Geospatial Intelligence Standards

Enabling a Common Vision

November 2006

NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY

Functional Manager's Message:

As Director of the National Geospatial-Intelligence Agency (NGA) and Functional Manager for the National System for Geospatial-Intelligence (NSG), I am responsible for establishing geospatial intelligence (GEOINT) standards for the defense and intelligence communities. Ensuring a universally adopted and implemented set of GEOINT standards is crucial to our mission success. These standards need to ensure access to timely, relevant, and accurate GEOINT data, services, and products regardless of source, exploitation process, or production element. I am accomplishing this goal through the National Center for Geospatial Intelligence Standards (NCGIS) at NGA and through the community-wide standards activities of the Geospatial Intelligence Standards Working Group (GWG).

Through the GWG, NGA has collaboratively defined a common baseline of standards in response to an NSG-wide need. That baseline is described in this document, "Enabling a Common Vision." By adopting these core standards across the NSG, we are enabling interoperability and providing capabilities to the warfighter and decision-maker.

By working together, the NSG is building a Service-Oriented Architecture (SOA) that enables the storage, retrieval, and sharing of vital GEOINT on which our national leaders, military, and other valued customers depend. This ongoing collaboration and information sharing will ensure even greater security for our nation and our allies.

ROBERT B. MURRETT

Vice Admiral, U.S. Navy

Director

Introduction: The National System for Geospatial-Intelligence (NSG) Standards Program

Shortly after the attacks of September 11 2001, the National Geospatial-Intelligence Agency (NGA) responded to the President's call for intelligence system interoperability and net-centricity by creating the National Center for Geospatial Intelligence Standards (NCGIS).

The Center was specifically designed to develop and coordinate data standards with other Department of Defense (DoD) agencies, other intelligence agencies, civil agencies, private industry, and foreign partners. Since its inception, the NCGIS has charted the course for the Nation's geospatial intelligence (GEOINT) standards, and today, in 2006, the benefits of that work are being realized.

The NCGIS supports standards and standardization efforts that enable effective, timely, and affordable geospatial intelligence in a networked environment. As outlined in Joint Vision 2020, the capability to operate jointly in coalition operations is critical to the success of the national security and defense missions. Inaccurate or time-consuming exchanges of data and information can have life or death consequences. Data accessibility, quality, and integrity are key capabilities required to achieve an optimal data-sharing environment. The need for common data standards that improve interoperability, an essential element of situational awareness, is also a recognized goal of the Defense Standardization Program (DSP), in which the NGA participates. NGA defines geospatial intelligence interoperability as the ability to discover, retrieve, exploit, and exchange geospatial intelligence data and information with other systems, units, and forces, through a system of networks and services, enabling the DoD, Intelligence Community (IC), and coalition partners to operate effectively together.

The goals and objectives of the NCGIS are aligned with the strategic direction of NGA as articulated in the NSG Strategic Intent, and they support the concepts of Joint Vision 2020. In addition, they advance the strategic goals of the DSP and the standards policy objectives of the Office of Management and Budget (OMB) in the executive office of the President, which include enhancing coordination of geospatial data activities and reducing the reliance on government-unique standards.

To achieve these goals and objectives and enable a common vision, the NCGIS promotes optimal interoperability through the use of a hierarchy of international, national, and Federal standards. To date, the NCGIS has engaged the international GEOINT community, identified a standards' architecture for the NSG, and initiated a conformance and interoperability testing environment, ensuring that NGA fulfills its functional management responsibilities for GEOINT standards.

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POLICE

NSG Standards – Enabling a Common Vision

The NCGIS has engaged with standards development organizations, the GEOINT community, and the private sector to develop and mature a set of standards and specifications that will enable data and service interoperability in the context of a Service-Oriented Architecture (SOA). The significant result of this effort is a suite of internationally coordinated standards that, in conjunction with corresponding standards-based commercial off-the-shelf (SCOTS) implementations, drive and enable the realization of an agile, cost-effective, service-oriented architecture. This architecture provides a clearer picture for the decision-maker, whether he is a soldier in the field or a policy-maker in Washington DC.

Understanding and implementing these specifications and standards is critical to true interoperability across the spectrum from data producers down to soldiers in the field. In many cases, the investment in the development and international coordination of these standards and specifications has already been completed. The NSG Functional Manager endorsed a set of key specifications known collectively as the Open Geospatial Consortium (OGC) Spatial Data Infrastructure (SDI) 1.0 baseline.

The OGC SDI 1.0 suite and the other standards shown below comprise the initial NSG standards baseline:

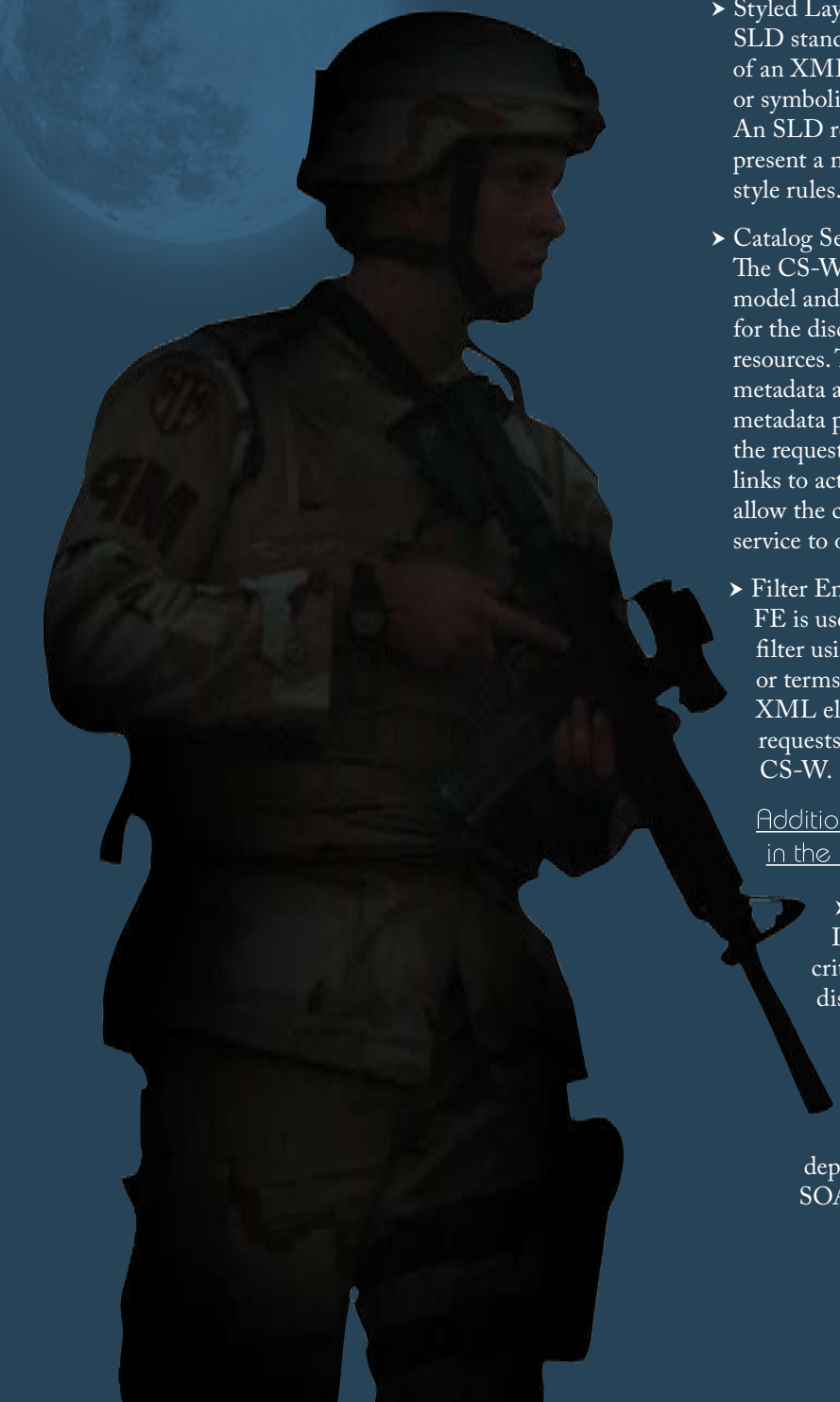
- Web Features Service (WFS): The WFS implementation specification allows clients to retrieve and update geospatial data encoded in Geography Markup Language (GML) from multiple WFSs. It defines interfaces for data access and manipulation of geographic features, and through these interfaces, a web user or service can combine, use, and manage geo-data.
- Web Map Service (WMS): The WMS implementation specification supports the creation and display of registered and super-imposed map-like views (graphical images, such as GIF, JPEG, TIFF, and NITFS).

Leveraging Local and Global Geospatial Data through The Use of Common Geospatial Standards

The fusion of remote sensing data, geographic information system (GIS) technology, and precise geographic information from the Global Positioning System (GPS) constellation, coupled with the increasing power and decreasing cost of computing over a network, has enabled an explosion of geospatial data across the United States and the globe. In the United States, there are approximately 3,300 counties and 85,000 municipalities, most of which have some level of ongoing geospatial data collection activities. The Federal Geographic Data Committee (FGDC) estimates that investments in geospatial data in the United States exceed $4 billion annually, much of which is invested by local governments. **It is also a simple fact of geography that people and organizations in these localities have the most direct knowledge of changes in the physical features (both natural and man-made) in their particular county, municipality, watershed, etc.**

The domestic civil community and the international community are implementing largely the same suite of common geospatial standards as the NSG. Standardization efforts within the NSG are bringing together diverse national and international community members to implement geospatial data standards that, through a Service-Oriented-Architecture (SOA), enhance interoperability across these communities. This architecture is particularly valuable to the Homeland Security community within the NSG, allowing it to share investments in geospatial data and knowledge related to critical infrastructure and natural environments with U.S. cities, counties and other organizations to support the prevention and mitigation of national disaster and security situations. Similar benefits will accrue to the warfighter with the addition of local/tactical knowledge to his or her geospatial understanding.

- Web Map Context (WMC): The WMC implementation specification is a companion to WMS. It describes how to save a map view comprised of many different layers from different Web Map Services.
- Web Coverage Service (WCS): The WCS specification allows access to geospatial "coverages" (raster data sets) that represent values or properties of geographic locations rather than WMS-generated maps (pictures).



- Geography Markup Language (GML): GML is eXtensible Markup Language (XML) encoding for the transport and storage of geographic information, including both the spatial and non-spatial properties of geographic features.

critical GEOINT Standards Baseline

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- Styled Layer Descriptor (SLD): The SLD standard defines the structure of an XML file that applies rendering or symbolization rules to features. An SLD requests a WMS to present a map according to submitted style rules.
- Catalog Services (CS-W): The CS-W provides an abstract model and protocol-specific solutions for the discovery of geospatial resources. Through catalog metadata and query interfaces, metadata properties are returned to the requestor, often embedded with links to actual data or services that allow the catalog to act as a referral service to other information resources.
- Filter Encoding Specification (FE): FE is used to express a query or filter using a predicate language, or terms and operators, stored in XML elements. FE is used in requests to WFS and queries to CS-W.

Additional standards included in the NSG baseline are:

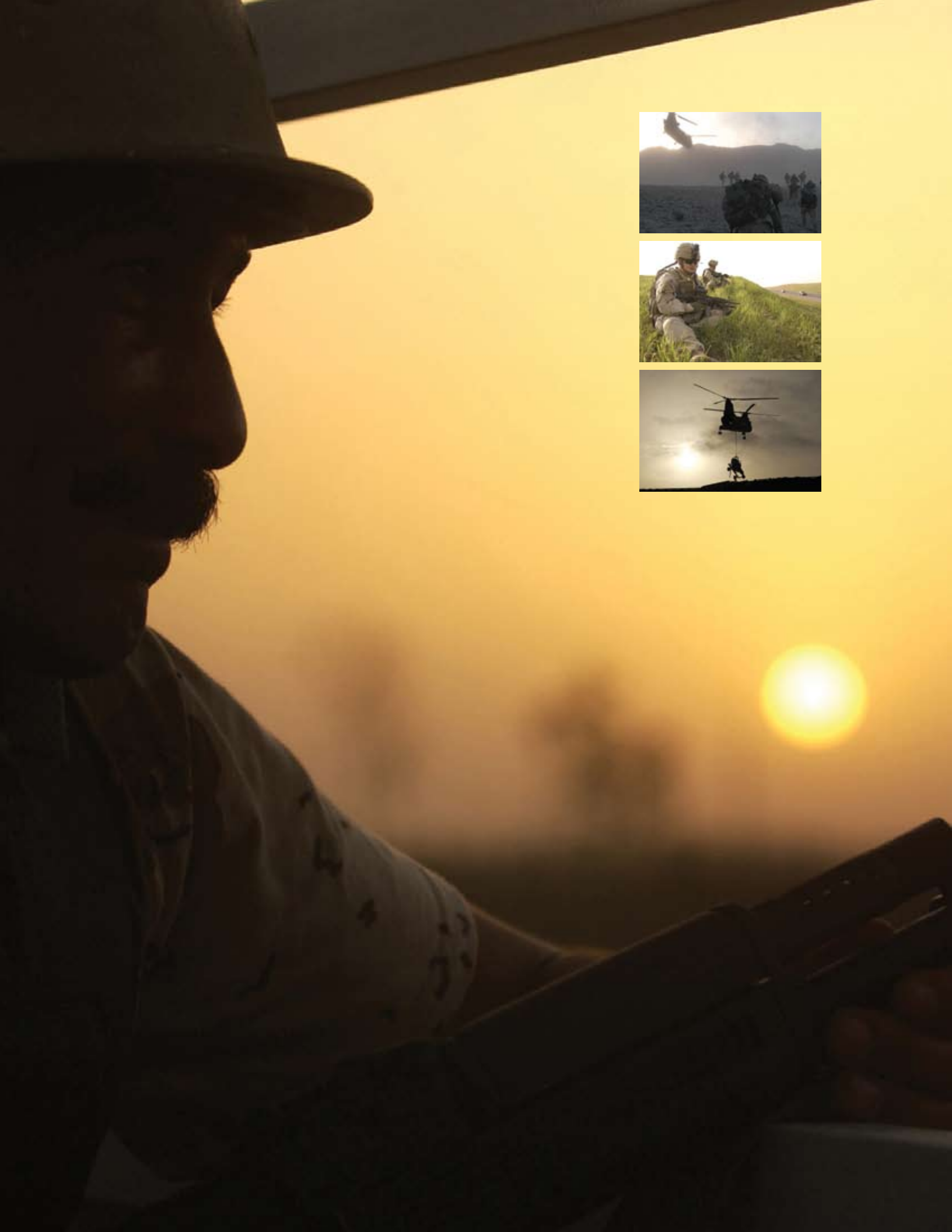
- ISO 19115 Geographic Information - Metadata: critical to making data discoverable and retrievable.
- ISO 19119 Geographic Information - Services: critical to defining where web services are deployed and used within an SOA.

- NSG Feature Data Dictionary and NSG Feature Catalog: critical to enabling the development of logical and physical data model.

The private sector has embraced the standards baseline and has already developed numerous SCOTS offerings that are fully compliant with these specifications.

The baseline includes critical standards in the areas of metadata, feature data dictionaries and catalogs, and the NCGIS is adding standards for portrayal and symbology. Combined with the SDI 1.0 baseline, these standards have emerged as a critical GEOINT baseline that the community needs to move toward profiling and adopting in the near term. Additionally, the NSG Chief Architect is evaluating other OGC services, to include sensor and processing services for incorporation into the baseline.

NGA and the geospatial community are well positioned to achieve coordinated implementation of these standards – the result will not only be enhanced interoperability, but also the ability to, at the lowest tactical level, return value-added content from the warriors on the front lines for re-use by others.



NSG Community Support for Standards

Under the leadership of the NGA, the GEOINT Standards Working Group (GWG) serves as a technical working group under the DoD Information Technology Standards Committee (ITSC). In this role, it recommends the adoption of standards into the DoD IT Standards Registry (DISR), helping to create a centralized database to better enable the discovery, access, integration, dissemination, exploitation, and interoperability of GEOINT. The GWG's Core members are responsible for reviewing current or emerging standards, coordinating advice with their agency's technical and acquisition experts, and reporting in GWG meetings their agency's position on the standards. GWG Core members include:

- NGA
- CIA
- NRO
- NSA
- Army
- Navy
- Air Force
- Marine Corps
- ODNI
- OSD (NII and AT&L)
- SOCOM
- JFCOM
- CENTCOM
- EUCOM
- NORTHCOM
- STRATCOM
- Joint Staff J2
- DHS
- DISA
- DIA
- DLA
- DARPA
- DOE
- FGDC

In addition to approving the placement of standards in the DISR, the GWG is the mechanism used by the NGA to carry out its role as Functional Manager of GEOINT standards. It provides a community-based, standards-focused forum to advocate and address standardization issues for the NSG. The GWG is the place where the NSG community can exchange information and discuss issues, identify emerging standards, provide advice on the development of standards, report on the activities of various international standards developing organizations (SDOs) and serve as the subject matter experts within the DoD and the IC on GEOINT standards matters.

Another key community forum involved with GEOINT standards issues is the Joint Forces Commands' GEOINT Activity (JGA). Battle space awareness and our ability to conduct joint operations as envisioned by JCS Joint Vision 2020 cannot be accomplished without robust, accurate, and timely GEOINT. The Joint Forces Command (JFCOM) and NGA have devised the JFCOM/NGA Initiative within JGA to ensure that GEOINT is provided in a bidirectional, standards-based environment that is net-centric and compatible with existing services and Combatant Command (COCOM) systems. JFCOM has chosen the GWG and the DISR as the means by which the JGA standards goals will be achieved.

JFCOM has assigned members to work within the GWG and its topical focus groups, such as the Metadata, Feature Encoding, Reporting, and Portrayal focus groups. The JGA activity also garners GWG participation from other COCOMs, including CENTCOM, EUCOM, NORTHCOM, and STRATCOM. The JGA/GWG members also participate in NGA's Geospatial Intelligence Board (GIB) to further the NGA/JGA standards goals.

By working together, the JGA and the GWG are:

- Developing and instituting a process to validate and implement GEOINT standards implementation profiles (IPs)
- Prioritizing IPs for validation
- Aligning NSG standards efforts with the DoD net-centric strategy
- Coordinating with Communities of Interest (COIs) on standards issues and COI interfaces with NGA
- Instituting a process for JFCOM to address standards issues/gaps in the GWG and its focus groups
- Contributing to the development of a geospatial SOA to promote interoperability.

Geospatial Intelligence Standards Working Group (GWG)

The GWG was established in October 2004 with the mission to identify and implement GEOINT standards in the NSG community. In January 2005, the GWG, led by the NCGIS, held its inaugural meeting with over 120 participants representing nearly every DoD, Intelligence, and civil standards entity. This high level of participation highlights the community's recognition of the need for enabling standards-based SOAs. The GWG has grown exponentially and continues to approve the placement of community standards in the DoD Information Technology Standards Registry (DISR) and address the serious interoperability challenges facing the NSG. One of those challenges is the development of a set of conceptual data models for the NSG. In August 2006, the GWG became a registered DoD Community of Interest (COI).

In addition to the Core Members of the GWG, the Associate Members serve as cardinal subject matter experts and include:

- Canada
- Australia
- United Kingdom
- DGIWG
- INCITS/L1 (ANSI Accredited)
- ISO/ TC2-11
- JISRCG
- OGC
- USGIF

In August 2006, the GWG became a **registered DoD Community of Interest (COI)**

Implementing NSG Standards That Support Interoperability

Standards Compliance Testing

Standards compliance testing is a significant step towards achieving interoperability. A fully interoperable NSG enterprise requires implementation of standards-based systems that are seamless and can be integrated into existing DoD and IC processes for delivery of GEOINT products and services. One of NGA's obligations as Functional Manager of GEOINT is to ensure that interoperability is achieved through standards testing and enforcement. The NCGIS is engaging elements of the NSG community to establish a test environment for architecture and GEOINT standards. Working under the guidance of the NGA Chief Architect, the NCGIS will establish this environment to accomplish two primary goals:

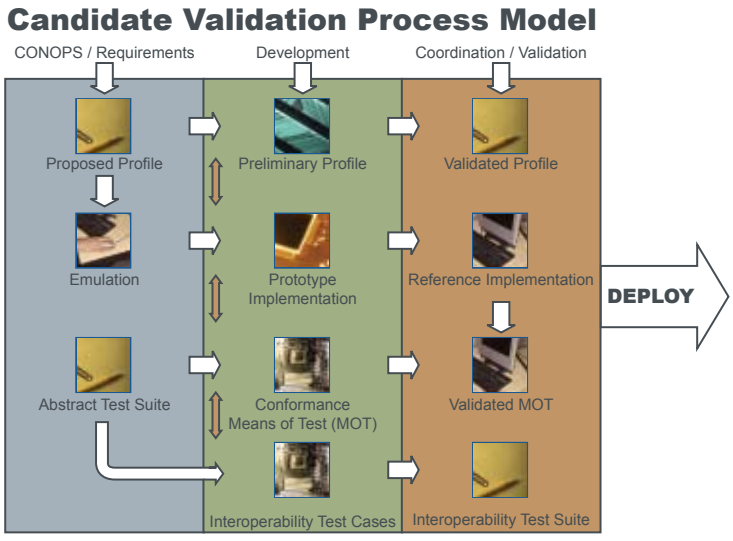
1. Ascertain the degree to which architectural design, principles, guidelines, concepts and standards, if deployed, will satisfy NSG:
   - Functional capability objectives
   - User agency requirements
   - Interoperability criteria
2. Validate, establish confidence in, and sustain the GEOINT Functional Manager's architectural and standards guidance to the IC and NSG communities.

Testing Methodology

The NCGIS will work with the NSG community to establish a methodology to conduct, document, and promulgate results emerging from the test activity. As an initial step, the NCGIS will employ a validation process model to guide preparation of test execution strategies and build appropriate plans, schedules, and budgets. The NCGIS is building on its track record of success in conducting compliance testing for the suite of standards that comprise the National Imagery Transmission Format Standards (NITFS) to bring this program to full fruition.

A focused standards validation testing strategy will support other test activities such as:

- Forward-looking Research and Development
- Technology Insertion Testing
- Developmental/Operational Testing
- Standards Conformance Testing
- Interoperability Testing
- Integration Testing
- Information Assurance Testing
- Performance Testing
- First Article Testing



- System/Capability Acceptance Testing

Standards validation can have substantial return on investment. NCGIS will work with the community to establish an initial test environment and will grow that environment over time. Participation of the NSG community is encouraged as the process moves forward.

Implementing Open Standards

Achieving interoperability in a net-centric environment is dependent on the development and industry-wide acceptance and implementation of non-proprietary standards and specifications for web-based applications. To this end, the OGC, a non-profit, international, voluntary consensus standards organization, is leading industry's development of standards for geospatial and location based services. OGC works with government, private industry, other standards organizations, and academia to create open and extensible software applications programming interfaces for geographic information systems (GISs) and other mainstream technologies.

The NCGIS, representing NGA as a principle member of the OGC, holds positions on the Planning Committee and Technical Committee, supporting and working with the OGC to ensure that NSG requirements are met in its interoperable solutions. The NCGIS supports a number of projects within the OGC Interoperability Program, focusing on collaborative developments related to such topics as interoperable sensors models and portrayal specifications, and using test beds, pilot projects, and interoperability experiments. In 2006, the Director, NGA, in the capacity of Functional Manager for GEOINT, endorsed adoption of the OGC web service specifications baseline. To date, the GWG has placed ten OGC specifications into the DISR.

Working with the OGC provides a greater "return on investment" than is achievable with other more conventional industry relationships. The NGA and NSG expressly benefit from using OGC's proven processes for developing, harmonizing, and promoting the use of open and freely available geoprocessing standards throughout the community.

These benefits include, but are not limited to:

- Technology risk reduction – the OGC process encourages the commercial marketplace to develop and validate new and open interfaces consistent with our needs.
- Improved choice and competition in the marketplace – participating vendors get visibility, early influence in specification development, early skill building, and the opportunity for early market deployment.
- Reduced technology costs – by increasing usage of standards-based SCOTS, we more readily reduce custom solutions and associated maintenance costs.
- Ability to rapidly insert new technology – by working with industry and academia to implement OGC specifications in their offerings, organizations can maximize their ability to rapidly implement new solutions.

Open Geospatial Consortium (OGC) and NGA: A Different Way of Doing Business

The success of standards development and testing programs within OGC benefits the NSG by enhancing data and system interoperability between key communities and aiding the move towards operating in a net-centric environment. The following benefits have already been realized:

Incorporation into Policy:

OGC consensus-based open standards are increasingly being applied as an integral component of organizational, national, and international policy for e-Government frameworks, procurement, and IT programs. NGA has adopted SDI 1.0 for use in its NSG enterprise architecture. OGC specifications have also been adopted in a number of other architectures, including those of the U.S. Department of Homeland Security, NATO, the Canadian Geospatial Data Infrastructure (CGDI), and the European Union. NGA benefits from the consistent application of OGC standards by our community partners, ensuring interoperability in systems and enterprise solutions.

Interoperability between Standards:

NGA provided requirements and support for the development of a core set of OGC specifications that will improve interoperability in a net-centric environment. The resultant SDI 1.0 defines a stable, integrated, and tested set of capabilities that "work together" in the geospatial technology marketplace. Implementation of an SDI-defined suite of standards ensures NGA and our partners a workable production flow that includes discovery, retrieval and manipulation of geospatial data. NGA is a strategic member of the OGC, representing the needs of the GEOINT community OGC's strategic planning.

SDI 1.0 defines a stable, integrated, and tested set of capabilities that **"work together"** in the geospatial technology marketplace

A Promising Standards Application – JPEG 2000 Interactive Protocol (JPIP)

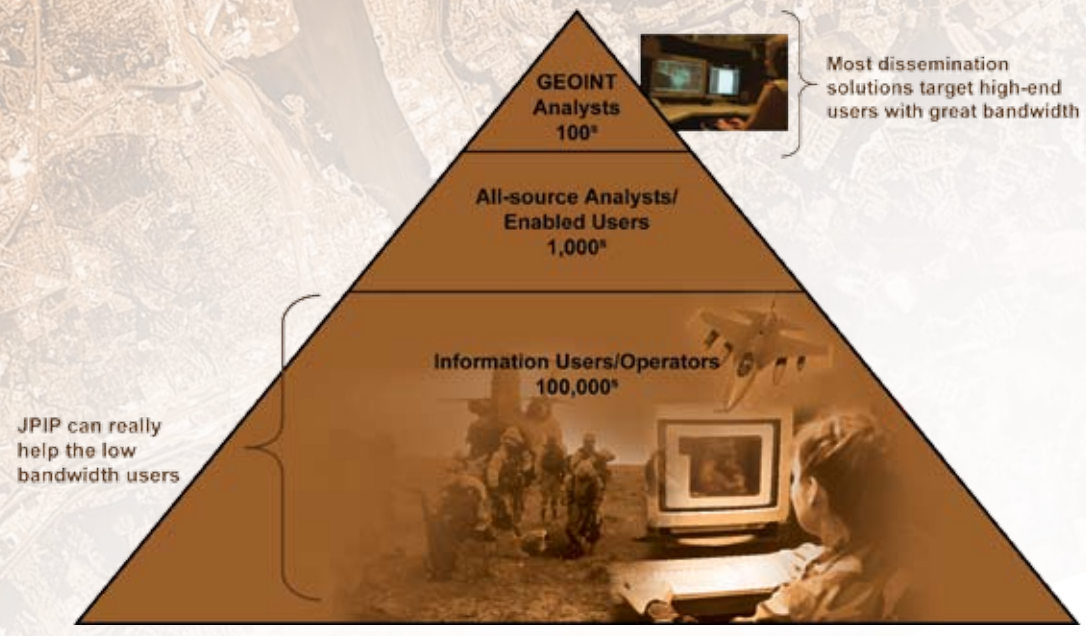
JPEG 2000 Interactive Protocol (JPIP), ISO/IEC 15444-9

The number of remote imaging sensors being deployed is increasing each year. The fidelity and resolution of the imagery being collected is also increasing dramatically. Managing the collection and dissemination of the ever-larger volumes of digital imagery can be daunting. Sorting through the collected data to find information of interest to a particular need is time-consuming. In a world where a single digital image can be multiple gigabytes in size, significant time delays can result as large files are exchanged across networks having various bandwidth capabilities. Often an entire file must be downloaded when the user needs only a small portion (region of interest) from the imagery coverage.

Enter the JPIP! This standard defines a protocol that takes full advantage of JPEG 2000's scalability properties and applies them within a net-centric environment. The JPIP can interactively access and deliver portions of a JPEG 2000 image in essentially arbitrary order, in response to real-time application requests. Typical user actions like zooming and panning are supported dynamically over the network without the need to download the entire image from the repository. The dynamic efficiency enabled by JPIP allows significant savings of bandwidth, reduces computer processing and storage requirements on both the server and client, and dramatically improves the timely access to the relevant portions of the collected data. While important to the strategic networks, deployment of JPIP will also give tremendous mileage to the bandwidth-constrained nature of the tactical, warfighting environments.

NGA contributed to the development of this standard and supported its adoption in ISO. NGA is currently sponsoring an OGC activity to integrate JPIP into the OGC SDI 1.0 baseline. The use of JPIP as a mandated standard has been

Who JPIP impacts



Moving Forward: Enabling A Common Vision

Today, the NGA has defined a critical standards baseline. Many SCOTS implementations that conform to approved standards and specifications are available right now for implementation. The GWG and JGA are vibrant and active community forums that can be exploited to realize the common vision shared across the NSG. The time is now to begin reaping the benefits of years of investment by NGA, the NCGIS, and the GEOINT community, moving closer to realizing the vision of true data and service interoperability and net-centricity. This clear movement toward the adoption of standards and SCOTS solutions will not produce full interoperability overnight, but NGA, along with its NSG GEOINT community members, is working diligently toward that vision.

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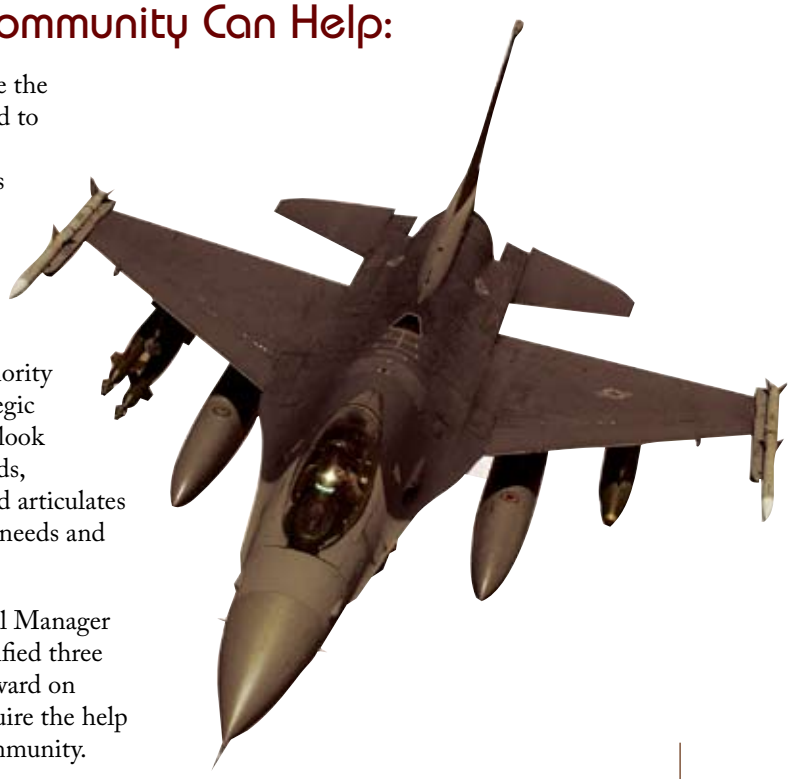
To keep this standards momentum going and to reach its goal of optimum interoperability and net-centricity, the GEOINT community must continue to rally around its commonly shared vision by capitalizing on the work and investments made to date and by understanding and investing in the adoption of solutions that move us toward interoperability and net-centricity. Together we will take advantage of today's opportunities to turn them into tomorrow's solutions that will then create more opportunities for achieving future solutions.




How the NSG Community Can Help:



NGA will continue to provide the leadership in standards needed to meet the challenges of the future. NGA has presented its vision and implementation strategy for the GEOINT standards program in a just recently completed study by the GEOINT Standards Management Authority (GSMA). The resultant Strategic Implementation Plan takes a look at the current state of standards, identifies the future needs, and articulates a set of actions to meet those needs and move toward the future.

NGA, in its role as Functional Manager for NSG standards, has identified three key strategies for moving forward on GEOINT standards that require the help and support of the NSG Community. They are as follows:

1. Continue to foster participation in the GWG in order to bring the NSG community together to solve standards issues, come to common positions, and create solutions that produce data and service interoperability.

2. Use the JGA forum and its activities to proactively engage the Services and Commands in:

   - Standards development
   - Development of GML application schemes to enable data interoperability
   - Development of standards testing programs to ensure that adoption of standards and SCOTS solutions produces the desired interoperability when fielded in actual architectures.

3. Follow the guidelines and complete the actions outlined in the GSMA's SIP to build a strong NSG Standards Program and meet the identified standards requirements of today and the future.

GEOINT Standards Baseline

The NSG community is moving towards the formal adoption of the following key standards into the GEOINT standards baseline:

- Web Features Service: The WFS implementation specification allows clients to retrieve and update geospatial data encoded in Geography Markup Language (GML) from multiple WFSs. It defines interfaces for data access and manipulation of geographic features, and through these interfaces, a web user or service can combine, use, and manage geodata.
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- Styled Layer Descriptor (SLD): The SLD standard defines the structure of an XML file that applies rendering or symbolization rules to features. An SLD requests a WMS to present a map according to submitted style rules.
- Catalog Services (CS-W): The CS-W provides abstract model and protocol-specific solutions for the discovery of geospatial resources. Through catalog metadata and query interfaces, metadata properties are returned to the requestor, often embedded with links to actual data or services that allow the catalog to act as a referral service to other information resources.
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Additional standards included in the NSG baseline are:

- ISO 19115 Geographic Information - Metadata: critical to making data discoverable and retrievable
- ISO 19119 Geographic Information - Services: critical to defining where web services are deployed and used within an SOA
- NSG Feature Data Dictionary and NSG Feature Catalog: critical to enabling the development of logical and physical data models.

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