft | Accelerate Innovation.

USGIF's mandate to foster the once emerging and now prevalent discipline of geospatial intelligence and to support professionalization of the GEOINT workforce is realized through myriad events and activities. Whether at networking events such as GEOINTeraction Tuesday, professional development opportunities with the USGIF Young Professionals Group, educational activities such as hands-on training sessions, or large-scale, community-wide events like the annual GEOINT Symposium, USGIF is recognized as *the* convening authority for the broader GEOINT Community. This is evidenced in part by the breadth of military, government, industry, and academic participation across all Foundation activities—to include this inaugural State of GEOINT report.

This year the report focuses on acquisition processes and the use of open-source intelligence for decision-making. Next year, it will include more technical papers as USGIF works to inform its Universal GEOINT Credentialing program. I believe the State of GEOINT report will provide the community with a vehicle to annually calibrate and take stock of the changes and trends in the international GEOINT Community. The need for this approach is reflected in the global nature of USGIF's members and stakeholders. Participants in the 2015 report are thought leaders in a broad range of GEOINT-related specialties, and we are pleased with the insights they developed and captured in the following pages.

USGIF strives for the highest quality in all of its endeavors, and the 2015 State of GEOINT report is a wonderful example of this commitment to excellence. Based on this inaugural report's success, we expect an even greater number of participants and entries in the years to come. I am hopeful this document will stimulate rich discussions about the current and future state of GEOINT.

Sincerely,

Keith J. Masback
CEO, USGIF

INTRODUCTION

What is the current "State of GEOINT" and what waits on the horizon? The answers are essential for professional agility in an era of accelerated GEOINT innovation. The United States Geospatial Intelligence Foundation (USGIF) presents this report to help answer these questions and support GEOINT Community interests and professional requirements.

The compilation of this inaugural report began with a diverse gathering of more than 50 geospatial intelligence practitioners Oct. 7, 2014, at the Hyatt Dulles in Herndon, Va. Participants were from academia, U.S. government, and large and small businesses. All business participants were USGIF members, and all academic participants were representatives of USGIF-accredited colleges and universities. Government participation ranged widely from uniformed military personnel and U.S. Intelligence Community employees to U.S. federal civil agency practitioners.

Participants were asked to think through a series of open-ended exercises and define which GEOINT topics, concepts, and challenges they consider at the forefront of their professions—these were categorized as "Hot" topics in GEOINT. Next, a similar exercise was conducted to determine what issues, policies, practices, or technologies are considered on the decline or are expected to depreciate in the next three to five years—these items were termed "Not Hot" topics. A final brainstorming session explored what is "On the Horizon" for GEOINT professionals.

A richness of ideas emerged from this intellectually robust environment, with a great range of perspectives recorded on easel pads, notepads, tablets, and laptops. We asked attendees to continue the dialogue over the next several weeks and, using teams formed throughout their day at the Hyatt, write short essays to capture the essence of their discussions. These essays form the basis of this 2015 State of GEOINT report. I envision this activity to become a key part of USGIF's annual events. Compiling the report not only gives the GEOINT Community an opportunity to tell USGIF what is happening, but provides information to shape the Foundation's nascent Universal GEOINT Credentialing program, helping point the way to new ideas, technologies, and tradecraft.

This year will be an exciting one for USGIF. Our Universal GEOINT Credentialing program is in development and will be rolled out during 2015. We have spent more than a year developing a GEOINT essential body of knowledge with practitioner contributions from defense, law enforcement, and U.S. intelligence as well as from the first responder, agriculture, oil and gas, mining and mineral extraction, and broader business communities. This essential body of knowledge will be used as the basis to develop a set of GEOINT credentials.

Some would ask, "Why a new geospatial credential?" It is a great question, which I am always happy to address. As a result of a confluence of technologies, the rise of ubiquitous computing power, global networks, and geospatial science and technologies that are available to a wider range of practitioners than ever before, there is a new model for the geospatial practitioner. New tools and data sources pop up seemingly overnight. For example, the number of geospatially aware apps on our smartphones is growing at an exponential rate. Nearly every new app leverages location-aware, smart-device capabilities. However, creating the underlying infrastructure, maps, and analytic tools needed within this ecosystem requires GEOINT professionals. Central to GEOINT we have imagery and sensor data. Increasingly, we also have geolocated social media and GPS enabled information. A picture paints a thousand words and the use of imagery, both literal and derived, coupled with other sources to answer a question is what makes GEOINT a unique discipline.

And GEOINT extends beyond imagery, features, and attributes. The professional practice of GEOINT includes the synthesis and analysis required to make sense of all data, including increasing quantities of open-source data available via a wide range of social media outlets. To understand, use, and explain analyses of disparate data and information to resolve complex challenges requires depth and breadth of both skills and domain knowledge. Certainly, parts of GEOINT are the specific domains of the GIS practitioner, the remote sensing professional, the IT guru, the business analyst, and the social media or data science expert. But bringing all of these disciplines together is at the heart of GEOINT—GEOINT is synthesis. It breathes through powerful collaboration, using place and time as its organizing principles. It grows as technology advances. And it requires practitioners to be open to change—all the time!

A few comments on the content of this publication. It is our intent that the Community organically develop the imaginative ideas that appear in this and subsequent State of GEOINT reports. We harnessed the experience of our Community, but did not attempt to cover all possible topics because the world of GEOINT is simply too large. Additionally, the hard-hitting nature of each article did not provide the opportunity to delve deeply into technical subject matter. However, just below the surface of the topics addressed you will find rich technical detail, which we plan to explore more thoroughly in future volumes.

There are obvious GEOINT trends that are noticeably absent from this volume, including the rise of small satellites and unmanned aerial systems as sensor platforms and how, analytically, we will handle the current crush of available data. In a way, we have come full circle. GEOINT was born when government collection systems were more prevalent than commercial collections. Now, both platforms and sensors have become commodities and we frequently struggle to make sense out of all the available data choices.

I invite each of you to join the discussion of how we can together build a stronger global GEOINT Community. Get involved. Join and actively participate in USGIF working groups, committees, and credentialing focus groups. Attend GEOINT Foreword and the GEOINT 2015 Symposium in the early summer or GEOINT Community Week in the fall. Experience USGIF workshops and networking events throughout the year. Strengthen your capabilities through the wide variety of training opportunities available from USGIF and our GEOINT Community partners. Enroll in USGIF-accredited colleges and universities. Become a mentor to promising young GEOINTers. Volunteer at STEM events in your area. And if you have an idea for a new USGIF initiative, please let us know. All it takes is a good idea and your focused energy to make things happen.

Thank you to everyone who has made this report possible. It is our intent to have a "State of GEOINT" event and publication each year. If you are interested in being invited to this fun and rewarding community event in 2015, please let me know.

Working together, 2015 can be our year of making a difference.

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USGIF would also like to thank key staff that made the State of GEOINT event and publication possible. Justin Franz, professional development administrative coordinator, and Ayana Nickerson, credentialing manager, helped organize and facilitate the in-person gathering of the GEOINT Community. Dr. Maxwell Baber, Ph.D., director of academic programs, was instrumental in reviewing, selecting, and shaping the submissions from the various participant groups. USGIF would also like to thank Kristin Quinn, editorial director; Lindsay Mitchell, marketing & communications assistant; and Jordan N. Fuhr, vice president of strategic communications & marketing, for editing the report and managing its publication and distribution.

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It's Not Open Source, It's the Real World

If Anyone Can See It, Is It Intelligence?

The senior intelligence official pours over the latest information gleaned from highly classified images, signals, and clandestine human sources engaged in foreign espionage. He's only got an hour to finalize what will be compiled, formatted, and delivered to "customer No. 1" at 1600 Pennsylvania Ave. He furrows his brow, knowing the President of the United States and the National Security Council may have as many questions regarding sources not contained in the President's Daily Brief (PDB) as they have about those that are. With this in mind, the senior asks his PDB analyst about the status of an important foreign facility of current interest.

The analyst clears his throat and says, "Sir, I know you are interested in that topic but we have no new information." The senior replies, "Look over your shoulder." The screen behind the analyst shows a live cable news broadcast regarding the facility halfway around the world.

The intelligence official presents the daily intelligence update and then returns to the Intelligence Community with new questions, and the daily cycle begins anew. Meanwhile, our nation's decision-makers are inundated throughout their day with real-time information from numerous Internet sources: professional and amateur news aggregators, individual bloggers, tweets, videos, images, instant messages, and myriad other means to continuously send and receive information about the world.

Why has it been so difficult for the Intelligence Community to integrate real-time open sources into its daily analytical workflow? Why hasn't the intelligence information technology enterprise been designed to merge these data sources, and what can be done? Understanding the history and cultural barriers is the first step to acceptance of the problem. After acceptance comes problem resolution.

If Anyone Could Do It, It Wouldn't be Special

Throughout history, timely insight into what one's adversaries (and competitors) may be planning or doing has been considered intelligence and integral to survival. Since the success or failure of an adversary's plans depends upon going undiscovered for a period of time, barriers are erected to keep enemies or other untrusted parties at a distance. By the Cold War era, the U.S. had closed borders, limited lines of communication, and carefully regulated transportation. We also witnessed the rise of highly classified global remote sensing as a response to these barriers. Highly specialized technical intelligence collection and analysis disciplines flourished to augment difficult and risky human collection. Highly specialized intelligence systems came with highly sensitive security clearances, and a high bar of personal character and integrity was rightly set to obtain these accesses. Once obtained, intelligence officers devoted their time to unique and classified sources.

Meanwhile, Things Changed

Since the Cold War ended, the explosion of the Internet, computer processing, communications bandwidth, technology miniaturization, and advanced manufacturing has radically changed the world's information flow. There are now 2.8 billion users of the Internet worldwide, including more than 240 million in Africa and more than 100 million in the Middle East alone. Today, there are more than 180 million active websites, and every second nearly 24 terabytes of information—or 24 trillion bytes—traverse the Internet. That single second of Internet traffic includes about 7,800 tweets, 1,400 Instagram photos, 1,500 Tumblr posts, and 1,500 Skype calls. It is estimated roughly one hour of video footage, much of it geotagged, is uploaded every second. During that same second, 46,000 Google searches are launched. Simultaneously, an estimated 12,000 television channels and 44,000 radio stations are operating around the world. As worldwide information flow became real-time and ubiquitous, print media, including monthly news

magazines and daily newspapers, suffered significant readership and advertising losses. The companies and organizations surviving have done so by keeping pace with their customers' needs: compressed timelines, aggregated information, real-time "tipping and cueing" to other sources of information, and content available to the consumer wherever they are and via the platform of their choosing.

Changing the Intelligence Community Culture

Fully integrating the real-time flow of publicly available and searchable information into the Intelligence Community's analytical realm ultimately means changing the overall systems architecture to perform integrated tasking, ingest, processing, correlation, enrichment, change detection, alerting, and analytics of both classified and unclassified sources. But moving in this direction will require a significant mindset shift that recognizes openly available information as holding value equal to traditional classified sources. This cultural change must occur not with the young analysts who want access to more information—the change is needed at the mid-to-senior levels in order to place priority and funding support behind the technical needs required to seamlessly integrate information streams. Cultural change is needed to help inform security policy decisions as well. For example, changing long-held views among policy staff that technical solutions do not exist to prevent "spillage" of classified information into unclassified systems. However, helping mid-level and senior managers through the cultural change is problematic because the majority spent their formative years "behind the green door" and without the benefits of the Internet. Many managers do not appreciate what their newest analysts know. They walk away from the vast majority of real-time global information flow once they park their car and turn off and stow their smartphones.

The GEOINT Community is Uniquely Positioned to Lead this Change

The National Geospatial-Intelligence Agency (NGA) has a history and tradition of incorporating openly available, unclassified, and commodity data into its product lines. For decades it has entered into government-to-government and government-to-commercial agreements for unclassified geospatial data sets, including commodity purchases of location data. NGA led the integration of commercial imagery into the Intelligence Community and its customer base against the skepticism of traditionalists who thought only intelligence satellites could produce imagery of value. NGA also fostered key technical advances in the open arena, including funding a development via In-Q-Tel, which led to what is now Google Earth—an open system used by more than 1 billion people around the world.

NGA is uniquely positioned to lead the Intelligence Community to seamless integration of open sources for additional reasons. More and more of the billions of images and millions of videos being uploaded to the web are geo-referenced, and a growing number of smartphones and other handheld devices now provide location information. Then there is NGA's role as the glue that puts other INTs in perspective. It is often said GEOINT is the foundation that provides context for all other intelligence sources. Director of National Intelligence James Clapper has noted, "Everything and everyone must be somewhere." This context-building role made NGA the champion for multi-INT efforts across the IC, and is still the reason NGA plays a central role in persistent surveillance, activity-based intelligence (ABI), and the Intelligence Community Information Technology Enterprise (IC ITE) transformation.

Conclusion

Outside the confines and restrictions of heavily guarded SCIFs, the world's real-time information flow has eclipsed anyone's imagination. As intelligence professionals, we must seek knowledge from any source and provide our customers with insightful analysis that incorporates a healthy awareness of our adversaries' denial and deception capabilities in the open source and multi-INT environments. To be truly effective, multi-INT, persistent surveillance, and ABI must rely on the real-time flow of all sources of information, including that which is openly available. These driving initiatives and convergence of the heretofore stovepiped IT architectures into IC ITE provide the needed push to change our culture and systems architecture. Now is the time to fully integrate openly available sources, and enable the IC workforce to access the real world.

Data: The Hottest Trend in the Geospatial Industry

Geospatial data is hardly a happy hour topic. So why would one choose data as a "hot" geospatial topic to write about when there are so many other headline-grabbers to consider? SmallSats, Big Data, the cloud, and UAVs are all much more interesting … Geospatial Data? Really?

And yet satellites and drones collect geospatial data, data is stored in the cloud, and, well, Big Data is ... data. While the media has changed, the fundamentals of geospatial data haven't changed since the first cave drawings showed where the bad tribe lived. But now, the way some spatial data is being generated by volunteers is unique and groundbreaking. And that's how geospatial data earned its place in the "What's Hot" category. In a 2007 article, Michael Goodchild wrote:

> ***"... the widespread engagement of large numbers of private citizens, often with little in the way of formal qualifications, in the creation of geographic information, a function that for centuries has been reserved to official agencies. They are largely untrained and their actions are almost always voluntary, and the results may or may not be accurate. But collectively, they represent a dramatic innovation that will certainly have profound impacts on geographic information systems (GIS) and more generally on the discipline of geography and its relationship to the general public. I term this volunteered geographic information (VGI) …"***

Since then, OpenStreetMap (OSM) has grown significantly in terms of coverage and quality. Spatial content mined from social media has been an information treasure trove for marketers and observers of social unrest in Northern Africa, the Middle East, and Hong Kong. Geospatial crowdsourcing is the most recent innovation where statistical techniques are used to validate the crowd. One notable example of the widespread interest can be seen in the more than three million people who logged into a popular portal to help look for the lost Malaysia Airlines Flight 370.

Not since commercial satellite imagery and satellite navigation data have we seen such an explosion of spatial content. But how good is this content? Unlike imagery and satellite navigation data, social media and crowdsourcing efforts are not aligned to traditional data quality rules. More mature efforts such as OSM apply some formatting and metadata standards, but consistency among original data producers can vary widely. While there is elegance in the relative simplicity of OSM, most authoritative producers are uncertain about VGI quality. Crowdsourcing efforts are elegant in their own way. If collection labor is volunteered, why not collect many times, compare the results, and statistically select the most frequent answers? Certainly, with a large enough sample size over every point on the Earth you could expect great data quality, but we're not there—yet. So how can social media and crowdsourced information—two promising sources of data—cross the threshold to become credible primary sources for national mapping organizations? This question is at the heart of why data and data quality belong on any geospatial "hot" list.

No discussion of the value of social media and crowdsourced data would be complete without acknowledging the risk of geo-spoofing. Could the crowd intentionally provide bad content in volumes significant enough to be credible? Could a bad actor promulgate bad location through Twitter in significant enough numbers to cause analysts to be misled? It would be naive to dismiss this risk. The current risk is not sufficient to avoid using social media and crowdsourced data but continued vigilance is strongly encouraged.

So far we have discussed two new data sources as alternatives to traditional primary sources of geospatial data. Perhaps a different perspective is needed. What if the world was mapped, given all currently available information, and all we were really interested in was maintaining it?

The objections of those reading this are deafening: "What does 'done' mean? It can never be done."

Before you judge the concept as completely insane, let's look at hydrographic charting. National hydrographic organizations have been cooperating since 1889 with what is now the International Hydrographic Organization, which was formed nearly a century ago. Generally the seas are well charted, enough that one could say the task at hand is simply

maintaining the data. In fact, in many ways, near real-time hydrographic chart maintenance has been crowdsourced for decades. Hazard to navigation broadcasts have been operated by many nations for years with less critical maintenance performed on a monthly basis. The entire maritime community has played a role in data maintenance with a long tradition of volunteered contributions to the chart updating process. Today, some nations have abandoned the monthly, postal service-dependent process by posting "notices to mariners" to the web nearly as soon as they are received. So, it's safe to say three-fourths of our world is charted and that, in many ways, critical locations and/or features are maintained rapidly.

So now comes the chorus of, "But geospatial data on land is far more complex than a mostly flat, featureless ocean." No doubt this is true and maintenance is a near impossible task if you try to apply traditional sources and processes. But we have many new sources. Does that change tradition? Did aerial imagery change mapping? With the explosion of crowdsourced data, commercial imagery, and location data over the last decade, how can it not have an effect on our traditional data compilation and maintenance processes?

Can similar methods be applied to spatial content on land? In fact, the United Kingdom's Ordnance Survey (OS) accomplishes this to a degree today. Its OS MasterMap has stringent timelines for the inclusion of changes. As such, changes are validated and posted quickly in a near-transactional process. A vision of "transactionally" maintained geospatial data doesn't scale to the world—yet. But it's time to test a process that can rapidly consume the explosion of new sources. If Visa can process several hundred million transactions per day, certainly we can target a few thousand geospatial transactions per day for a pilot maintenance test.

The OS example almost always elicits a comment such as, "But the UK is so small we could never do that in the U.S." The UK has a very efficient process relative to the U.S. and probably uses far less resources per square mile than we do. Consider the following list of domestic geospatial producers:

- **Federal** – USGS, Census, DHS, DoT, NGA, EPA, plus hundreds of small GIS support organizations
- **State and Regional** – Planning, development, infrastructure management, etc.
- **Regional and Tribal** – Planning, development, permitting, infrastructure management, etc.
- **Commercial** – Location-based services and the base data needed to make the services work

Does anyone doubt there are sufficient resources available if we all work together?

Here is an outline of how the U.S. government could launch a pilot program:

- Identify a small to mid-size country where there is enough interest (committed GEOINT resources) to warrant a pilot program. Afghanistan, Iraq, or Iran might be good choices.
- Complete a country-level vector and imagery database with the most accurate and current data available. The decisions here should not be onerous as omissions can be recovered in the maintenance process. There are sufficient standards and GIS technology in place to get started.
- Dedicate a team of maintainers with 20 to 30 initially dropping down to five to 10 in a year. Include developers on the team and adopt agile methods to rapidly update processes. Also include a social media-mining expert.
- Organize in an operations center environment. The team needs to be fixated on maintaining the most current and comprehensive operational picture possible.
- Set a requirement that changes will be incorporated into the database 24 hours after a new source is received. At a minimum include every image, every mission-specific database, every Modernized Integrated Database update, and every OSM update.
- Use change detection techniques to target areas for tasking in the broadest sense, including new imagery perhaps, targeted crowdsourcing through a commercial provider, or social media mining.
- Develop internal "community sourcing." The DoD and IC have a wealth of local knowledge. Enlist a crowdsourcing entity to help develop "our crowd" into "our community."

It is hoped that this paper helps ignite a desire not just to leverage the explosion of new sources available to the GEOINT Community, but to also think about new ways to apply them alongside more traditional sources. It's time for the terrestrial geospatial community to take some wind from the mariner's sails and see if the accelerating availability of sources can be incorporated into a continuously maintained spatial database. It's important to start the experiment.

GEOINT: So What & Now What?

Socrates said, "Wisdom begins with the definition of terms." The definition of geospatial intelligence, or GEOINT, as termed in this article, creates the discipline's identity, defines the responsibilities, and establishes expectations—in short, it creates the profession. For those in training and education, the definition frames the curriculum, and ultimately, the preparation of the GEOINT professional.

The U.S. Government Code Title 10 definition of GEOINT is tied to the creation of the discipline and the National Geospatial-Intelligence Agency (NGA). This agency was formed to integrate information, intelligence, and tradecrafts under a single discipline named by then-NGA Director James Clapper. It is worth noting the name of the agency includes a hyphen, so what might be "NGIA" is referred to today as NGA. It has been suggested this was done to give parity with the agency's three-letter counterparts such as FBI, CIA, DIA, NSA, and NRO. It's not difficult to imagine internal politics influenced not only in the name, but also the scope of the discipline that emerged from the Title 10 definition of GEOINT.

While the government defined GEOINT in order to describe NGA's mission with respect to other U.S. intelligence agencies, the discipline itself has broader applications. A global revolution of geospatial information science, technologies, and data has created the opportunity to apply GEOINT in other fields. Other domains such as public safety, homeland security, disaster management, and business are leveraging geospatial information to provide an advantage to decision-makers, thereby creating GEOINT. However, Title 10 limits U.S. government agencies other than NGA from explicitly producing GEOINT products. As a result, other government agencies produce essentially the same information under different names. Redefining the term "geospatial intelligence" is necessary to allow the discipline to be applied more broadly and include the hidden GEOINT Community outside the narrow intent of Title 10. With this expansion, it is important to examine and understand what GEOINT has become beyond the constraints of its original definition.

What is GEOINT?

Let's begin by examining the terms that comprise GEOINT.

> ***"Geospatial" pertains to or relates to the relative position of things (spatial) of (e.g., in/on/around) our Earth (geo).***
>
> ***Intelligence is actionable information about both the physical (landscape) and human activity that provides necessary insights (data needs) to a decision-maker.***

Expanding upon the word "geospatial"—while the words geospatial, geographic, and spatial are often used interchangeably to mean similar things—the reasoning behind the linguistic blend forming "geospatial" is that "spatial" alone is too generic and "geographic" is too related to the particular discipline of "geographic intelligence," one of the oldest forms of military intelligence.

Expanding upon the word "intelligence," intelligence provides a "decision advantage" intended to prevent surprise, capitalize on emerging opportunities, neutralize threats, or provide time to adapt to a changing situation.

GEOINT has the following qualities that help to determine where it can be applied: A decision advantage resulting from insights gained through place and time; and an integration of knowledge from Geographic Information Science (GIScience), geographic technologies, and GEOINT tradecraft.

Place: Place is a fundamental concept in geography and the most important GEOINT concept. At first glance, location and place seem to be similar terms. Location is a coordinate on the Earth's grid with values for x, y, and z. However, places have physical and human attributes that make them what they are. Physical attributes may include a description of such things as the mountains, rivers, beaches, and topography of a place. Human characteristics may include the human-designed cultural features of a place, from land use and architecture, to forms of livelihood and religion, to food and folkways, to transportation and communication networks. Place emphasizes the understanding of both of these factors and their integration.

Places are building blocks of analysis in GEOINT—keys to making sense of the landscape, stages for events, and testimonial to the fact that humans require space to live, work, play, and flourish. People create distinctive places according to their knowledge, technology, and needs. Places are involved in important personal, corporate, and governmental decisions. Places exemplify the principle events of history. Understanding a place's history, variety, and complexity, and how that place may have shaped a human's life and experiences is key to cultural understanding.

Ultimately, in the practice of GEOINT we are concerned with understanding why places, and the people in those places, are located where they are. We must be comfortable with the underlying concepts and theories of the spatial distribution of a particular phenomenon. Spatial distributions can reveal a relationship between nature and society, such as hurricane hazards as linked to potential deaths, or as a reflection of topography and socioeconomic processes associating particular places to particular kinds of people and architectures. Spatial distributions can also be strictly human phenomena, such as population and religion.

The practice of GEOINT means you are analyzing something within all of its contexts—physical, spatial, historical, cultural, and political. For example, populations, evacuations, crime, and retail stores all exist or occur in a particular place or at a particular time for a set of specific reasons. Applying a geographic perspective improves understanding of what things are, where they are located, why they are located there, how they came to be, and why they change, while providing a framework to understand anything that has a spatial component.

Time: Place and time are inexorably linked. Swedish geographer Torsten Hägerstrand emphasized the importance of time in human activity and how human spatial activity is often governed by time limitations. He identified three categories of limitations:

- Capability constraints refer to the limitations on human movement as a result of physical or biological factors.
- A coupling constraint refers to the need to be in one particular place for a given length of time, often in interaction with other people.
- The authority constraint is a controlled area that sets limit on its access to particular individuals.

Hägerstrand's space-time model provides a framework for understanding human activity in space, and provides a theoretical foundation for intelligence concepts such as Activity-Based Intelligence (ABI).

GIScience: Geographic Information Science (GIScience), and its parent discipline geography, is about ways of looking at and understanding the world. When you view the world through the lens of geography, you answer the questions of where things are located on the Earth, how places differ from one another, how people interact with the environment, and why people are located where they are.

Looking "under the hood" of the discipline of geography, it has a number of branches and subfields. The two main branches of geography are physical geography and human geography—in that order. One must understand the physical Earth first before one can attempt to understand how humans live upon it. From a U.S. Department of Defense perspective, physical geographers and physical geography are closely associated with traditional military geography and terrain analysis. Here, geographers investigate the effects of weather, climate, landforms, vegetation, soils, and water bodies on military activity. Human geography is concerned with critical aspects of humanitarian and defense activities, such as how people and their activity are distributed in space, how people use and perceive space, and how places on Earth impact humans, and, in turn, how humans impact places.

The concept of human geography has existed for centuries. The importance of understanding the socio-cultural aspects of societies is necessary for success across a range of humanitarian, public safety, business, and defense endeavors. Cultural awareness provides an important human context. At the strategic level, human geography provides a backdrop that describes

the socio-cultural undercurrents that limit options and define goals. At the tactical level, socio-cultural dynamics impact interpersonal communications and relationships that enable or prevent attainment of goals.

Tradecraft: Distinctive tradecraft makes GEOINT unique within the discipline of geography and differentiates it from other activities utilizing GIScience and geographic technologies. Historically, intelligence agencies use the term "tradecraft" to refer to the techniques or methods by which an agency conducts its business. The term conjures up images of a craftsman or a skilled artisan, but it also describes the undisclosed techniques and wisdom handed down from one generation to the next. The word "tradecraft" when applied to GEOINT reflects the exclusivity and the non-scientific aspect of an analyst's sources and methods. As a tradecraft, GEOINT depends on the technical and cognitive capabilities handed down from one generation of analysts to the next.

To many people, the intelligence tradecraft is about secrets and spying. However, according to noted author, academic, and experienced national security expert, Mark Lowenthal, viewing intelligence as primarily secrets misses the important point that intelligence is ultimately information that meets the needs of a decision-maker. While we agree with this viewpoint, it is important to appreciate that any decision advantage disappears if you indiscriminately give your insights, sources, or methods to others.

As such, GEOINT, by the nature of its purpose—which is to achieve an information advantage—may require sources and methods that are secret. Secrecy is the practice of hiding information and methods from certain individuals or groups, perhaps while sharing it with other certain individuals. Although sometimes controversial, information secrecy is normal, frequently essential, and often required in aspects of our daily lives. It is not a concept that only applies where governments conceal information from other governments. Nature evokes secrecy when animals conceal their location from predators. Sports teams keep their playbooks secret from the opposition. Secrecy of one's vote is a basic right in many societies. Business organizations keep secrets for competitive advantage or to meet legal requirements. Trade secret laws protect new products under development, unique manufacturing techniques, or lists of customers. Secrets are normal and part of GEOINT as it is practiced outside NGA.

Now What?

We suggest adopting a broader, community-wide definition of GEOINT. We appreciate the challenge of achieving a new definition everyone will agree on since GEOINT can be used to describe a knowledge artifact, a process, and a discipline. This difficulty notwithstanding, we suggest a broader definition of GEOINT as a means to guide the training and education of the geospatial professional. The proposed definition we suggest is:

> ***GEOINT is actionable knowledge, a process, and a profession. It is the ability to describe, understand, and interpret so as to anticipate the human impact of an event or action within a spatiotemporal environment. It is also the ability to identify, collect, store, and manipulate data to create geospatial knowledge through critical thinking, geospatial reasoning, and analytical techniques. Finally, it is the ability to present knowledge in a way that is appropriate to the decision-making environment.***

We hope this definition of GEOINT frames a curriculum to meet tomorrow's educational challenges.

Intelligence Stovepipes are Dying

A World Brimming With Danger and Changing Through Technology

Today's global enemies present a complex set of challenges to the U.S. Intelligence Community (IC) and Department of Defense (DoD). At one end of the spectrum, the Islamic State of Iraq and the Levant (ISIL) is aggressive, unpredictable, and deploys violent tactics that have horrified the civilized world. On the other, the recent Ebola outbreak in Western Africa is driving the deployment of U.S. Army resources in a humanitarian assistance mission aimed at containing the spread of the disease.

To more effectively counter these evolving threats, U.S. intelligence agencies must improve collaboration among organizations and take maximum advantage of developing technologies. This powerful combination can break down the traditional intelligence collection "stovepipes" to allow an open flow of ideas and complementary capabilities that will inspire new levels of collaboration and innovation. By accelerating the innovative process, we can arrive more quickly at better solutions to difficult problems.

Those who work within the IC's geospatial community have long known imagery and maps support a common framework for a broader level of collaboration. Geospatial intelligence serves as a canvas and unifying element to bind the range of organizations and collection mechanisms. We understand the GEOINT discipline will not achieve its potential without better incorporating how our mission partners use geospatially-enabled data generated by those systems. Rigorous attention to open geospatial standards and formats also will expand the utility of geospatial elements. The National Geospatial-Intelligence Agency's (NGA) initiative to provide GEOINT via a "self-service" model in addition to finished GEOINT products allows for creative use of geospatial information in ways that effectively support rapidly changing mission requirements.

Budget Cuts are a Key Driver

Budget pressures will continue for the foreseeable future even though mission demands may increase. An impartial survey across key IC organizations leaves no doubt that some redundancies exist in direct mission and support functions. To ensure the shrinking pool of resources is best spent, we support taking a hard scrub of organizational structures to minimize functional duplication. The choices that affect one agency may help the broader IC to become more effective and efficient. These tradeoffs are already occurring with the transition to the Intelligence Community Information Technology Enterprise (IC ITE).

Technology Makes this Transition a Reality

The IC's technology backbone has evolved to a level that is breaking down barriers and supporting greater collaboration than ever before. IC ITE is a key example. In 2012, the IC Chief Information Officer embarked on the largest IT transformation in community history. Guided by the IC ITE Strategy, the initiative focuses on enabling greater integration, information sharing, and information safeguarding through a common IC IT approach that substantially reduces costs. IC ITE seeks to provide improved integration, information sharing, and security through the use of a cloud-based architecture.

Of IC ITE's five key goals, two directly address the dismantling of stovepipes.

- The first goal, "Fortify the Foundation," defines, implements, and sustains a single, standards-based, interoperable enterprise architecture and survivable infrastructure to accomplish mission objectives and drive efficiencies across the enterprise and all security domains. Elements built on this foundation can further improve IC cross-fertilization and integration.

- The second goal, "Forge Strategic Partnerships," is aimed at developing and enhancing the trusted partnerships within the Office of the Director of National Intelligence (ODNI), IC agencies, other U.S. government and allied partners, and industry by leveraging innovative capabilities to enhance and integrate the intelligence mission. One of the main ways this is accomplished is by assigning responsibilities across IC agencies: NGA and the Defense Intelligence Agency are service providers for IC ITE's desktop and enterprise management while the Central Intelligence Agency and the National Security Agency are responsible for portions of the cloud and identification, authorization, and authentication services. The National Reconnaissance Office is the initiative's networks requirements and engineering service provider, and ODNI will manage a security coordination center.

The IC ITE initiative has established an IT backbone that supports the dismantling of intelligence stovepipes, but roadblocks to collaboration remain. The boom in "apps" development has proliferated dozens of applications that operate independently of one another and maintain their own isolated data stores. An approach focused on open services or other modular components that allow end users to combine and create their own versions of applications would improve the information sharing and collaboration.

The 21st Century Workforce Demands Change

New IC employees come equipped for a "non-silo" environment and assume open collaboration occurs naturally. These individuals enter the government workforce from an agile and freeform environment—what those in the IC think of as the "outside world." Their personal experience and educational environment lead them to expect instant access to friends and information via social media and other online channels they adeptly traverse by posting, sharing, collaborating, and innovating.

These newcomers are essentially adept at all-source intelligence; it has been part of their upbringing. The human brain synthesizes information through sights, sounds, and other cues, then performs background processing to fuse these various sensations into insight. Critical thinking skills today demand multi-disciplinary approaches, but enforcement of strict organizational boundaries impedes good thinking, sequesters information, and stalls creativity. Most analysts enter their first jobs with aspirations of doing great things and making a difference, but the weight of years of cultural and organizational bias can smother that drive. Many seasoned veterans of the government and contractor workforce may be able to relate to this. Finishing up a long and arduous college degree program can be a rewarding and exhilarating experience. Graduates are ready to enter the workforce with vim and vigor, eager to apply their newly gained knowledge and experience in the real-world environment of their chosen career. Government and industry must work together to establish a new cultural infrastructure and keep that drive alive to maximize the contributions these new professionals offer.

The transformation in GEOINT tradecraft development and certification must focus on developing cross-disciplinary critical thinking skills that create a cross-IC mindset, instill intellectual rigor, and encourage imagination. Members of our workforce need to have a broader context for their work that will enable them to see themselves first and foremost as IC assets in service of our nation and secondly as members of a specific agency or organization.

Building a true cross-IC mindset independent of traditional stovepipes requires us to examine carefully the types of partnerships developed across intelligence agencies. Each is unique in its mission and information holdings, but constrained resources and technical interoperability should encourage us to look across organizational boundaries for solutions that will provide the greatest benefit to the IC and the taxpayer. Our partnerships must become more flexible and extensible; we need to become comfortable with task forces and working groups that are less static and more dynamic in terms of mission and membership.

Conclusion

Twenty-first century global threats, workforce demographics, and technology advancements are forcing changes in the government-based organizational and cultural fabric of the U.S. Intelligence Community that will ultimately improve collaboration and accelerate innovation among agencies, collection capabilities, and industry. By adopting open computing environments, incorporating IC ITE protocols, and tailoring the work environment to meet the needs and expectations of newly minted GEOINT analysts, the dismantling of stovepipes can be a reality and these goals can be achieved.

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The Clouds and Crowds in Our Future

Looking out three to five years, the GEOINT horizon is filled with crowds and clouds. The need to solve global issues will give rise to the "crowds," which we define for the purposes of this paper as groups of self-organizing citizen analysts enabled by the clouds. The "clouds" are the embodiment of advances in Information Technology (IT), changes in access to education, and the increase in availability of high-quality, free, and open-source software. Fueled by their desire to address global issues, passionate and self-organizing groups will form to create solutions to our planet's geopolitical problems. Ubiquitous access to advanced computing power, the continued rise and adoption of open-source software, and the ever-expanding availability of global higher education will create a worldwide coalition of people more agile than governments and just as technically capable. These crowds will not be performing menial tasks; rather these are people in the future who will contribute meaningful analysis toward solving large global problems. The crowds are also not so literal. Crowds represent the unification of people behind a common goal—people who are geographically, socially, and culturally diverse coming together to battle a global problem.

The not-so-distant future will present world issues crossing more than just physical borders. Today's geographically local problems will not necessarily be so in the future. Geographically diverse groups of people, our crowds, will self-organize around issues and morph into effects-causing groups capable of not only identifying, but also creating change. These crowds may garner notoriety and gain backing in the form of donors and tastemakers throwing financial and political weight behind their interest areas. We will see their efforts become just as, if not more, effective than entire government organizations. Furthermore, these crowds will be highly effective even in the absence of the exquisite data and computational power government entities possess.

The need for good geospatial intelligence (GEOINT), not blind mapmaking, will be paramount. Educated crowds capable of helping others navigate the increasingly complex geopolitical landscape of the future will be of key value. Crowds will have the ability to form and move fast, gain support, and then pivot quicker than any traditional organization.

There will be no shortage of problems in our world future, but change agents will arise based on the ability of average citizens to bring about solutions. No longer will people solely rely on the government or organization of states. Unifying issues that have common global impact, such as water scarcity and natural resource depletion, will spur crowds of non-state actors into action.

Water supplies in one region can affect hunger in entire countries and security across an entire continent. Interconnectivity is not just a digital or technological concept. The people of this planet are more interconnected than ever before. With global sourcing of almost every commodity, people will become motivated by the widespread influence of seemingly local issues played out on the other side of the world. It will be these transcendent issues that unite us, our education that guides us, and the evolution of technology that fuels us.

In order to tackle future big-ticket issues and for crowds to form, citizen-analyst groups will need to organize, communicate and, most importantly, perform. By virtue of the ongoing IT cloud revolution, we have on-demand, cost effective computing power, ubiquity of data, and availability of advanced open software. Data availability, data storage, and current transfer speeds put unprecedented compute power in the hands of the average person. Globally, people will be able to collectively wield the same power as a nation state in terms of information and intelligence creation.

This ever-evolving compute power eases many concerns about Big Data. It is often forgotten that storage, compute, and transfer abilities have all kept pace with the size of data at any given point in time and are likely to do so into the future. The ability exists to store vast quantities of data, process them in an efficient manner, recall them when necessary, and move them quickly from place to place. With decreasing cost and increasing simplicity, capacity, and performance, small communities of citizen-analysts can form into crowds and, in aggregate, amass technical capabilities on par with large-scale organizations. Further, with no hindrance from corporate security or company policies,

crowds are only bound by law and their own morality. Such crowds can be more agile, respond to change, and even form, grow, split, or disband as needed.

While the information super highway has widened to make possible this envisioned future, the means of traversing this highway is still coming of age. Software companies and government organizations are increasingly moving to open-source their software, making available to anyone Big Data databases, full-featured Geospatial Information Systems (GIS) software, advanced analysis capabilities, and visualization suites. Further, the free and open-source (FOSS) community has proven it can contribute to a common baseline and drive innovation and change further and faster than private entities with closed-source software. These same companies have also realized they are not losing money by open sourcing their software. What the GEOINT Community has learned is that a hammer by itself cannot build a house—the value is not in the software, it is in the people using the software. In order to keep pace with future issues that will face our global population, the open-source community provides a greater potential to invent and innovate. It will be these innovations that will continue to fuel future GEOINT analysts.

Mercator, Latitude, Longitude, geofence, buffer, shapefile—these are words which used to alienate most people and were reserved for only the geogeek. Now, these words are no longer foreign concepts and do not scare people away. Access to geospatial education has increased tremendously over the past decade. Currently, without leaving your home, students can take courses at leading institutions all over the world. Students are in virtual classes with highly diverse groups of classmates. This helps to create and grow communities centered on areas of interest. This globalized education is the seed for the rise of small citizen-analyst cells to self-organize into crowds and realize change. Outside of the classroom, average people are honing their skills using map applications in most aspects of daily life. And, at the same time, we are realizing a steady increase in the quality of citizen imagery analysis due to the continued advent of free geospatial data. Further, with mobile devices and GPS, the applications of these technologies are becoming embedded in our DNA, enhancing our means to understand and apply these ideas to a wide spectrum of GEOINT challenges.

In order for future citizens to be better civil servants, a resurgence in geography as a discipline is needed at the grade school level within the United States. Map creation, understanding, and global geography are undervalued skills. Without proper investment, the young people of today will not have the necessary foundation to build upon. This strong educational foundation is paramount to the success of our future. Knowledge is power, and in our future this will be clear.

The ideas this paper describes depend on a passionate and educated people—the crowds motivated by future state world events. The enablers, clouds of education and technology, are already present in our lives today and with continued advancement in technology will only further the enablement of the world citizens. But, what remains to be seen is twofold: whether the geopolitical atmosphere allows global issues to be solved by non-state actors such as our citizen-analyst crowds; and whether these crowds can organize to move swiftly enough to stave off future disasters and lead us to promising solutions.

The Visualization Imperative: Transformation in Conveying GEOINT Content

On Oct. 3, 2014, NGA Director Robert Cardillo issued his intent for the future of NGA. “Consequence for our customers is the ultimate objective of our efforts,” Cardillo stated, and elaborated that delivering consequence encompassed bringing valued content that conveyed relevant, timely information in a way that deepened contextual understanding of NGA customer missions, intelligence needs, and decisions. For Cardillo, the “4Cs” that will drive his tenure as the GEOINT functional manager are related in a simple formulae: “consequence = conveyance + content + context.” This contribution to the USGIF “State of GEOINT” report addresses the conveyance component of Cardillo’s strategic intent.

In this article, conveyance is addressed by exploring the state of visualization and visual analytics. There are many components to conveyance, including how information is provided, the timeliness of information, the formatting of the information and its metadata

that enables it be integrated with other information and discovered through search engines and the mix of graphics, text, video, and other multimedia that calibrates the complexity of the content being conveyed to the optimal or most effective means through which customers ingest, understand, and utilize information.

In many GEOINT strategies and transformation documents the future of conveyance has been hijacked by large enterprise initiatives, transformation to IC ITE, and how content is discovered, accessed, and transferred through websites. But these are primarily the logistics and mechanics of conveyance. They are important, but they are arguably not the essence of conveyance in the Cardillo 4C formulae.

NGA's "Defining the Analysis and Technology Vision for 2020" document, for example, outlines four categories of technologies for agency investments in the future of analysis: research and discover; access and visualize; exploit and analyze; and expose and report. Interestingly, the only category explicitly defined by visualization involves how users visualize data in the process antecedent to exploitation and analysis. But elsewhere in the vision for technology the criticality of visualization technology is evident. At every stage in the process, the future of GEOINT hinges on the capacity to leverage the human visual system, which drives analytic reasoning, learning, and decision-making. There can be no generational leaps in GEOINT analysts' capacity for conveyance without investments in visualization technology. We need more than immersive visualization at the analyst's desk. We need immersive visualization throughout the GEOINT food chain, from requirements generation to collection all the way to the customer.

The GEOINT Community needs to rethink where conveyance fits in Cardillo's 4C formulae. In the past, conveyance has been a secondary consideration in the analytic food chain that derives intelligence value from GEOINT data. The priority has traditionally been on content, mostly in the form of data and the analytic judgments brought to bear on intelligence issues or military operations. It is no longer the case, however, that content reigns supreme. For many, the most important contribution that content makes to consequence is expertise and intimacy with customer missions and needs. In this sense, content is about judgment, insight, and human cognition. These are indeed the most important factors in the future of GEOINT. Until recently, the essence of content has been tied to data and collection. Content has been about the "secrets" adversaries wish to deny us that collection sources provide. However, insight on the most important and pressing national security issues now require more sophisticated, dynamic, and interactive visualization capabilities.

Conveyance is no longer a matter of deciding at the end of the analysis and production process how to annotate textual reports, add graphics, or embed tables or simple visualizations into a report before it is published. The visualization component, especially analytic visualization, must be considered as part of the overall design and management of all analytic missions. Content and conveyance overlap. In some mission areas they are inseparable. Context, another of the 4Cs, is also becoming part of conveyance. The essence of context is locating GEOINT content that supports mission context, the decision space, or the decision process as a multi-dimensional, integrated, and adaptive resource. To consider content and context as components of consequence requires analytic visualization.

National security decision-making is largely a realm of vision and foresight—of seeing realities unfold across time and through space and steering the ship of state away from the shoals. This requires spatial referencing data, information, and knowledge, as well as technical capabilities and analytical services to enhance and extend innate visualization faculties. Spatially and temporally, the boundaries and conceptualization of national security have shifted over the last two decades into a more dynamic, asymmetric, and unpredictable threat landscape that stresses traditional organizational constructs for analyzing, understanding, and addressing security challenges. In the past, security challenges have been spatially organized using political or human geographic methods rich in thematic layers which, when combined, provide context about threats and support policy development and operations. Traditionally this has meant the military or geopolitical delineation of front vs. rear, forward vs. reach-back operations, and foreign vs. domestic jurisdictional boundaries. On a much different level, however, it is the combination of both spatial awareness and augmented visual thinking capabilities that holds the greatest promise for enhancing the strategic effectiveness of U.S. intelligence.

Why visual thinking? Throughout history, the spatial and visual components of strategic planning, including spatial awareness, visual thinking, imagination, and the spatial-visual dimensions of the sub-conscious mind have been the cornerstones of political and military

success, primarily because they are the foundation for decision-making, organizing and coordinating behavior, and imagining alternative courses of action. Visualization is much more than a by-product of optical nerve activity; it is the sine qua non of imagination, foresight, creative thought, pattern matching, intuition, diagnostics, simulation, analysis, and cognitive processes central to intelligence analysis and the emergence of "wisdom" from corporate knowledge management activities. Cognitively, the visual pathway associated with the cerebral and visual cortices is the seat of mental prowess, the brain's high bandwidth process for integrating all sources of sensory information, memory, and imagination. Since the days of Ptolemy, moreover, the synergistic effects of spatial awareness and visual thinking have formed the core of the "mind's eye" for correlating disparate pieces of information to simulate present and future realities. It is this combination that gives rise to predictive analysis—the ability to anticipate behavior and make proactive decisions.

Problem solving, creativity, and thinking through different courses of action arise from cognitive subsystems that tap into spatial reasoning and the mental mapping facilitated through the visual cortex. This is a constitutively multi-spectral and all-source process, which results in a layered visualization capability that can fold space and time in any direction to facilitate reasoning, critical analysis, and the connection or correlation of fragments—real or imagined—to find hidden patterns or expose connections that do not yet exist. Einstein exemplified this ability when he imagined himself in a box traveling by the Earth at the speed of light, a visual journey that shattered existing concepts of physics and collapsed space and time inward.

It is time to rethink our conceptualization of, and approach to, the emerging visualization imperative. For the Intelligence Community, implementing reform requires a more self-conscious understanding of spatial and temporal aspects of visualization. Investments in enterprise-level search and discovery capabilities, cloud-based knowledge management programs, and new content management services must be matched with similar investments in training, analytic visualization tools, and the understanding of customer requirements. The GEOINT Community discusses visualization and situational awareness too narrowly, tending to think of visualization only in terms of imagery, remote sensing, information displays, and operational pictures.

Indeed, increased information gathering, sharing, and correlating capabilities along with growing experience in virtual communities have defined new organizational expectations for data and information visualization. Visualization facilitates alternative approaches to problem solving by allowing cognitive "simulation" and rehearsal, which provides for internal "gaming" of solutions and the development of creative, successful outcomes. In the case of insight into the present and foresight into the future, visualizing actions and decisions is a crucial, necessary step in affecting the unfolding of history.

Like Napoleon, Clausewitz considered the visualization of forces moving through both time and space as critical for success. To master space, according to Clausewitz, a special gift is needed: the ability to quickly and accurately grasp the topography of any area. This special ability was "imagination," which in today's parlance would have to be defined using such terms as terrain visualization, spatial awareness, battle space visualization, foresight, and others. Seeing, understanding, and extrapolating from spatial and temporal awareness constituted the essence of military genius, which for Clausewitz was the conjoining of innate and learned faculties to overcome or moderate the friction and fog of war. The fundamental goal was achieving superior thought, decisions, and actions while under great stress and when facing mounting uncertainty about the future.

Drawing on advances in cognitive neuroscience and brain imaging techniques, we know that cognitive imagery processes, including spatial referencing and information visualization, are central to problem solving and other higher brain functions. The message for GEOINT transformation, based on new insights into the role of cognitive visual and spatial faculties, is straightforward: as a species we are spatially oriented problem-solvers who generally rely on visual cognitive capabilities to make sense of the world and integrate sensory input and memory. The current "state of GEOINT" receives at best a mixed report card regarding visualization. Investment is spotty. Experimentation portfolios are lackluster. Integrating advances from open-source media, where complex analytic visualization and graphics are central to the vitality of both print and online publishing, is virtually nonexistent.

The task ahead of us is overcoming organizational barriers to fully leveraging visual thinking, barriers that prevent the full analytic capabilities—or the inherent human potential of analyst collaboration—from being fully utilized in policy-making and for decision support during crises. There are a number of areas the GEOINT Community should focus on to leverage the explosion in analytic visualization driven by innovation across the data science, gaming, cognitive imaging, social neuroscience, workforce career paths, graph theory, experiential learning, and user experiences.

The GEOINT analysis and production community must develop a more comprehensive program to both derive meaning from ingested data and analytics and to enable customers to dynamically interact with their reporting. Research indicates decision-makers do not want to be locked into one visualization application or tool. Instead, they want to be linked to dynamic content in which hybrid visualizations are possible with text, images, and more pedestrian visualization from spreadsheets and pivot tables combined with advanced visualization tools. They want to be able to explore data.

Analysts should have analytic visualization tools that enable automated taxonomies and augment mapping to facilitate search, network analysis, and collection strategies that are discoverable by customers. These capabilities need to be tied across temporal reporting so customers can experience learning over time and require collaborative visualization using multiple perspectives. Analysts and their customers must compare, contrast, and challenge how information is viewed.

The GEOINT Community also needs to integrate development programs and transformation agendas to assure seamlessness across discovery and reporting visualization, visual analytics that facilitate or complement critical thinking/analytic methods, and any initiatives to convey complex information to customers. This requires dynamic visualization, automatic hypothesis testing, and automatic updating of divergent visualizations with version mapping, the latter being a capability IC ITE directly addresses through metadata tagging and tracking of different user experiences. One benefit of this for the conveyance objective is embedded visualizations that automatically render from available data and that update dynamically over time. Another benefit of advanced conveyance technology is visualization capabilities that allow freeform annotations throughout the GEOINT Community.

In conclusion, it is time to rethink our concept of, and approach to, the emerging visualization imperative. For the Intelligence Community, implementing reform requires a more self-conscious understanding of spatial and temporal aspects of visualization that continue to influence modern intellectual life and underwrite the processes of decision-making. Current investments in enterprise-level search and discovery capabilities, cloud-based knowledge management programs, and new content management services must be matched with similar investments in training, analytic visualization tools, and customer experiences that enable hybrid visualization services for customers to embed interactive conveyance services into their decision-making processes.

Human-centric Data Immersion

Today, we have the luxury of being ensconced in data. Data is everywhere and it engulfs us. It's geotagged so it can be mapped, and the visualization possibilities are prolific. It can be used in vulnerability and risk assessment, human crises, and is available to prevent, protect, and care for human security. Data might be classified or open-source, crowdsourced, social media sourced, in real time (UAVs, full-motion videos), archived, historic, even non-intuitive. There are new analysis techniques for Big Data extraction and the quick delivery of actionable knowledge. Data provides the means to answer the questions of what, when, how, where, and why—all key factors needed to identify, prepare, prevent, protect, respond, and recover from events. High levels of abstraction exist.

And as the day of the autonomous car approaches, so do other opportunities. For example, as we hear about the spreading of the Ebola virus and the Enterovirus, the question arises about what we can do to provide aid or prevent additional outbreaks. Obvious and essential GEOINT requirements exist for outbreak mapping centers, as well as for identifying where and how best to send relief and educate individuals in precautionary measures. Yet, within this data ubiquity how can and should social responsibility be considered? This was alluded to when the Dallas county prosecutor considered pressing criminal charges against the now deceased Thomas Eric Duncan in consideration of whether he intentionally and knowingly exposed the public to the Ebola virus. The question we might ask is whether geodata could be used to prevent the spread of contagious diseases by identifying key signs in infected individuals and enforcing containment?

Technically it could. Take Fitbit, for example. These wearable devices track daily activity, calories burned, sleep patterns, and weight, then upload the information wirelessly so progress can be tracked on mobile and online dashboards. Already seen in bracelet form, it is feasible such tracking could be embedded in watches and wedding rings. The opportunity is there to give away or even sell an individual's spatial health information. The idea in itself is radical and flips the GEOINT coin. A conceptually noble undertaking might be for authorities to use this information to prevent the spread of disease, yet the human repercussions of such implementation could be massive.

One side of the coin exposes an obvious pursuit to safeguard the human condition, and the other to retain human privacy, even dignity. Both sides could be inspired and reactive, both defensive and intelligent. Those wrongly implicated might expect, even demand, such information be commonly available and released to set the record straight, while others might shrink away from the invasion of privacy. Others will suggest it has utility to address bioterrorism, others simply won't care. Some might insist it be implemented for all airline passengers, at least those traveling from countries affected by a disease such as Ebola. Irrespectively, all human vantage points and perceptions should be recognized, not excluding the momentum lent to practices of denial and deception, geospoofing, bad reporting, and disconnectivity. Such covert operations merit further discussion.

While there will be great advantages to broadening geolocation services, there will undoubtedly be those who do not want to be part of human-centric GEOINT. When everyone is connected, conspicuous holes in the data may draw more attention than the elements that fit in.

The next intelligence "arms race" may be development of tools to create a credible geospoofed record for consumption by the various engines that track a digital life. The deceptive information provided by the geospoofer needs to be sophisticated enough to respond to his or her purported environment. For instance, a track that is supposed to be of a person in a car needs to show response to traffic accidents and slowdowns, events that both the spoofer and law enforcement (or commercial data consumer) might not know about in real time. To counter geospoofing, law enforcement will need to identify reoccurring sameness in space patterns as a potential "replay" of previous normal day tracks.

Thus, the complexity of the human response system and the GEOINT process is mutually inclusive. The time is dawning, therefore, to move toward human-centric GEOINT.

Data Privacy and Security

Emerging Boundaries and Restrictions

As we consider what's on the horizon, the frequent temptation is to scope the proverbial "art of the possible" rather than focus on potential impediments to fully realizing the potential of existing GEOINT sources and methods. Unfortunately, several topics currently swirling within the Intelligence Community may greatly impact our ability to effectively utilize capabilities and sources that demonstrate great potential. In particular, issues associated with data privacy and security will merit increasing attention if we are to realize the exciting futures that are emerging, and even those yet to be discovered. Specific challenges include restrictions and constraints regarding the use of location data and related analytic capabilities, as well as the unauthorized use of, access to, or adversary exploitation of these same resources. These challenges may significantly limit, or even preclude our ability to use important sources and methods, and also negatively influence the public perception of our work. They may even limit our ability to effectively recruit and retain talent.

With these data privacy and security challenges in mind, several questions emerge that should be considered by the community as we work to not only fulfill our primary mission, but also to protect and preserve the great benefits GEOINT sources and methods provide. Ideally, we will be proactive in solution-focused discussion of these hard problems because if history provides any clues, poorly timed and/or reactive responses are not likely to generate workable answers.

Unauthorized Access/Use, Adversary Exploitation

Location not only adds value but it inherently increases the potential sensitivity of the data. Therefore, just as GEOINT can support meaningful insight, anticipation, and influence, it would be naïve to believe we are the only ones with the foresight and ability to effectively exploit such information. Access to and use of GEOINT sources and methods by our adversaries creates a new dimension in risk and threat assessment. At a minimum, the increasing frequency of data breaches represents an inconvenience to consumers as credit cards and passwords need to be updated, and fraudulent transactions resolved. Perhaps more troubling, however, would be the ability to effectively exploit stolen GEOINT content in support of truly informed and specifically targeted attacks. Again, geolocation concurrently adds value to and increases the sensitivity of associated data—something the crisis and conflict mapping community is acutely aware of and actively works to address and mitigate in an effort to ensure they do no harm to the communities they serve. Similarly, the routine collection of geoenabled data and increased ability to create truly prescient derived products in support of meaningful and actionable pattern of life analysis represents an entirely new domain of risk and threat that will complicate decisions regarding the collection and use of GEOINT.

Privacy, U.S. Persons, and Personally Identifiable Information

Perhaps the most pressing question facing our community is how the expectation of privacy aligns with GEOINT. Privacy and the protection of civil rights and liberties is not a new issue for our community, particularly as it relates to U.S. persons and personally identifiable information (PII). Recent public debate, however, has identified GEOINT as a potentially intrusive data source that merits review and scrutiny.

Adding to the controversy is the increasing use of transactional data and other sources to infer location and/or identity, even when the individual has explicitly opted out. For example, recent reports suggest the social media app Whisper can use a smartphone ID and IP address to infer location, while also being able to use this and related content to derive a unique identifier, if not actual PII. Similarly, IBM Watson has been able to effectively leverage high-performance computing, natural language processing of social media feeds, and geoenabled financial transaction data to infer links between social media accounts and specific customers in support of pattern of life analysis and related targeted marketing.

While these sources and methods are currently confined to commercial uses, and the requirements and constraints are relatively clear and fixed as they relate to U.S. government collection and use of GEOINT, the potential for misuse is readily apparent. To date,

the commercial segment has operated in this space relatively unfettered and people have demonstrated an intriguingly transactional approach to their PII, willingly sharing private data including location in exchange for a real or perceived benefit. Whether it is a location-specific coupon, discount, or some other relevant offer or suggestion, individuals are willing to share their information in exchange for a personal benefit.

Our community needs only to look at the data science domain to see a glimpse of our future. From the Data Mining Moratorium Act of 2003, which stated: "[t]here are significant concerns regarding the extent to which privacy rights of individuals would be adversely affected by data mining carried out by their government," to the European Union's "right to be forgotten," government collection and use of data and the associated analytics have increasingly been contested and curtailed. In a move reminiscent of the Data Mining Moratorium Act, legislation proposing "guidelines" for the use of geolocation data is being considered currently by the U.S. Congress. The commercial sector has not been immune to questions regarding data privacy, and missteps such as the Target "pregnancy model" underscore the potential for backlash if the public believes their trust has been misplaced or abused, even if only inadvertently. We would be smart to learn by example from these lessons.

Sensors, Automated Collection, and Unreasonable Search

Closely following questions regarding the expectation of privacy are concerns regarding the use of sensors or other methods of automated collection and associated prohibitions against unreasonable search (i.e. Fourth Amendment). While the use of sensors and automated collection methods appear to represent a logical extension of manual approaches, public perception seems to suggest there is a very important distinction, particularly as applied to government collection and use. For example, while there is no obvious expectation of privacy regarding your location in a public place, the use of geo-enabled apps, automated license plate readers, toll collection, or other automated methods has resulted in heated public debate and legislative action, including provisions requiring warrants for the "digital tracking of location."

With the public conversely demonstrating remarkable tolerance for the use of automated collection capabilities for tangible benefit, the result is a relatively opaque space where the lines of acceptable collection and use appear to be exceptionally fluid with regard to collector, source, and perceived benefits to the end user. Unfortunately, the application of 18th century legal concepts to 21st century technology will continue to create legal questions with no easy or readily identifiable answers or solutions, and at least some of the remedies being discussed may severely limit or otherwise curtail the collection and use of GEOINT in support of public safety and national security missions.

Public Perception of GEOINT

As we contemplate the many and diverse challenges associated with acceptable collection and use of GEOINT, it will be important to step back and also consider public perceptions of these activities, particularly in support of public safety or national security missions. For many, perception is reality. Therefore, while the GEOINT Community is frequently constrained by a need to protect sources and methods, Hollywood has been particularly adept at framing the narrative in a manner that portrays the government as extraordinarily intrusive and manipulative. The collection capabilities and use of advanced analytics to inappropriately monitor and target citizens has been portrayed in popular culture for decades in a manner that nurtures distrust. Unfortunately, the information leaked by Edward Snowden merely represents "confirmatory evidence" for what many already "knew" or at least suspected.

More broadly, will these perceptions of the government use of GEOINT, whether realistic, influence whether people are willing to support the community? Is a transactional approach similar to that adopted by the commercial segment practical or even appropriate? Experience from the Sochi Olympics suggests both spectators and athletes were willing to accept extensive surveillance and monitoring in support of a safe experience. Would this exchange of privacy for security translate to other locations and venues, and for how long? Perhaps more important, though, is whether increased surveillance and monitoring is in keeping with our understanding of a free society and the role government should play in collection and use, and who should ultimately make these choices?

As we consider the potential consequences associated with a diminished public perception of the collection and use of GEOINT, will increased transparency help or hinder the community, particularly when it comes to sensitive sources and methods? Perceptions of inappropriate collection, access, and use have been

associated historically with reactive attempts to regulate and the introduction of other legal constraints. The current consideration of legislation to control or otherwise limit the collection and use of GEOINT is something we should note and consider carefully. Again, these are really hard questions without easy or obvious answers, but it behooves us to at least consider these issues so we will be able to respond with truly informed input.

Recruiting and Retention

Finally, of direct concern to the future of our community is whether these challenges will influence our ability to recruit and retain the best and brightest analysts and technical experts. For many, the opportunity to support the U.S. national security mission offers the unique opportunity to change outcomes and truly make a difference on a daily basis through service that frequently is unheralded and anonymous. Will this commitment to mission be sufficient going forward to overcome potential barriers created by the perception that government is intrusive in its collection and use of GEOINT? On the other hand, will our mission become so constrained that the most attractive environment for doing truly innovative GEOINT work becomes the commercial setting? Even today, the commercial sector frequently offers highly competitive salaries and benefits. Will the opportunity to do more interesting work with a greater breadth and depth of content and related capabilities in the commercial environment divert the most highly qualified applicants away from national security? The importance of recruiting and retaining the best and brightest to ensure continuity and excellence in the workforce will require that we not only consider these challenges, but also make sure they are effectively addressed.

Conclusion

The future of GEOINT is exciting and promising. Novel sources and methods for meaningful analysis are emerging daily, and solutions to some of our hardest problems appear to be just on the horizon. With great power, though, comes great responsibility. Considering some of the potential challenges facing our community, particularly as related to the privacy and security of GEOINT data and capabilities, it is important that we begin asking the hard questions of ourselves about who should have access to what data, when, how it will be protected, and how it will be used. There are no easy answers or solutions. However, it is imperative that we as a community start at least considering data privacy and security to ensure access to important GEOINT sources and methods now and in the future.

The Transition of GEOINT to a Market-Directed Model—Crisis or Opportunity?

"How did it get so late so soon?" - Dr. Seuss

Until the 21st century, the U.S. government drove innovation by its large yearly investments in GEOINT research and development (R&D) and by establishing classification and export/import barriers to control access to the data and technology. Commercial innovation leaders such as Northrop Grumman, IBM, and Hewlett-Packard were largely directed by government funded and controlled activities such as the race to space and the development of advanced arms needed during the Cold War.

As a result of the explosion of global connectedness during the last decade, the demand and expectations for GEOINT data by an increasingly impatient mobile global citizenry have fueled an explosion in commercial geospatial innovation.

Is this a crisis or an opportunity for the U.S. government? Is it too late for the U.S. government (USG) to engage in meaningful ways to benefit from this commercial market-driven innovation? More importantly, did the early export/import control of technology developed by U.S. firms prevent the global competitive market interactions by these firms and, instead, erode U.S. dominance in commercial GEOINT innovation? Has the continued ITAR restriction relegated U.S. commercial GEOINT innovation permanently behind European and Asian nations? Is it too late?

USG and Innovation

Let's first look at whether the USG can leverage and benefit from commercial innovations. Innovative uses of geospatial data to support commercial users

have driven the creation of markets for geospatial data that were unforeseen just a few years ago. The innovative players in the commercial geospatial industry are developing products at a rapid pace that outstrips the USG's ability to acquire and ingest these new applications and products into the USG GEOINT enterprise baseline. Commercial technology has leapfrogged ahead of the defense industry in almost every important area. As a result, commercial geospatial capabilities are rapidly diverging from the USG baseline of just a few years ago.

New players, such as Google and Skybox Imaging (which is now owned by Google), arrived with new business models and disruptive technologies. Existing market players have responded by transforming their business models away from selling to the USG and are instead focusing on much larger, more lucrative commercial GEOINT endeavors. Although the primary obstacle preventing the USG from acquiring commercial innovations is indeed its broken procurement practices, the role of antiquated policies also has had an effect. USG policy has failed to keep pace with the rate of daily operational innovations—innovations that promote a mobile, interconnected workforce driven by open information sharing. One could argue that a commercial company selling to the USG risks becoming obsolete in the global market if it must conform to USG acquisition and policy constraints. This strong set of disincentives pushes away precisely the types of innovation the USG desperately needs, and the USG GEOINT user base often has to make do without.

The size of these diversified commercial GEOINT markets has attracted commercial investment that now dwarfs the U.S. government's yearly investments in GEOINT R&D. Google's market value is approaching $400 billion, more than double the combined value of the top four U.S. defense contractors. The combined R&D investments of the top five U.S. defense contractors amount to less than half of the yearly Microsoft R&D budget. Thus, the government budget no longer shapes the geospatial and GEOINT market as it once did. The Department of Defense procurement process has become more of a barrier to new entrants in recent years, which often leaves key geospatial acquisitions to the least-qualified defense contractors. At a minimum, the procurement process appears parochial and preferential to companies already conducting business in the government space. Declining budgets, an archaic acquisition process, Byzantine policies, and USG demands that require companies to turn over intellectual property—even if developed using private investment—are continuing barriers to USG influence, ensuring the shape of the future GEOINT market will be formed primarily by commercial pressures and interests.

As a result, the USG is missing out on several levels of the ongoing geospatial revolution. The USG is struggling to bring existing GEOINT tools and products developed in the 20th century for 20th century production workflows, to a wider audience. At the same time new and innovative commercial, geospatially-based products are being developed and deployed by the commercial geospatial industry at a pace the USG can never hope to match.

Is it too late? Beyond the USG acquisition cycle and policy challenges, are there other factors impacting adoption of commercial products and solutions by the USG? The rapid development and deployment of innovative commercial geospatial products could have been (and could still be) a boon to the USG GEOINT Community. Unfortunately, the USG has so far proven to be resistant to adopting these commercial developments. The inability of the USG to accept commercial GEOINT solutions to government challenges stems in part from a cultural antipathy to procuring commercial solutions. This natural antipathy perhaps stems from a misplaced over-confidence that "we have better solutions developed behind our secret door" because the lack of transparency prevents challenge to such claims. Or is it simply a result of the USG not knowing how to effectively partner with commercial business? Federal Acquisition Regulations have been modified over the past decade to mandate consideration of commercially available solutions, but any impartial assessment of recent acquisition programs will show that commercial solutions are rarely adopted.

The expanding dichotomy of commercially available functionality and lack of USG application affects every aspect of GEOINT. The wide range of geospatially-enabled and social media commercial capabilities commonly used on smartphones are generally not available to a USG GEOINT analyst. The GEOINT tools and products available to the intelligence analysts are largely the same as those available to an analyst more than a decade ago. As an example, the Intelligence Community continues to rely on a 1970s construct, the BE number catalog as their main entre to target search and collection tasking rather than adopting the far more intuitive and practical latitude/longitude or graphical zoom-in/zoom-out search applied via commercial platforms and apps.

The Global Marketplace: The U.S. as a Geospatial Innovation Leader

Secondly, let's explore whether U.S. firms can continue to drive and lead geospatial innovations in the global market. Are we losing our position? The world is developing technology at a rapid rate—as much as we would like to believe the U.S. has cornered the market on innovation, we are no longer in a position of leadership in many relevant areas. We need to be able to trade ideas and capabilities and to partner with allies and cooperative parties.

Boundary conditions placed on our technology development and sharing have become critical impediments to U.S. participation in the broader GEOINT world. These conditions include the continued role of ITAR in limiting international technology evolution—we are constrained from including many sensor analytic methods and processes due to their prior association with weapons development. The rule that technology first developed for a weapons purpose will be forever controlled by the ITAR regimen needs to be re-evaluated. The first digital computers were developed to solve nuclear weapons calculations and cryptographic problems, but today their descendants drive all commercial technology. It is time to constrain the ITAR limits (if they remain necessary at all) to technologies with the CORE purpose of weapons control or development. Only then can the U.S. maintain a position in the pack of geospatial innovators and developers.

Some Final Thoughts

"Action expresses priorities." - Gandhi

The future is full of opportunity and it is not yet too late for the USG to get in position to take advantage of commercial GEOINT capabilities and innovative thinking. Driven by the market, the rate of technology change and innovation are ever increasing. Leadership within the Intelligence Community will have to take forceful action to change the current trajectory of the acquisition system. Visionary leaders who understand current realities, working with a plausible set of assumptions, must develop multiple plans with alternative future images rather than betting on a single forecast of the future and rigidly adhering to a single path forward. The USG acquisition must exhibit more flexibility, transparency, and openness to innovation from a much broader spectrum of providers. While changing the current culture will be challenging and require the long-term attention of agency leadership, the payoff will be a dramatic leap forward into 21st century GEOINT capabilities.

GEOINT at a Crossroads: A View from the Federal Sector

Over the last several years the world of GEOINT has changed dramatically. There has been widespread adoption and innovation in geospatial capabilities across the public and private sectors. Geospatial capabilities have become ubiquitous in everyday life—from powering smartphone applications, to buying a house, to driving cars with GPS. This ubiquity in geospatial capabilities is challenging many long held assumptions about how we operate in the national security, natural resources, disaster response, and other traditional U.S. federal domains. GEOINT and the "power of where" have transformed the way we interact with each other, conduct business, and view the world. With this shift in the GEOINT universe, with "where" in everything we do, GEOINT is at a crossroads—how U.S. federal GEOINT practitioners respond and view the world must continue to evolve.

The GEOINT roadmap needs to be grounded in the geospatial art and science from where the discipline came, while remaining agile enough to embrace innovation and change. At the heart of GEOINT is location-enabled information. No longer is GEOINT simply the making of maps or analyzing of imagery. Nor is it just the domain of the U.S. federal government. Because the federal government is no longer the primary producer of data, it should instead prepare to take advantage of what is already available from a blend of public and private sector data holdings. At the core of this roadmap, GEOINT must change by:

- Drawing on data already available instead of creating it
- Partnering with new entities to find the answers
- Teaming across public and private sectors to problem solve
- Taking advantage of technology improvements to share information
- Leveraging new thinking developed through evolving academic programs and experts

These suggested changes provide an opportunity to transform U.S. federal operations by leveraging the power of the GEOINT revolution. Identifying opportunities for change is one important step. However, taking advantage of these opportunities requires a major shift in GEOINT culture—the federal sector does not have to do everything for itself. Fundamentally, the GEOINT Community needs to contemplate some tough questions:

- Should the U.S. government continue to make maps? Even though there may be a need for very specialized maps or niche products for unique applications, how can we better leverage print-on-demand technology to streamline mapping requirements?
- Will the U.S. government continue to produce geospatial data and products, even when these same data and products are also available through public domain or commercial means? Can we shift our GEOINT data provisioning strategy from collections to acquisition?
- Can the U.S. federal GEOINT enterprise shift to leveraging other producers for derived products instead of generating those products on our own? Can we ask questions of producers and let them provide the answers?
- Can we let go of costly legacy GEOINT systems and databases and take advantage of global data and the cloud?
- What skill sets should we continue to require from our workforce and should we be acquiring new skill sets to take advantage of shifts in GEOINT? How do we continue to evolve GEOINT tradecraft, training, and education?

The GEOINT Community must consider the following observations in answering these questions.

The U.S. federal government is no longer the sole driver of new technology and data creation in the GEOINT world. The federal government will be a major driver of standards to ensure, most importantly, that the data be interoperable, discoverable, and accessible to all.

The explosion of mobile capabilities will drive major changes in how the federal government applies GEOINT to conduct missions. The current uneven deployment of these mobile tools must be addressed so federal users can optimize use of these capabilities, particularly to enable teaming across federal, state, local, international, and business domains. Within current budget constraints, federal partners must jointly invest in new technology and training to keep pace with GEOINT change and avoid becoming "disadvantaged users."

We can't lose the tradecraft—we still need to understand the science and art behind GEOINT, but the workforce we hire in the future will need vastly different skills than what we have today. The workforce living in a GEOINT-rich world will need data science and data analytics skills to make sense of vast amounts of information served up from across the globe. That workforce will move in and out of the federal sector and possess credentials that allow them to move into many GEOINT data fields—they will live within the data—to answer the questions we face.

Finally, there are several GEOINT policy issues that must be addressed related to geospatial information sharing, safeguarding, privacy, and the rights of U.S. persons. With the ongoing GEOINT revolution, U.S. decision-makers will face even more complex policy challenges to keep pace with emerging GEOINT capabilities and practices that will quickly outpace existing policies and authorities.

The proliferation of GEOINT capabilities and data is changing our viewpoint. Geospatial capabilities have become ubiquitous to our lives. It's time for the federal domain to aggressively embrace these shifts to ensure we can meet our national goals. The focus should be on maintaining and improving relevance and ensuring the U.S. federal government can keep pace as the rest of the GEOINT world moves ahead.

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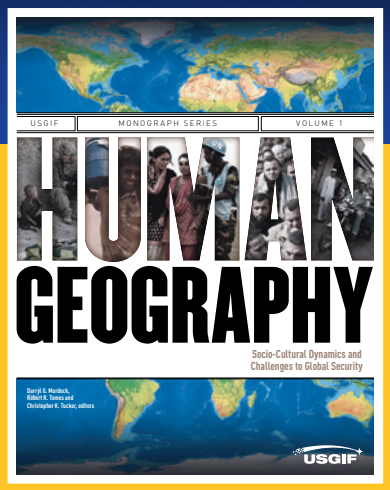

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