Geospatial Intelligence Standards
Enabling a Common Vision

November 2006

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 align 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, assuring that NGA fulfills its functional management responsibilities for GEOINT standards.

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 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 with the other standards shown below comprise the initial NSG 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.

➤ 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, NITFS, etc.).

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 have enabled an explosion of geospatial data across the United States and the globe. In the U.S., 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 U.S. 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.**
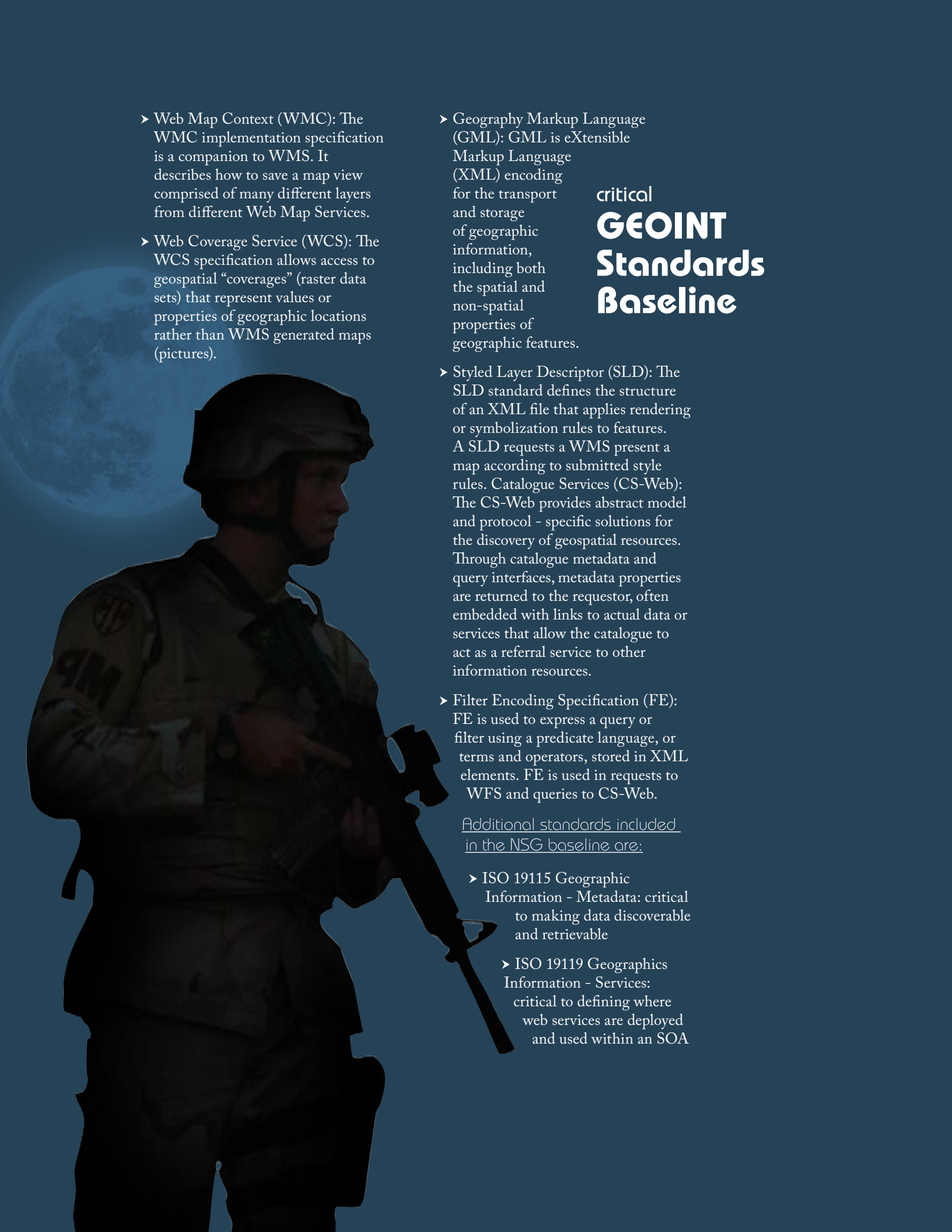
The domestic civil community and the international community are implementing largely the same suite of common geospatial standards as the NSG. Standardization efforts within the NSG are bringing together diverse national and international community members to implement geospatial data standards that, 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 geospatial understanding.

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

> 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

> Styled Layer Descriptor (SLD): The SLD standard defines the structure of an XML file that applies rendering or symbolization rules to features. A SLD requests a WMS present a map according to submitted style rules. Catalogue Services (CS-Web): The CS-Web provides abstract model and protocol - specific solutions for the discovery of geospatial resources. Through catalogue metadata and query interfaces, metadata properties are returned to the requestor, often embedded with links to actual data or services that allow the catalogue 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-Web.

Additional standards included in the NSG baseline are:

> ISO 19115 Geographic Information - Metadata: critical to making data discoverable and retrievable

> ISO 19119 Geographics Information - Services: critical to defining where web services are deployed and used within an SOA
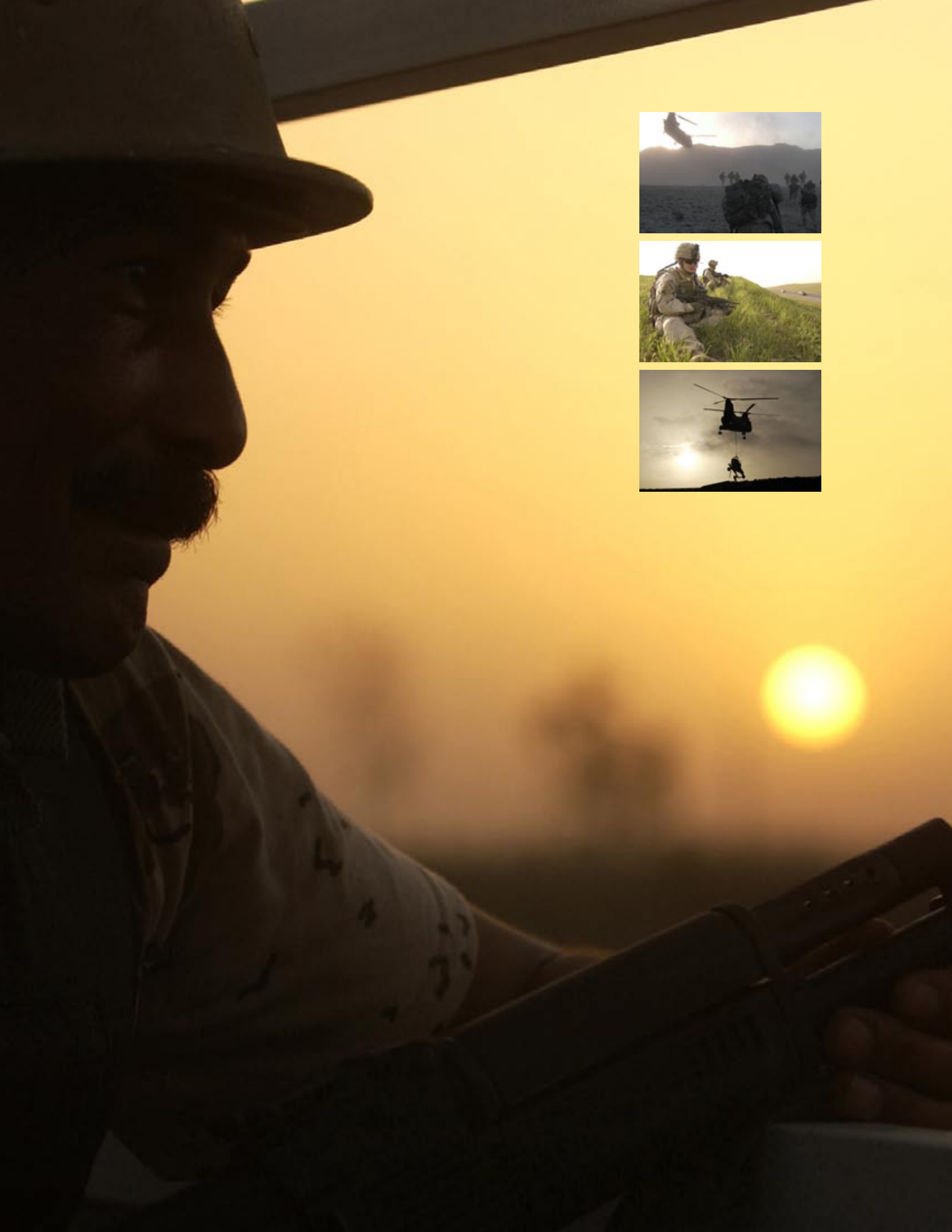
➤ NSG Feature Dictionary and NSG Feature Catalog: critical to enabling the development of logical and physical data model

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 of which will be not only enhanced interoperability, but the ability, at the lowest tactical level, to return value-added content for reuse by others, thereby leveraging resources across the NSG.

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	¤ CENTCOM
¤ CIA	¤ EUCOM
¤ NRO	¤ NORTHCOM
¤ NSA	¤ STRATCOM
¤ Army	¤ Joint Staff J2
¤ Navy	¤ DHS
¤ Air Force	¤ DISA
¤ Marine Corps	¤ DIA
¤ ODNI	¤ DLA
¤ OSD (NII and AT&L)	¤ DARPA
¤ SOCOM	¤ DOE
¤ JFCOM	¤ 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 Joint 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 Geospatial Intelligence Standards Working Group (GWG) was established in October 2004 with the mission to identify and implement GEOINT standards in the NSG community. In January 2005,

the GWG, lead 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 Service Oriented Architectures (SOA). The GWG has grown exponentially and continues to approve the placement of community standards in the Department of Defense 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 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
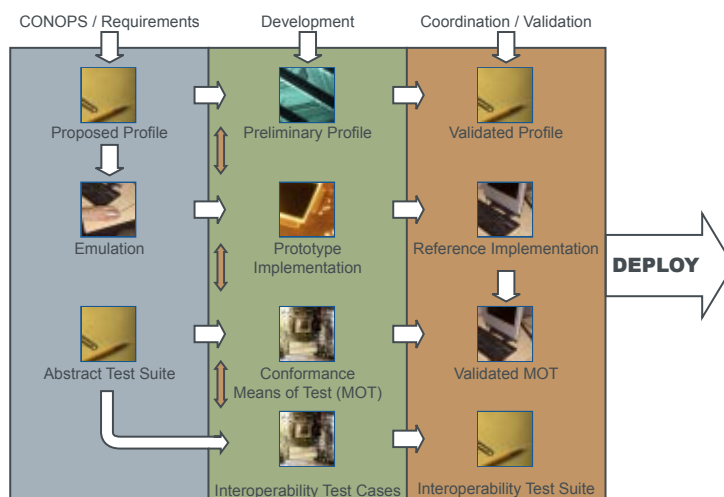
Testing Methodology

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 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

Candidate Validation Process Model

CONOPS / Requirements   Development   Coordination / Validation

Proposed Profile	Preliminary Profile	Validated Profile
Emulation	Prototype Implementation	Reference Implementation
Abstract Test Suite	Conformance Means of Test (MOT)	Validated MOT
	Interoperability Test Cases	Interoperability Test Suite

DEPLOY

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 community, to include the DoD Services and Commands, 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 (GIS) 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:

➤ 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 benefit 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, assuring 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.

define 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)

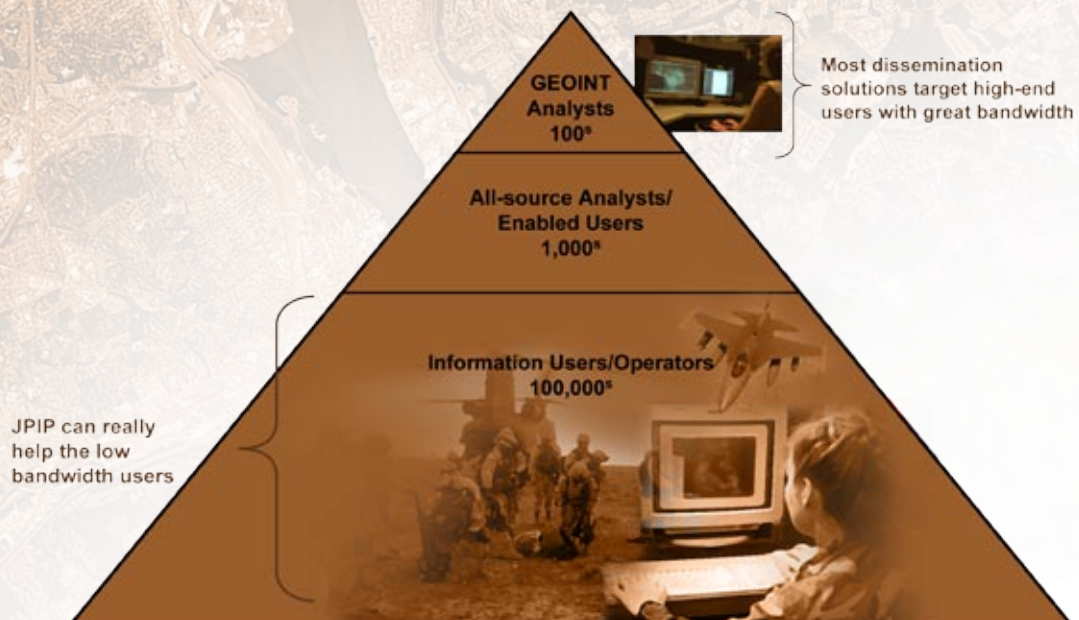JPEG 2000 Interactive Protocol (JPIP),
ISO/IEC 15444-9

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 only needs 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, reduced 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 be a tremendous boon to the bandwidth-constrained nature of the tactical, war-fighting 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 approved by the GWG.

Who does JPIP impact

GEOINT Analysts 100s

Most dissemination solutions target high-end users with great bandwidth

All-source Analysts/ Enabled Users 1,000s

Information Users/Operators 100,000s

JPIP can really help the low bandwidth users

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. This clear movement toward the adoption of standards and SCOTS solutions will not produce full interoperability overnight, but NGA, along with its community members, is working diligently toward that vision.

approved standards and specifications are available right now for implementation

To keep this standards momentum going to reach its goal of optimum interoperability, 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. 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. The NGA has presented its vision and implementation strategy for the GEOINT Standards Program in a just completed study by the GEOINT Standards Management Authority (GSMA). The resultant Strategic Implementation Plan takes a looks 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.

The NGA, in its role as functional manager for NSG standards, has identified (3) 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 pro actively 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 produce the desired interoperability when fielded in actual architectures.

3. Follow the guidelines and complete the actions outlined in the GSMA's strategic plan 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.

- ➤ 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, NITFS, etc.).

- ➤ 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.

- ➤ 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 present a map according to submitted style rules. Catalogue Services (CS-W): The CS-W provides abstract model and protocol - specific solutions for the discovery of geospatial resources. Through catalogue metadata and query interfaces, metadata properties are returned to the requestor, often embedded with links to actual data or services that allow the catalogue 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 Geographics Information - Services: critical to defining where web services are deployed and used within an SOA

- ➤ NSG Feature Dictionary and NSG Feature Catalog: critical to enabling the development of logical and physical data models

For more information contact ncgis-mail!@nga.mil