



NGA

Tech Focus Areas **2020**



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LETTER FROM THE CHIEF TECHNOLOGY OFFICER

In 2019, we published the first NGA Technology Focus Areas as a way to share our technology needs with the larger geospatial intelligence (GEOINT) community. As our needs and expertise continue to grow and evolve, it is incumbent on us to provide an updated document reflecting these changes. We collaborated across NGA to gather both our current and enduring needs – and the future problems we see on the horizon. This year, we expanded the scope of the document beyond analytics and data to include software engineering, artificial intelligence, and the future of work.

The National Defense Strategy declares that we have entered an era of a Great Power Competition. Several near-peer adversaries are investing significantly in new technologies to close the gap with U.S. and allied capabilities. To stay ahead of these adversaries, we must bring together our world-class experts at NGA, industry partners with exquisite domain expertise and technical capabilities, and companies who have never worked with government before but whose products could help advance NGA's mission. This document is designed to facilitate collaboration among all three and help get everyone on the same page so we can work with a common language as we solve these hard problems together.

To that end, this document is focused on our needs, rather than specific technologies. The changes we must make cannot only occur within the confines of NGA – they require the innovative spirit of industry to find new and unique solutions to some of our most intractable challenges.

Also, this year, we are releasing NGA's first Technology Strategy, which outlines our principles and strategy for maintaining our nation's GEOINT advantage. The Technology Strategy outlines 'how' we will change as an agency and as a GEOINT community to enable us to solve our technology challenges, while this NGA Technology Focus Areas document describes the 'what.' Together, these two products illustrate the direction we are moving NGA's technology efforts. Please read them both; they provide a roadmap to protecting and advancing our nation's GEOINT advantage for years to come.



Mark Munsell
Chief Technology Officer
National Geospatial-Intelligence Agency

NGA Today

The National Geospatial-Intelligence Agency (NGA) is a unique combination of combat support agency and intelligence agency. We are the world leader in timely, relevant, accurate, and actionable GEOINT. Anyone who fights wars, locates targets, sails a U.S. ship, flies a U.S. aircraft, makes national policy decisions, responds to natural disasters, or even navigates with a cell phone relies on NGA.

The year 2020 will represent a historic inflection point for our agency, our community, and our nation. In addition to the challenges we currently face from the COVID-19 pandemic, great power competition has reemerged as another challenge to U.S. prosperity and security. From a national security perspective, our near-peer adversaries pose real threats. To win this great power competition, the GEOINT community must be prepared to help us meet a number of shared mission objectives:

- 1. Preserve and advance U.S. and allied competitive advantage in all realms, below the level of armed conflict;**
- 2. Enable Joint Forces to fight and win a major war with a near-peer competitor at any time, in any place, in any domain; and**
- 3. Preserve shared advantage in the face of hostile action from our adversaries.**

The nature of GEOINT has shifted. Years ago, our advantage rested on the fact that our technology enabled us to observe better than other nations in the world. Today, with commercial GEOINT available worldwide, we face a much more level playing field. NGA is responding by growing existing partnerships, expanding the number of partnerships, and bringing new technologies into the analytical process. The pandemic of 2020 has also forced us to move more of our efforts to the unclassified realm. In all realms, collaboration and innovation are key to meeting the challenges that lie ahead.

PURPOSE

The NGA Technology Focus Areas enable stronger partnerships between NGA, industry, academia, and other government and community partners around NGA's most challenging needs. It describes five primary themes for NGA's focus on planned technology investments, outlines NGA's enduring and future technology needs in these areas, and describes how industry can collaborate with NGA to meet these needs: 1) advanced analytics and modeling; 2) data management; 3) modern software engineering; 4) artificial intelligence; and 5) future of work.



1 Advanced Analytics and Modeling



2 Data Management



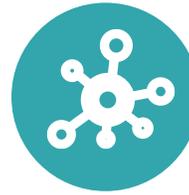
3 Modern Software Engineering



4 Artificial Intelligence



5 Future of Work



ADVANCED ANALYTICS AND MODELING

Advanced analytics and modeling enable the discovery, assessment, understanding, measurement, enrichment, and use of geospatial data from around the world. The analytical capabilities of today's global GEOINT enterprise continue to build a rich foundation of unstructured and structured information in multiple dimensions and formats. Driven by the availability of geospatial data and the advancement of artificial intelligence (AI), emerging machine-assisted processes, and access to the right mix of computing hardware are shaping the future of the GEOINT mission.

NGA analysts need to create mission-focused models that describe knowledge about an intelligence topic in a machine-readable format. These object- and relationship-centric models will allow analysts to identify collection opportunities, process and characterize multiple sources of GEOINT data, and monitor and infer activity and outcomes. An effective knowledge model will also enable analysts to create and test analytical hypotheses and conduct predictive and anticipatory analysis. These advancements will help NGA get the best product to the end user faster.

NGA's Technology Focus Areas are shaped by analytical expertise monitoring enduring threats, assessing emerging issues through activity-based intelligence, and conducting extensive research on long-term intelligence topics. To address the increasing complexity of today's challenges and prepare for the imperative of future power competitions, NGA is investing in advanced analytical and visualization capabilities. Incorporating augmented and virtual reality systems and 3D gaming technologies has the potential to unlock the ability of GEOINT professionals to synthesize incoming data that is ever-growing in scale and complexity and to produce new intelligence products for NGA's customers. NGA's specific needs in this area include:

ANALYTICAL MODELING: NGA analysts need to conduct model-driven assessments of activities, the associated indicators, and their interrelationships across multiple domains to generate deterministic or probabilistic estimates of events.

ACTIVITY MODELING: NGA analysts need a way to describe an intelligence topic or challenge in order to process activity-based data for localization, characterization, correlation, and tracking of objects.

KNOWLEDGE MODELING: NGA analysts need a discoverable and collaborative knowledge reference base of assertions against structured objects and activities to enable the synthesis of different information.

INSIGHTS-AS-A-SERVICE: NGA analysts need geospatial web services that feed analytic, detection, and monitoring insights into existing workflows to more quickly derive intelligence value from GEOINT.

SUPPLIER CAPABILITY EVALUATION: NGA source strategy analysts need decision aids to: 1) automatically evaluate the range of geospatial data supplier content and services accessible to NGA; and 2) for those NGA accessible items, recommend the optimal supplier offerings to effectively and efficiently satisfy needs based on cost, timeliness, and performance parameters.

IMMERSIVE PRODUCT GENERATION: NGA analysts need the ability to build immersive GEOINT products for augmented and virtual reality systems to support their customers’ evolving needs.

ANALYTIC SUGGESTION SERVICE: NGA analysts need a user-friendly, machine-assisted modeling capability able to recommend statistical approaches based on observed workflow data to ensure they are aware of analytical options that may be of use.

CONTEXTUAL LEARNING: NGA teams need extended reality tools in order to leverage abstract information for intelligence products and training material.

GEOINT PHYSICAL SCIENCES: NGA researchers need advancements in technology to improve the terrestrial and celestial reference frame, gravity, magnetics, manmade and natural feature extraction and attribution, and bathymetric, topographic, and infrastructure models in order to improve its ability to model the physical Earth.



DATA MANAGEMENT

The creation and dissemination of GEOINT data, products, and services allows users to answer questions such as “What’s happening where?” and “What could happen when?” Observation datasets of the Earth’s physical and

cultural characteristics – including elevation, bathymetry, gravity, and human geography – enable the GEOINT community to orient, decide, and act faster than ever before, and geospatial data is now viewed as an important commodity with universal demand across an ever-increasing marketplace.

The rapid advancement of technology and the increasing density of interconnected devices and sensors has led to an explosion of geospatial data from sources with diverse organizational schemas and security requirements. Data vary in source, quality, reliability, format, and transmission method and include diverse collection methods, such as space-based satellites, airborne platforms, maritime vessels, foreign governments, and open sources.

The following technology needs demonstrate the increasing demand for timely and agile integration of new data management technologies. Capable of operating on a global scale, force-multiplied, and augmented through innovative

data synthesis and visualization, NGA’s data management infrastructure will serve the agency’s evolving geospatial digital business model. Our specific needs in this area include:

DATA INTEGRATION: NGA analysts need the ability to rapidly discover and integrate diverse data types and multiple types of pixel- and non-pixel-based data from multiple sources to discover and characterize relevant patterns.

MULTI-DOMAIN DATA AGGREGATION: NGA analysts need to rapidly aggregate diverse data types and schemas from sources across multiple domains to quickly extract intelligence at scale.

LOCATION-BASED INSIGHTS: NGA analysts need to integrate large amounts of data from commercial location-based services into existing workflows to improve their spatial and temporal insights about the physical environment.

MULTI-DIMENSIONAL DATA MANAGEMENT: NGA systems engineers need to organize and store geospatial information in data models that reflect temporal currency in order to produce more comprehensive intelligence products.

AUTOMATED OBJECT VALIDATION: NGA analysts need a way to automatically distinguish between multiple observations of the same object and observations of similar objects to validate the accuracy of imagery-based observations.

TERRAIN ELEVATION DATA ALIGNMENT: NGA analysts need to align standard foundation terrain elevation datasets from different geodetic approximation models, such as ellipsoid, spheroid, and geoid, in order to be imported into 3D gaming platforms.

CUSTOMER EXPERIENCE METRICS: NGA data scientists need a way to identify how and where NGA products, services, and data are utilized in order to identify customers and measure the impact on their missions.

RELEASABILITY SERVICE: NGA needs an access control mechanism that considers geospatial and temporal restrictions in order to secure sensitive information within data objects.

AUTOMATED CONDITIONING SERVICE: NGA needs the ability to automate data conditioning for easy and accurate metadata tagging so that data is discoverable and accessible by the enterprise.

ENTITY RELATIONSHIP MODELING: NGA analysts need to conflate the ontologies, schema, and knowledge graphs of multiple non-pixel datasets and model the relationships between them.

MACHINE-LEARNING TRAINING DATA: NGA scientists need analysis-ready, structured, and validated data sets to support dynamic algorithms and model development that is repeatable and auditable for new and existing use cases.

MULTI-DOMAIN DATA TRANSFER: The COVID-19 pandemic illustrated how quickly NGA analysts need to transfer data between multiple security classification domains to exploit all the geospatial data relevant to an intelligence problem.

DATA INTEGRITY: NGA analysts need the capability to automatically identify the source, format, and transmission method of data to assess its potential risk.

DATA ASSURANCE: NGA analysts need a scalable and interoperable way to continuously evaluate data provenance through its lifecycle so that they can make informed decisions about how all data sources can be used by the enterprise.

CAPABILITIES AND DATA PROTECTION: NGA systems engineers need a way to safeguard geospatial capabilities and data against malicious alteration and machine-generated errors.

RELIABLE COMMERCIAL AND PUBLICLY SOURCED DATA: NGA analysts need to determine the “fitness of data” from public and commercial sources NGA has access to, so they can be used in GEOINT data, products, and services.

AUTOMATED CONTENT CLASSIFICATION: NGA analysts need the capability to automatically classify natural language content in accordance with security protocols in order to minimize misclassification and to dynamically and more easily share information.



MODERN SOFTWARE ENGINEERING

To build the level of software NGA requires to perform its mission, NGA needs modern software engineering practices and environments. New software approaches are creating

efficient ways for NGA’s government, military, and contractor teams to deliver the services and capabilities necessary for supporting the GEOINT mission. Investments in a robust development platform, continuous integration/continuous delivery (CI/CD) processes, and shared development, security, and operations (DevSecOps) tools enable NGA software engineers to quickly build and iterate on software. The agency is enhancing its infrastructure to support greater unclassified collaboration and increase execution speed, while lowering risks and costs.

NGA is lowering the barriers to entry as part of our effort to empower the builders and makers of geospatial technology. Modern development practices enable teams to rapidly build, test, and deploy capabilities to the enterprise that have been built with users at each step in the process. Enhancements, such as a software application reference architecture, will support all application development, and an Application Programming Interface (API)-first approach will unlock more rapid integration with

reuse of existing services. Improved visibility and testing of the software supply chain will enable open-source software to be more widely and easily used and allow NGA to embrace open-source innovation.

NGA’s software engineering technology needs are driven by an infrastructure-as-code approach. Whether on-premises, at the edge, or in one or more cloud environments, NGA is working to ensure that software development and security practices meet the requirements of our internal and external builders and makers. Our specific needs in this area include:

AUTHORITY TO OPERATE AUTOMATION: NGA software engineers need tools to ensure the automation of security hardening and vulnerability assessment. Software application authority-to-operate (ATO) must be reciprocal across a multi-cloud architecture so that engineers can rapidly deploy software to the enterprise.

AUTOMATED MONITORING: NGA site reliability engineers need a way to automatically understand which applications are currently up or down and be able to rapidly respond to issues so that they can increase IT system availability, resilience, and security.

AUTOMATED TESTING AND DEPLOYMENTS: NGA software engineering teams need the ability to run automated tests when code is checked in and to be able to automatically deploy that code to various environments and networks when appropriate, without causing downtime or impacting mission critical processes.

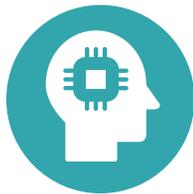
DEVSECOPS AUTOMATION: NGA software engineers need a development and integration platform that automates enterprise policies and observability of new application performance to reduce the time to deployment and increase the quality of code.

SOFTWARE SUPPLY CHAIN TRANSPARENCY: NGA system engineers need to identify and programmatically track the provenance of all imported software, so they can determine how it can be used and what security procedures are required.

IDENTITY AND ACCESS MANAGEMENT: NGA needs effective and reliable identity and access management (IDAM) mechanisms to increase the security of and access to applications and data repositories.

RAPID DEPLOYMENT OF UNCLASSIFIED CODE: NGA analysts need to pull software developed in unclassified settings to sensitive networks and rapidly determine where such software can be deployed across the enterprise to more effectively leverage unclassified developer talent.

DEVELOPMENT ENVIRONMENT FOR 3D DATA: NGA developers need a development environment to build software applications to analyze multi-dimensional spatial data sources and integrate into the enterprise.



ARTIFICIAL INTELLIGENCE

A revolution in geospatial AI is driving the urgent technology needs of the GEOINT community. Built on a modern software environment and data management framework, AI is a necessary force-multiplier for advanced analytics and modeling capabilities. Machine-assisted technologies, such as computer vision, endeavor to automatically detect, extract, and attribute features and objects in imagery and video. Geospatial AI will be needed to support and expand our intelligence professionals' depth and coverage. While conventional approaches have had success, NGA is seeking novel, innovative approaches to increase capability in computer vision on existing geospatial datasets.

NGA's needs for high confidence in AI and understanding of the generated output under varying conditions are supported by the larger Department of Defense (DoD) and intelligence communities. Under the DoD's ethical principles of AI, machine-assisted processes will be responsible in their development, deployment, and use; equitable with minimal unintended bias; transparent and auditable; reliable through extensive testing; and governable throughout the lifecycle. NGA's specific needs in this area include:

MACHINE-LEARNING MODEL FITNESS FOR USE: NGA analysts need the ability to assess the fitness for use of complex machine-learning modeling algorithms in order to ensure understanding by human subject matter experts.

RISK ASSESSMENT: NGA analysts need to calculate the risk level of a piece of software by estimating its complexity and potential impact so that users can apply the right level of governance.

ACTIVITY CONTEXTUALIZATION: NGA analysts need to extract and correlate tracks of activity from non-imaging sources, such as radio frequency and automatic tracking system data, with more traditional geospatial data, such as imagery, to contextualize changes in an area of interest.

OBJECT DETECTION: NGA analysts need to detect objects and changes in an image with little or no description in order to assess movement or changes to features.

FEATURE EXTRACTION: NGA analysts need to extract geospatial data feature geometries and their attributes with the highest measure of accuracy and speed from various sources in order to reduce labor-intensive manual extraction hours.

OBJECT CLASSIFICATION: NGA analysts need to categorize detected objects at a broad level of organization or feature and further classify within that category.

FEATURE CHARACTERIZATION: NGA analysts need to automatically characterize the attribution information of extracted foundation geospatial data in order to

build upon the knowledge recorded from previous recognition, identification, and classification of objects with the highest level of specificity.

QUANTUM COMPUTING FOR GEOSPATIAL OPTIMIZATION: NGA analysts need a hybrid quantum computing approach that combines classical and quantum computing to solve complex, multivariable geospatial optimization problems.



FUTURE OF WORK

The future of work at NGA requires the amplification of human-machine partnerships and a more productive and collaborative workforce. Increasing the efficiency and ability of NGA's internal elements to work better together – across classifications – will amplify the intelligence products that we can provide to NGA's customers.

This will include: acquiring tools that enable real-time collaboration across a team's physical or organizational location; permitting secure work using open-source data in unclassified spaces; creating visualization tools that enable work with multi-dimensional data; and identifying and implementing tools that automate and adapt to specific workflows and tasks.

NGA is committed to ensuring our workforce remains agile, connected, and able to respond to mission and customer needs, regardless of where they are globally. We need partners who can assist us in streamlining and automating common work processes. These processes vary broadly from, GEOINT collection management to analytics to integrating tools that enable access and the use of data, despite evolving security protocols. Our specific needs in this area include:

MAXIMIZING REAL-TIME AND REMOTE COLLABORATION: NGA employees need tools that allow them to coordinate and collaborate in real time across multiple devices, security domains, and geographic locations.

MULTI-DOMAIN AND MULTI-PARTNER COLLECTION MANAGEMENT: NGA collection managers need to coordinate the planning and execution of GEOINT collection missions with ad hoc and virtual teams across multiple security domains and partnerships.

FLEXIBLE AND SECURE WORK TOOLS: NGA teams need tools to work securely in unclassified and flexible workspaces in order to provide continuous access to data and mission work, while still adhering to location and security protocols.

SECURE CROSS-DOMAIN ACCESS: NGA engineers need to protect and run sensitive queries on networks with lower security levels so that they can leverage unclassified web services for sensitive analysis.

Collaborating with NGA

There are a few initial steps all businesses, whether large or small, must take in order to do business with the federal government:

1. Register in the System for Award Management (SAM).

SAM is a consolidated portal used across the U.S. government to conduct acquisition and financial assistance processes and share information on the latest solicitations. SAM is unclassified.

For additional information: <https://sam.gov>

2. Register in the Acquisition Resource Center (ARC). ARC is a website used by members of the U.S. intelligence community to exchange information with industry about business opportunities and conduct source selection activities. ARC is both unclassified and classified.

For additional information: <https://acq.westfields.net>

3. Leverage cross-government partnerships. Resources such as the General Services Administration (GSA) provide a wealth of resources and information on how you can partner with NGA.

For additional information: www.gsa.gov

4. Explore opportunities. NGA uses both Federal Acquisition Regulation (FAR)- and non-FAR-based agreements for partnering with non-Government entities. Through SAM and ARC, you will be able to stay on top of opportunities to work with NGA. Your thoughtful responses to FAR-based solicitations, such as Broad Agency Announcement (BAA) requests, Requests for Information (RFIs), and Requests for Proposals (RFPs), help us to understand your capabilities and make more informed decisions on our acquisitions.

For additional information:

<https://www.nga.mil> (innovative, non-FAR-based opportunities)

<https://www.nga.mil/partners/researchandgrants/> (research and grant solicitations)

Here are some of the tools NGA uses:

5. Broad Agency Announcements. BAAs are used to solicit innovative ideas on basic and applied research. NGA uses BAAs to fulfill our requirements for scientific study and experimentation directed toward increasing knowledge and advancing the art of the possible. These are normally posted on SAM and/or the ARC.

For additional information:

Contact BigRBAA@nga.mil (BAAs).

Contact NARPPO@nga.mil (Grants BAA).

- **Cooperative Research and Development Agreement (CRADA).** A CRADA is a low-risk, flexible, mutually beneficial opportunity to partner on a collaborative research and development (R&D) project. Although this option cannot provide funding to the partner, NGA and the partner can share resources, such as personnel, facilities, equipment, data, and intellectual property.

For additional information: Contact CRADA@nga.mil.

- **Other Transactions (OTs).** An OT agreement is a flexible acquisition tool for prototype projects that enhance the mission effectiveness of the DoD. A competitively awarded prototype OT can include an option for a noncompetitive follow-on production OT to be awarded after successful completion of the prototype.

For additional information: Contact OTA@nga.mil.

- **Small Business Innovation Research (SBIR).** NGA takes part in DoD's SBIR program to fund early-stage R&D projects at small technology companies — projects that serve a DoD need and have the potential for commercialization in private sector and/or military markets.

For additional information: Contact SBIR@nga.mil.

- **Prize Competitions.** Competitions provide an opportunity to crowd source NGA's most difficult problems by leveraging the public for innovative solutions.

For a sample of past NGA challenges: www.challenge.gov>>search 'NGA.'

For additional information: Contact prize_competition@nga.mil.

- **Innovative GEOINT Application Provider Program (IGAPP):** IGAPP serves as NGA's method to work with innovative app developers on providing useful apps and web services for consumers of GEOINT data.

For additional information: <https://igapp.com/about/us>

- ### 6. Contact Us.
- We have offices that can help with some specific opportunities to work with NGA. For more information, please feel free to reach out to any of the following:

- **Small Business Office:** You must complete a SAM Small Business Profile for Dynamic Small Business Search (DSBS) at https://web.sba.gov/pro-net/search/dsp_dsbs.cfm before reaching out to NGA. If you need specific assistance on an existing contract, contact smallbusiness@nga.mil.
- **NGA Industry Engagement:** If you are interested in providing a demo of your capability, contact IndustryEngagement@nga.mil.
- **NGA Research:** For outreach regarding GEOINT research opportunities, please contact NGA Research at nga_research@nga.mil.

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