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USIGS TECHNICAL ARCHITECTURE

(UTA)

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PREFACE

This document was prepared for the National Imagery and Mapping Agency (NIMA), Architecture Office (AR). The purpose of this document is to define the United States Imagery and Geospatial information System (USIGS) Technical Architecture (UTA). Within this overall framework, the intent of this document is to:

- Present a technical reference model that details geospatial and imagery services and emphasizes the distributed object computing approach being taken by USIGS
- Profile the Department of Defense (DoD) Joint Technical Architecture (JTA) for the geospatial and imagery domain represented by the USIGS Community
- Provide the rules and guidelines for further development and implementation.

Please refer questions, comments or requests for additional copies to:

National Imagery and Mapping Agency
USIGS Architecture Division (ARU)
Attention: K. Loudon
Phone: 301-227-3554
Email: LoudonK@nima.mil

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TBD/TBR LISTING

PARAGRAPH	PAGE	TBD/TBR	DESCRIPTION
3.2.1	3-6	TBD001	IR motion imagery standards not yet identified
3.2.1	3-6	TBD002	SAR motion imagery standards not yet identified
5.2	5-7	TBD003	USIGS OGE service priorities not yet determined
1.1	1-2	TBR001	Further refinement of definitions pending
3.3.1.1	3-20	TBR002	Server naming conventions pending
6	6-1	TBR003	Identification of technology gaps pending
Appendix E	E-2	TBR004	Operational Concept Diagram pending
Appendix E	E-2	TBR005	"USIGS Glossary" approval pending

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1. Introduction

1.1 Purpose

The purpose of this document is to define the United States Imagery and Geospatial information System (USIGS) Technical Architecture (UTA). *USIGS* is the single, integrated system which is evolving from multiple systems to support the Imagery and Geospatial Community (IGC) in the US Government's acquisition and production of imagery, imagery intelligence, and geospatial information. The USIGS has a common information management framework that enables sharing of data, services, and resources among IGC members and their consumers [UAF97]. A *technical architecture* is a minimal set of rules governing the arrangement, interaction, and interdependence of the parts or elements whose purpose is to ensure that a conformant system satisfies a specified set of requirements. The technical architecture identifies the services, interfaces, standards, and their relationships. It provides the technical guidelines for implementation of systems upon which engineering specifications are based, common building blocks are built, and product lines are developed [C4ISR96].

This document has these primary functions: (1) It presents a technical reference model that details geospatial and imagery services and emphasizes the distributed object computing approach being taken by USIGS; (2) it profiles the Department of Defense (DoD) Joint Technical Architecture (JTA) for the geospatial and imagery domain represented by the USIGS Community; and (3) it provides the rules and guidelines for further development and implementation.

Based on these functions, the document is important from a variety of different perspectives:

- 1) It establishes the set of principles (in terms of standards, conventions, guidelines, data formats, etc.) applicable to new and migration system development, and application component development, across the USIGS community.
- 2) It establishes the context within which international standards can be established for the broader imagery and geospatial community.
- 3) It provides a technical architecture environment based upon the concept of open distributed computing.
- 4) It promotes interoperability across the USIGS community by focusing on common services and open interfaces among USIGS systems and components, and by profiling the JTA set of standards.
- 5) It provides standards as inputs to the USIGS Interoperability Profile [UIP97]. These standards will be referenced by USIGS Program Offices and Program Managers, as well as their contractors, in the development of requirements

documents for development and migration initiatives. It will also assist in the selection of COTS (Commercial Off-The-Shelf) hardware and software products by acquisition personnel.

- 6) It provides information that Program Offices/Managers or system architects can use to proactively plan for future technology advances as well as future standards compliance.
- 7) It influences and is influenced by the USIGS System, Operational, and Data Architectures, all of which are under development.

The USIGS technical architecture is defined in three time-phased views:

- Currently mandated standards
- Emerging and candidate standards (near-term)
- Emerging technologies (longer term)

Using this approach, standards can be tailored by user organizations to facilitate system development and evolution. As emerging technology matures and existing standards approach obsolescence, the technical architecture must evolve to establish new standards at reasonable, announced intervals. This approach supports both stability and progress.

1.2 Key USIGS Definitions

The definitions presented here are architectural terms of reference intended to assist in understanding the architecture, reference model, and standards discussions in succeeding sections of this document. These definitions are expected to be refined (TBR). An extensive set of USIGS definitions is provided in the USIGS Glossary [Ugloss97].

API Specification: A formal specification, which is expressed using the compilable Interface Definition Language (IDL) promulgated by OMG and ISO, and which

- Is defined in terms of scope and objectives
- Is used in either a calling (client/audience) or a responding (server/bearer) mode by one or more Application Software Components

Application Software Component: An executable software module, which may comprise one or more sub-modules, and which

- Can be run (executed) on one or more suitable Computing Platforms
- Is developed just once, as part of some Segment
- Can be reused multiple times, as part of other Segments
- Implements one or more Service Definitions
- Complies with one or more API Specifications
- Can be further classified as being a Mission Specific Application or a Common Support Application

Common Facilities: A collection of services that many applications may share, but which are not as fundamental as the Object Services. [CORBA97a]

Common Support Application (CSA): A type of Application Software Component that is of use across two or more mission domains (such as logistical command & control, weapon system mission planning/ targeteering, or medical logistics management), and which therefore requires especially careful cross-domain interoperability engineering

Computing Platform: A physical device (such as a workstation or a server) which acts as a computational resource, generally having at least a memory and often a processing capability as well, and which

- Serves as a host for the execution of one or more Application Software Components
- Is procured for or reused by one or more Segments

Mission Specific Application (MSA): A type of Application Software Component that is principally of use in one mission domain. USIGS MSAs are applications that process geospatial and imagery information; each consists of an arrangement of multiple components (OGE services, Common Facilities and platform services) to perform the specific mission

OGE Services Application: An Open Geospatial Exchange (OGE) Services Common Support Application, which delivers imagery or geospatial services that are of interest across one or more other mission domains (such as logistical command & control, weapon system mission planning/ targeteering, or medical logistics management), and which therefore requires especially careful cross-domain interoperability engineering by NIMA, the agency that is by statute tasked to develop such services

Segment: A programmatic unit of work concerned with the procurement, development, integration, installation, testing, and/or maintenance of a collection of hardware and software resources that together deliver useful information systems capabilities; a segment

- Is implemented as the result of an Acquisition Program
- Is defined via a planning process carried out by an Element (PEO)
- Contributes to the development and evolution of a System (USIGS)
- Is expected to deliver the capabilities described in one or more Service Definitions
- May involve reuse of existing Application Software Components
- Very likely entails building new Application Software Components

Service Definition: A short narrative description of a distinct functional capability, which is to be delivered or realized by some kind of information system, and which

- Specifies a development objective of some Segment
- Guides the development of associated Application Program Interface (API) standards
- Is to be implemented by one or more Application Software Components

1.3 USIGS Perspectives

To provide a basis for understanding the context and scope of the UTA, this section describes three interrelated perspectives of USIGS: as a collection of **organizations**, as a domain, and as an architecture.

1.3.1 Organization Perspective

Many diverse organizations, including but not limited to the list in Table 1-1, are a part of USIGS to the extent that they interact in some fashion with imagery, imagery intelligence, and/or geospatial information. NIMA has the responsibility of leading and coordinating the development of the USIGS architecture. Within the U.S. Federal Government, NIMA's responsibilities are defined in [DoD5105.60].

Table 1-1. USIGS Stakeholder Organizations

DoD	Other Government		International	Industry
Commands	CIA	DOI	Agreements with 114	OGC
DIA	Commerce Dept.	DOT	Countries/Political Entities	OMG
NIMA	Dept. of Energy	FEMA		
JTFs	Dept. of Justice	EPA		
NSA	NRO	NASA		
OSD	State Dept.	USDA		
Services	Treasury Dept.	USGS		

Some of the organizations involved in USIGS are in DoD, and others are not. The DoD organizations are required to use the Defense Information Infrastructure (DII) Common Operating Environment/Shared Data Environment (COE/SHADE), while non-DoD organizations may not be. The UTA must ultimately address both of these situations.

DoD customers/users contribute or directly use the data holdings with standardized tools. Other Government partners assist in the collaboration/co-production in their specific functional area. This information and USIGS data is shared, under agreements. International partners assist in the collaboration/co-production in their specific regional area. This information and USIGS data is shared, under collateral agreements.

The role of industry is also important in USIGS:

- The Open GIS Consortium (OGC) provides industry-specific direction and products within the imagery and geospatial community. The primary interest of this consortium is to promote the development of open system approaches to geoprocessing, including technologies and standards that integrate geoprocessing with distributed architectures.
- The Object Management Group (OMG) provides distributed object computing technology based on an Object Management Architecture [OMG97] that specifies key parts of the USIGS Technical Reference Model.

1.3.2 Domain Perspective

USIGS also represents a domain of specialization and a corresponding community of specialists that cut across organizational boundaries. The scope of this domain is the union of these areas of specialization: mapping, charting, geodesy, imagery, and imagery intelligence. This scope is approximately equivalent to the areas of specialization represented by the union of the former agencies that were combined into NIMA (Defense Mapping Agency, Central Imagery Office, etc.). The domain corresponds to the Imagery and Geospatial Community (IGC), which is defined in [UAF97] as the set of US and allied governmental, military, academic, and commercial organizations involved in the acquisition and production of imagery, imagery intelligence, and geospatial information. Additional information on how IGC organizations relate to USIGS is provided in [OCD97].

1.3.3 Architecture Perspective

Framework. Architectures define the structure of components, their relationships, and the principles and guidelines governing their design and evolution over time. The USIGS Architecture Framework document [UAF97] discusses the USIGS Architecture components, their roles and relationships, and identifies architecture documentation which needs to be developed to define and evolve an integrated, interoperable USIGS. The USIGS architecture components are based on the Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) Architecture Framework [C4ISR96]. The interrelated set of USIGS Architecture components include the Operational Architecture, the Technical Architecture, the Systems Architecture, and Data Architecture. Operational Architecture documentation identifies operational elements, activities, and information flows. The Technical Architecture (this document) identifies applicable standards and conventions that govern systems implementation and operation. Systems Architecture documentation overlays system capabilities onto requirements and identified standards to provide a map of current and future capabilities. Data Architecture provides the common data modeling and terminology baseline needed to articulate and integrate the other component

architecture views. An overview of USIGS Architecture components is shown in Figure 1-1.

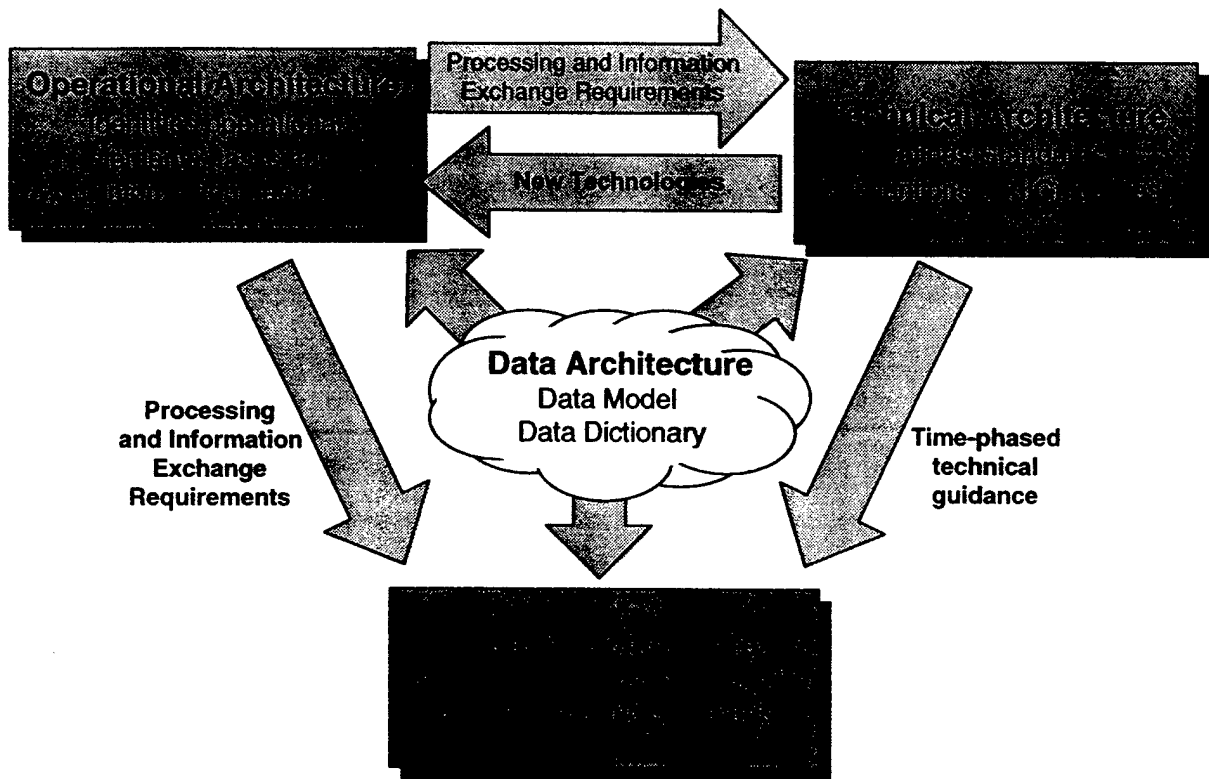


Figure 1-1. USIGS Architecture Components (from [UAF97])

The USIGS architecture is aimed at implementing the vision stated in the NIMA Business Plan [NBP97]. The overall architectural concept describes processes and information flows from suppliers of the enterprise into the NIMA production services and providing information and products to USIGS customers (Figure 1-2). The NIMA Business Plan drives the Operational Architecture, which in turn affects the technical and system architectures. (Note that the data architecture cuts across the other three architectures, and is not explicitly shown in Figure 1-2.)

The Technical Architecture products influence other architectural components and also reflect the software strategy of the overall architecture. The emerging technologies will be a factor in the USIGS Operational Architecture in deriving the business changes based upon those technology implementations. The UTA is a key element in the operational architecture vision.

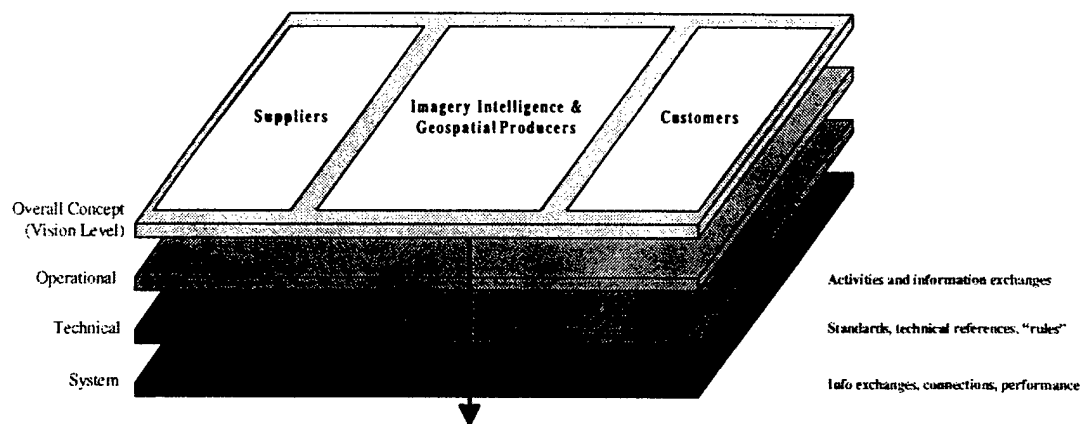


Figure 1-2. The USIGS Architecture Supports the Vision Identified in the Business Plan

In turn, the UTA is heavily dependent upon the other architectural components and predominantly reflects standards unique to the USIGS domain. The operational architecture will influence the development and design of software components and applications with input from the legacy and migration components of the systems architecture to leverage current software investments. The future or "to be" systems architecture will be driven by the standards selected and identified by the UTA and will be included in specific migration plans and products. The migration plans will also include standards development needed for the specifications of services common within USIGS. In addition, the USIGS data architecture provides data standards cited within the UTA. The logical and process relationships among the architecture products are illustrated in Figure 1-3. The highlighted (Technical Architecture) portion on the left is the target of the UTA.

The linkages between the Technical Architecture and other parts of the architecture, labeled A through G, are described as follows:

- A: UTA Reference Model reflects basic mission functions from operational needs and information exchange matrices. This provides the base relationship of components.
- B: UTA standards include data standards (Defense Data Dictionary System-DDDS, and USIGS Data Model) and data tool standards for USIGS.
- C: UTA candidate standards and emerging technologies provide insight to the data modeling effort and data standards for USIGS objects.
- D: UTA standards profile provides current mandates and basic rules/guidelines for use by the System Architecture for design of specific profiles.

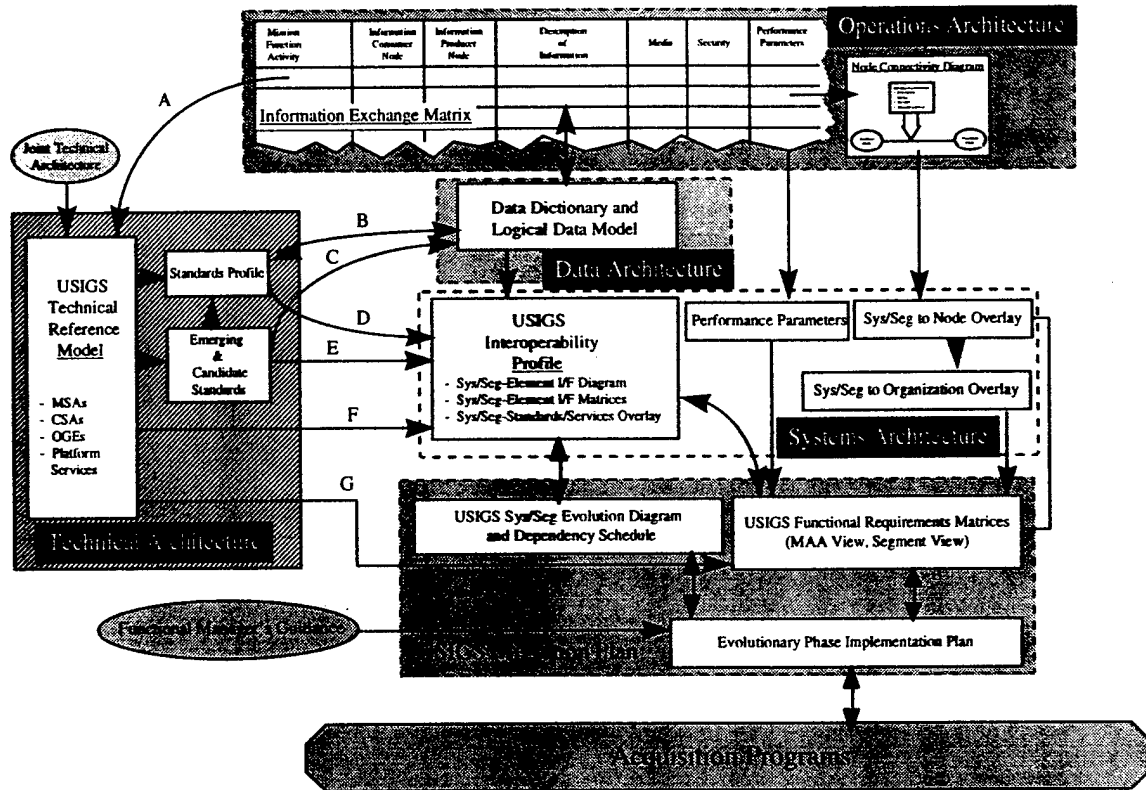


Figure 1-3. USIGS Architecture Document Linkages

- E: UTA candidate standards and emerging technologies provide system architects and program managers information for standards planning activities.
- F: UTA Reference Model provides the basic breakdown of services and components that should directly relate to the USIGS Interoperability Profile(UIP) diagrams, matrices, and overlays.
- G: UTA Reference Model provides a basic framework for functional requirements matrices and supports the USIGS Migration Plan for implementation.

Technical Architecture. A technical architecture captures, refines and establishes the technical standards and guidelines applicable to the overall architecture. A technical architecture in general is based on requirements defined in the operational architecture and analyses of enabling technologies [C4ISR96]. This approach is intended to achieve agreed-upon standards with a high degree of interoperability, and a smoother systems integration process. The guidelines can be tailored by the user organizations to facilitate system development and evolution. As emerging technology matures and standards approach obsolescence, the technical architecture must evolve to establish new standards at reasonable, announced intervals - supporting both stability and progress. Based on these concepts, the UTA is defined in three time-phased views: currently mandated

standards; emerging and candidate standards (near-term); and emerging technologies (longer-term future).

Technology and Interoperability. To make use of imagery and geospatial information effectively, it must be accurate and accessible across organizations, even across the world. This means that CPUs must be intimately linked to the networks of the world and be capable of freely passing and receiving information. Therefore, the USIGS community needs to exploit the emerging paradigm of distributed or cooperative computing. The intelligence and DoD communities are defining a common computing environment based predominantly on commercially developed technology and standards. A key element of the approach to the UTA is to exploit commercial technology, including standards and tools based on open distributed systems to achieve interoperability. The Object Management Architecture (OMA) defined by the Object Management Group [OMG97] is a primary driver of the USIGS Technical Reference Model defined as part of the UTA (see Section 2). This model identifies the components, interfaces, and protocols that enable clients and objects to communicate in a distributed environment.

Implementations that will make up the USIGS must operate within this environment. The USIGS Interoperability Profile (UIP) [UIP97] defines the profile for software interface standards to be used to achieve interoperability between multiple clients and servers within the USIGS architecture. The UIP profiles applicable standards and specifications to specific USIGS system components, and this level of detail provides the basis for evaluating compliance. This is a key link between the Technical Architecture and Systems Architecture.

JTA. The Joint Technical Architecture (JTA) provides the most direct architectural context for the USIGS Technical Architecture. The JTA represents the technical architecture part of the C4ISR set of operational, systems, and technical architecture types. The JTA is defined in [JTA96, p. 1]: "The JTA identifies a common set of mandatory information technology standards and guidelines to be used in all new and upgraded C4I acquisitions across DoD." The standards and guidelines in the JTA are the result of collaboration among the Services, Joint Staff, USD(A&T), ASD(C3I), DISA, DIA, and other elements of the Intelligence Community. Version 1.0 of the JTA [JTA96] is mandated for use by the ASD(C3I). Version 2.0 is in development; the latest draft of Version 2.0 is dated July 18, 1997 [JTA97]. *The standards for USIGS are those that are defined in [JTA97], as profiled and augmented in this UTA document.* Since both the JTA and UTA are viewed as living documents, those standards and specifications that may appear in a version of the UTA, but are not in the current JTA, will be submitted for consideration by the JTA Development Group (JTADG).

Other DoD Context. Appendix A provides further discussion of several DoD architecture initiatives and programs that form the larger context the UTA:

- Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) Architecture Framework
- Technical Architecture Framework for Information Management (TAFIM)
- Information Technology Standards Guidance (ITSG)
- DII COE/SHADE, including the Integration and Runtime Specification (I&RTS)

Summary of UTA Architecture Context. Figure 1-4 summarizes the architecture context of the UTA. The USIGS Architecture consists of the Operational, Systems, and Technical Architectures and the core Data Architecture that cuts across the other three. The time phasing is shown in the Technical Architecture as Current, Candidate, and Future. The JTA is the foundation set of overall standards for use in all Services and Agencies. Within the context of the JTA, imagery and geospatial standards are incorporated within the body of the document. This UTA extends the JTA specifically to support internal projects, national and foreign interests, and additional profile specifications for USIGS implementation.

1.4 Scope and Content of UTA

The scope of the UTA may now be defined as the intersection of the three perspectives described above, that is, it is the technical architecture that addresses the IGC and applies to USIGS organizations. The UTA is compliant with the JTA Version 2.0 Draft [JTA97], with specific extensions and profiles for the IGC as indicated in this document.

This document supersedes the direction given in the following documents:

- USIS Standards & Guidelines, Version 1.0, 13 Oct 1995 (CIO 2008) [USIS95]
- USIS Standards Profile for Imagery Distribution (SPID), Version 1, 13 October 1995 [SPID95]
- Technical Architecture Framework and Implementation Guidance (TAFIG), Version 1.0, 28 Oct 1994, (Defense Mapping Agency) [TAFIG94]

Some parts of the technical architecture are mandated and other parts are optional. Table 1-2 indicates this more specifically. The elements of the UTA are listed and described in this table. All these elements are delineated in this UTA document. USIGS Security standards are being developed and documented separately [Usec97].

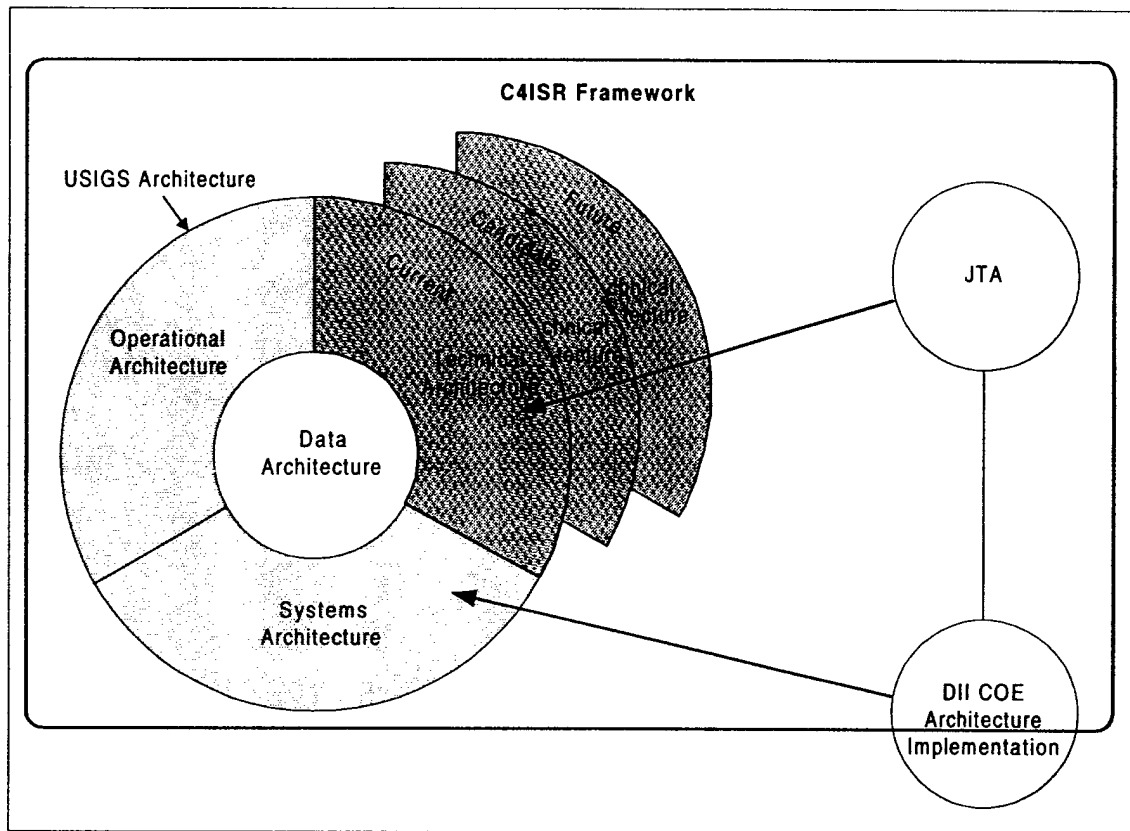


Figure 1-4. UTA Architecture Context

1.5 Considerations in Using the UTA

The applicability and use of the UTA is closely related to the more general considerations in using the JTA [JTA97, p. 1-6]. The UTA is intended to be used by anyone involved in the management, development, or acquisition of new or improved USIGS segments. Specific guidance for implementing this UTA is provided separately. USIGS component developers are expected to use the UTA, in conjunction with the JTA, to ensure that new and upgraded systems (and the interfaces to such systems) meet interoperability requirements. USIGS system integrators should use it to facilitate the integration of existing and new segments within USIGS. Operational requirements developers should be cognizant of the UTA in developing USIGS requirements and functional descriptions.

Like the JTA, the UTA is a "forward-looking" document. It guides the acquisition and development of new and emerging USIGS functionality and provides a baseline towards which existing systems will move. It is NOT a catalog of all information technology standards used within today's USIGS segments or 'pre-USIGS' systems. It represents those standards (for interfaces/services) that should be used now and in the future. If

Table 1-2. UTA Elements

Element	Description
USIGS Technical Reference Model	Used as the distributed computing framework by which USIGS services are organized and standards are applied. Open geospatial exchange services are emphasized.
USIGS Standards Profile	A set of mandated standards, used to collectively standardize the USIGS interfaces and services
USIGS Conventions	A non-standardized but binding specification of practices within USIGS implementations. Certain conventions are needed for enforcement both internal and external to the USIGS enterprise.
USIGS Guidelines	A non-binding specification of rules or accepted methods for implementing USIGS
Candidate Standards	Emerging community and technology standards not yet approved or sufficiently mature for application within USIGS
Candidate Conventions	Potential USIGS Conventions
Candidate Guidelines	Potential USIGS Guidelines
Emerging Technologies	Technology being developed but not yet standardized, judged to be important to USIGS
Technology Gaps	Services needed but for which technology is not being developed

legacy standards are needed to interface with new segments, they can be considered on a case-by-case basis in addition to the mandated standard.

1.6 Control and Update of the UTA

This document is controlled by the NCCB and administered by NIMA/ARU, USIGS Architecture Division. The content of UTA, in terms of imagery and geospatial standards, conventions, and guidelines in Section 3, is developed in concert with the overall activities and products of the USIGS Architecture Integration Group (AIG), and established by agreement with the members of the USIGS community and coordinated through the tandem of standards committees, ISMC/GSMC (Imagery Standards Management Committee/Geospatial Standards Management Committee). Chaired by NIMA, the ISMC/GSMC oversees geospatial and imagery community efforts to develop, adopt, implement, and maintain information technology standards. It is the focal point for geospatial and imagery standards within the DoD, other Intelligence Community (IC) organizations, and non-intelligence civil agencies that produce or use geospatial and

imagery data. The ISMC/GSMC is subordinate to the DISA Center for Standards (CFS) Standards Coordinating Committee (SCC).

1.7 *Organization of document*

A USIGS Technical Reference Model (UTRM) is presented in Section 2. The UTRM is used as the basis of the content and organization of the standards, conventions, guidelines, and technologies in the remainder of the document. Sections 3 through 6 reflect the time-phasing of the UTA:

- Section 3: Currently mandated standards, conventions, guidelines
- Section 4: Candidate standards, conventions, guidelines
- Section 5: Emerging technology
- Section 6: Technology gaps

These are followed by appendices which respectively provide further context information, a standards summary, a JTA-formatted annex, acronyms, and references.

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2. USIGS Technical Reference Model

The previous section outlines the inherent and mandated relationships associated with technical architectures that influence the UTA. This section presents the USIGS Technical Reference Model (UTRM). Technical reference models (TRMs) are used to organize discussion of a Technical Architecture and serve to highlight the *interfaces* borne by *services in an information system*. They do not show physical components or connections, nor do they show software modules or aspects of software implementation.

2.1 Background

A TRM should reflect the operational needs of an organization and have a solid basis in the organization's business model as well as other predecessor documents. Hence, the format of the UTRM (a simplified version is shown in Figure 2-1) is based upon that defined in the DoD Technical Architecture for Information Management (TAFIM) Volume 2 and various of its derivatives, including the DII COE Reference Model and the draft Intelligence Community Technical Reference Model (IC TRM). The IC TRM was adopted by the Intelligence Systems Board (ISB) Standards Panel in April 1996, but was never officially published.

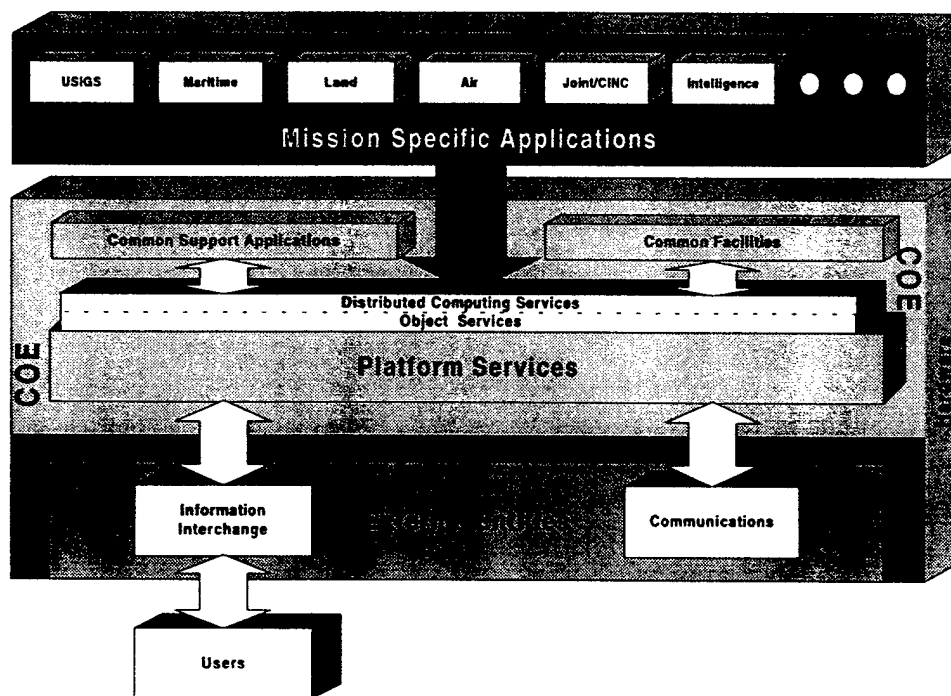


Figure 2-1. Simplified USIGS Technical Reference Model (UTRM)

The content of the UTRM is a profile of the DoD Joint Technical Architecture (JTA) that borrows from the Object Management Group's (OMG's) Object Management

Architecture (OMA) [OMG97]. The UTRM is used to organize discussion of the standards, conventions, and guidelines that are applicable to the USIGS. The functionality identified as being unique to USIGS or provided by USIGS has been organized to be consistent with the *NIMA Business Plan* [NBP97] and the USIGS Operational Architecture.

It should be noted that the USIGS Technical architecture provides the means by which a functionality or process identified in the operational architecture (Figure 2-2) is translated into services and APIs in the Technical Architecture. Further refinement of each of the business processes will identify services necessary for the brokering and trading of imagery, imagery intelligence, and geospatial information. These services can be organized based upon existing and future capabilities of the USIGS Systems Architecture. The services and APIs are used in the system architecture for the definition of systems and the applications that make up those systems (Figure 2-3).

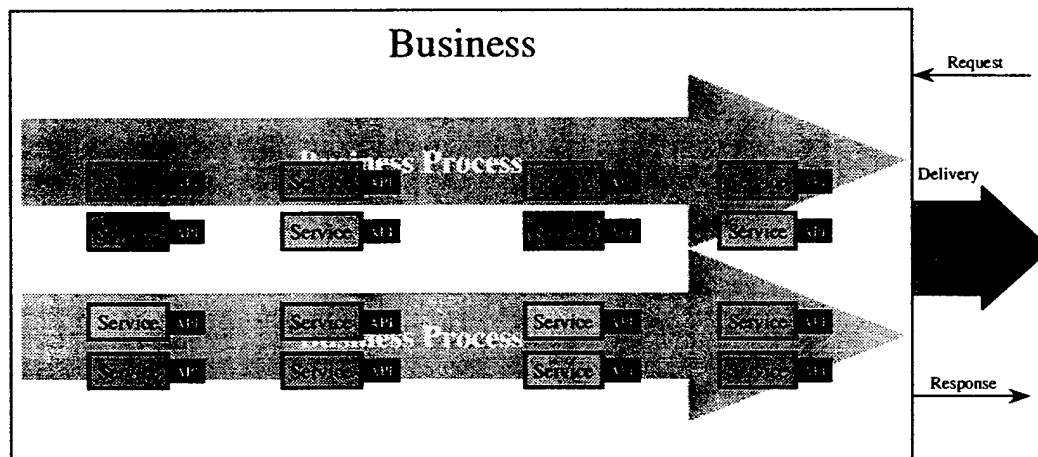


Figure 2-2. The Technical Architecture Translates Business Processes into Services and Their APIs

The remainder of this Section will discuss the structure and content of the UTRM. Content will be discussed in terms of application and service categories. Specific interfaces will not be described in this section, as they are addressed in the remainder of this document. Thus, this Section will discuss the USIGS TRM components, or entities, their derivation, and their definition.

2.2 USIGS TRM Entities

The USIGS TRM consists of six basic entity types:

- Mission Specific Applications
- Common Support Applications

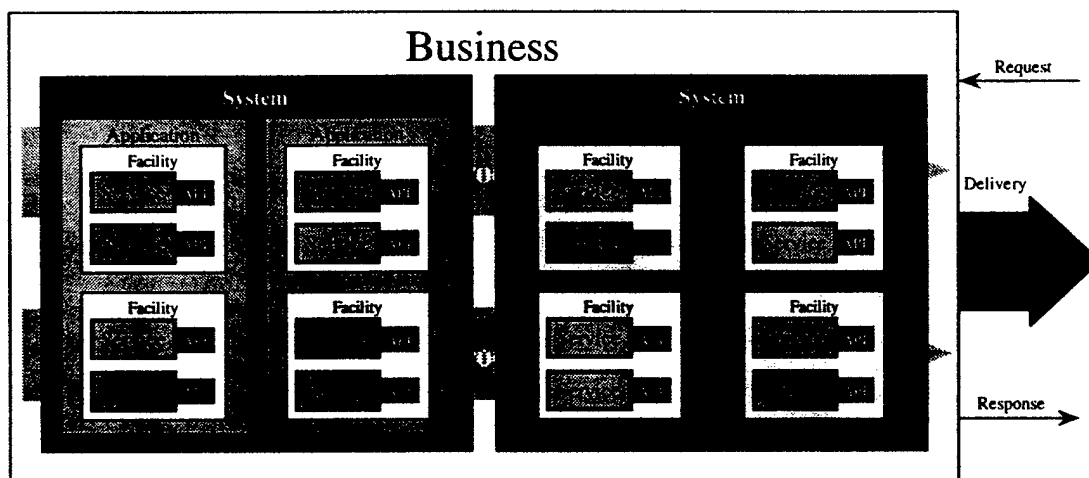


Figure 2-3. The System Architecture Uses Services and APIs Identified in the Technical Architecture in Defining Systems, Applications, and Facilities

- Common Facilities
- Distributed Computing and Object Services
- Platform Services
- External Entities

Mission Specific Applications are, typically, custom-built computer programs or scripts with which the user interfaces, to perform specific tasks related to a specific mission. In the traditional procedural environments, the Common Support Applications are computer programs or scripts that provide general support across multiple mission areas (e.g., spreadsheets, word processors, etc.). In an object-oriented environment like USIGS, Common Support Applications also include component objects that can be invoked by Mission Specific Applications in multiple domains. Objects in this latter group are also commonly referred to as vertical domain objects, because they are specific to a single information domain, yet are invocable by applications in multiple information domains.

Common Facilities are specific to the object-oriented Common Object Request Broker Architecture (CORBA) environment and are similar to the latter group of Common Support Applications, in that they are invocable by Mission Support Applications and Common Support Applications alike. They are normally available off the shelf from more than one vendor and are often referred to as horizontal domain objects.

Distributed Computing and Object Services provide services by which distributed processing is enabled. The Joint Technical Architecture (JTA) mandates that the Distributed Computing Environment (DCE) be used in procedural programming environments and that CORBA and CORBAServices be used in an object-oriented environment. More specifically, in a CORBA environment the integral Object Request

Broker (ORB) acts as an intermediary between invoking and invoked objects. In essence, the ORB acts as a software backplane. Mission Specific Applications invoke Common Support Applications, Common Facilities, and Object Services via the ORB. Common Support Applications and Common Facilities can invoke other Common Support Applications and Common Facilities, as well as Object Services, via the ORB.

Object Services are the interface between the object-oriented CORBA environment and the underlying Platform Services, which are the typical operating system services delivered on any computer. The Platform Services, in turn, provide the interfaces between the Distributed Computing and Object Services and the hardware upon which all of this software runs. Thus, these services provide the interfaces to the underlying hardware as well as the External Entities from which information is obtained and upon which information is written. These External Entities are categorized as Communications Entities (the wires or optical fiber across which communication occurs) and Information Interchange Entities, which include information storage devices such as disk drives, tape drives, etc., and devices through which a user communicates with a system, such as keyboards, display devices, and mice.

Thus, the USIGS Technical Reference Model is representative of any computer system. In fact, it is also representative of a computing entity of any size and makeup, ranging in size from a system as small as an embedded computer in a weapons system, up to a desktop computer, further up to a workgroup on a single Local Area Network (LAN), and even further up to a complete corporate intranet, etc. What differentiates one from another is the specific content of each of the entities. The remainder of this section consists of a discussion of the makeup of each of these entities.

2.2.1 Mission Specific Application Entities

Mission specific applications are, typically, those applications that a user interacts with and that provides specific services to a user. This entity type is based upon the Defense Information Infrastructure (DII) Common Operating Environment (COE) view, wherein an application is considered to be mission specific if it:

- Is used to support a specific military mission (e.g., maritime, land, Joint/CINC/Coalition, air, intelligence), or
- Provides user services for "vertical markets" within the DoD (e.g., imagery intelligence and geospatial information production)

For the most part, the UTRM does not identify specific applications, but rather, identifies the kinds of applications that may be regarded as mission specific. The applications that are mission specific to the USIGS were determined through careful examination of the *NIMA Business Plan* and co-referenced with the *USIGS Operational Architecture*. Each element of the NIMA Business Plan Model represents a combination of functionality that

can be represented by one or more application program categories. USIGS mission specific applications categories (Figure 2-4) include, but are not limited to:

- Information Discovery and Retrieval -- Applications to navigate the USIGS to locate and retrieve information, products, and services
- Information Viewing and Enhancement -- Applications to open, view, and enhance imagery, imagery intelligence, and geospatial products and information
- Information Exploitation and Analysis -- Applications to analyze, exploit, and extract information from geospatial products and information
- Information Integration and Fusion -- Applications to combine, integrate, layer, and fuse multiple types of information
- Order Entry & Tracking -- Applications to accept, process, track, and support delivery of information, products, and services

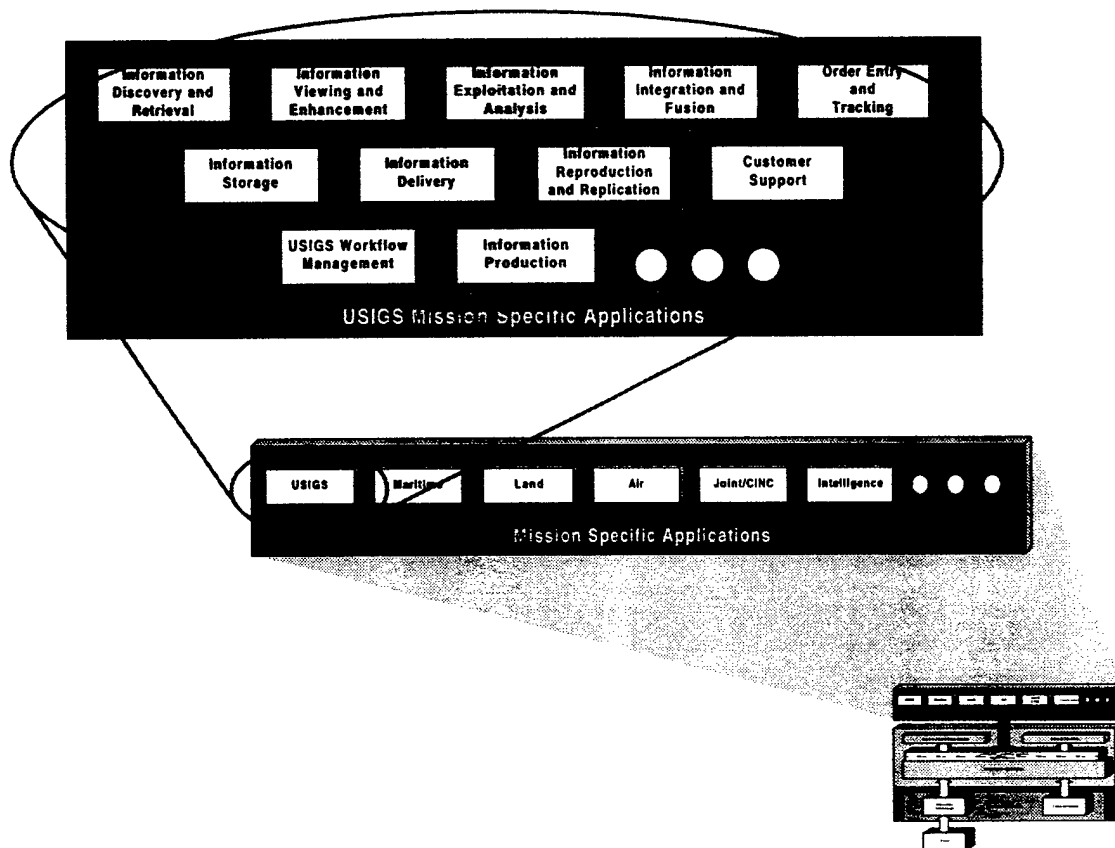


Figure 2-4. USIGS Mission Specific Application Categories

- Information Production -- Applications that are used to generate imagery intelligence and/or other geospatial information
- Information Production Management -- Applications that manage information production processes
- Information Storage and Retrieval Systems -- Applications that provide for digital storage and retrieval of formatted products and seamless data
- Information Delivery -- Applications that accept, store, and execute information interest profiles to deliver required information
- Information Reproduction and Replication -- Applications that generate, reproduce, and replicate digital products
- Customer Support -- Applications that deal with customers' needs for information about products and services

2.2.2 Common Support Application Categories

Common support applications (Figure 2-5) are of two basic types: cross-domain and domain-specific. Cross-domain applications provide general support across multiple mission domains. These are typically stand-alone applications that have their own user interface. This type of Common Support Application will be identified within the DII COE.

Example categories of non-domain specific Common Support Applications include:

- Alert Services that include generic mechanisms to support an alert process. When an alert process has determined that a predefined criterion or event for notifying other processes has occurred, that process will use the Alert Services software to notify all interested processes and parties of the event. Alert Services software is composed of an Alerts Server mechanism and a generic Alerts Display mechanism. The Alerts Server allows processes to register to create and receive alerts. The server distributes Alerts using the COE communications support and ensures that Alerts when issued are delivered.
- Correlation Services include, but are not limited to, maintenance of a track data base in near-real-time to include the following information:
 - high level tactical objects to represent platforms (ships, submarines and aircraft)
 - installations both fixed and land mobile, land force units
 - technical collection and reporting domain track objects to represent ELINT, COMINT, ACINT, and TADIL tracks.

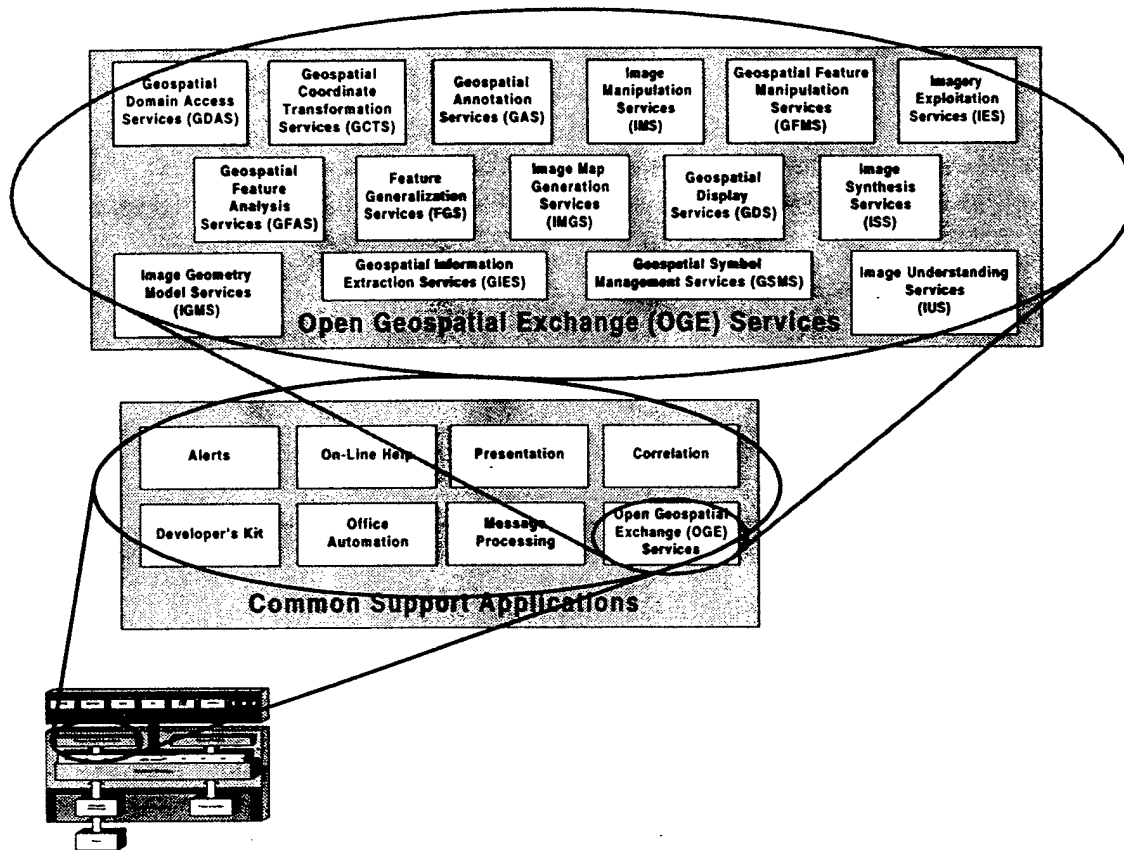


Figure 2-5. Common Support Applications and the Open Geospatial Exchange (OGE) Service Categories

- Office Automation Services are functional capabilities that include, but are not limited to, word processing, email, presentation graphics, spreadsheet, drawing, illustration, and other office tools identified as necessary within the DII COE.
- On-Line Help Services provide users with the necessary assistance in all aspects of system operation. Four basic support services are required to achieve comprehensive coverage of system operation: On-Line Help, On-Line Job Planning, On-Line References, and Computer Based Instruction (CBI).

The second type of Common Support Applications are domain-specific component objects, or business objects, that are used by other applications. In a component-based architecture, such as the USIGS, these business objects are based upon standardized interfaces and provide services that can be invoked in common by applications in multiple information domains. Further, these same business objects are invoked by mission specific applications in order to use the services offered through their standards based interfaces. In essence, these Common Support Applications act as a tool box to be used in any combination and with any combination of Common Facilities and Object

Services in the construction of Mission Specific Applications. Some non-USIGS business objects are expected to be used by USIGS Mission Specific Applications and will be procured from the appropriate vendor or government agency, not developed or defined as part of USIGS. USIGS-specific business objects, on the other hand, will be defined by the USIGS community in cooperation with the Open GIS Consortium (OGC) to ensure that the USIGS architecture can be realized with standards-based, COTS products.

The components (or business objects) that comprise the information domain-specific Common Support Applications categories will vary according to the specific domain being served. The Common Support Application business objects that are components of the USIGS are known as the Open Geospatial Exchange (OGE) Services. The USIGS reference model identifies a set of OGE service categories into which the OGE services themselves are collected for ease of reference and discussion. The OGE service categories are:

- Geospatial Domain Access Services – A set of interfaces for locating, retrieving and disseminating selected geospatial products from a geographic information system (GIS) and for updating the contents of a GIS (by storing, deleting, or modifying geospatial products)
- Geospatial Coordinate Transformation Services – Services for converting geospatial coordinates from one reference system to another
- Geospatial Annotation Services – Services to add ancillary information to an image or a feature in a Feature Collection (e.g., by way of a label, a hot link, or an entry of a property for a feature into a database) that augments or provides a more complete description
- Image Manipulation Services – Services for manipulating images (resizing, changing color and contrast values, applying various filters, manipulating image resolution, etc.) and for conducting mathematical analyses of image characteristics (computing image histograms, convolutions, etc.)
- Geospatial Feature Manipulation Services – Services that support creation, quality control methods, analysis, display, and generalization of feature collections of interest to an end user
- Image Exploitation Services – Services that support the photogrammetric analysis of remotely sensed and scanned imagery, and the generation of reports with respect to the results of the analysis
- Geospatial Feature Analysis Services – Services that exploit information available in a Feature or Feature Collection to derive application-oriented quantitative results that are not available from the raw data itself

- **Feature Generalization Services** – Services that modify the characteristics of a feature collection to increase the effectiveness of communication by counteracting the undesirable effects of data reduction
- **Image Map Generation Services** – Services for manipulating and combining images for use as image maps and other uses
- **Geospatial Display Services** – Services that prepare and render one or more Feature Collections or Coverages to an output device. The output device may be a (temporary) electronic display or (permanent) hardcopy printer (e.g., printing a map or chart)
- **Image Synthesis Services** – Services for creating or transforming images using computer-based spatial models, perspective transformations, and manipulations of image characteristics to improve visibility, sharpen resolution, and/or reduce the effects of cloud cover or haze
- **Image Geometry Model Services** – Support using mathematical models of image geometries, that relate image positions to corresponding real-world (e.g., ground) positions
- **Geospatial Information Extraction Services** – Services supporting the extraction of feature and terrain information from remotely sensed and scanned images
- **Geospatial Symbol Management Services** – Services for management of symbol libraries
- **Image Understanding Services** – Services that provide automated image change detection, registered image differencing, significance-of-difference analysis and display, and area-based and model-based differencing

OGE Services may be of two levels of applicability (Figure 2-6). Certain of the USIGS applications will be unique to NIMA. Similarly, certain OGE services will provide capability that will be shared among NIMA unique applications, but will have no applicability elsewhere (for example certain intelligence oriented services). There will be a second level of OGE services that are generally available across the USIGS information domain and with applications in other information domains that require some OGE services.

There is a third level of Common Support Applications (from the viewpoint of USIGS). These are business objects made available from other information domains and general business objects that are non-domain specific.

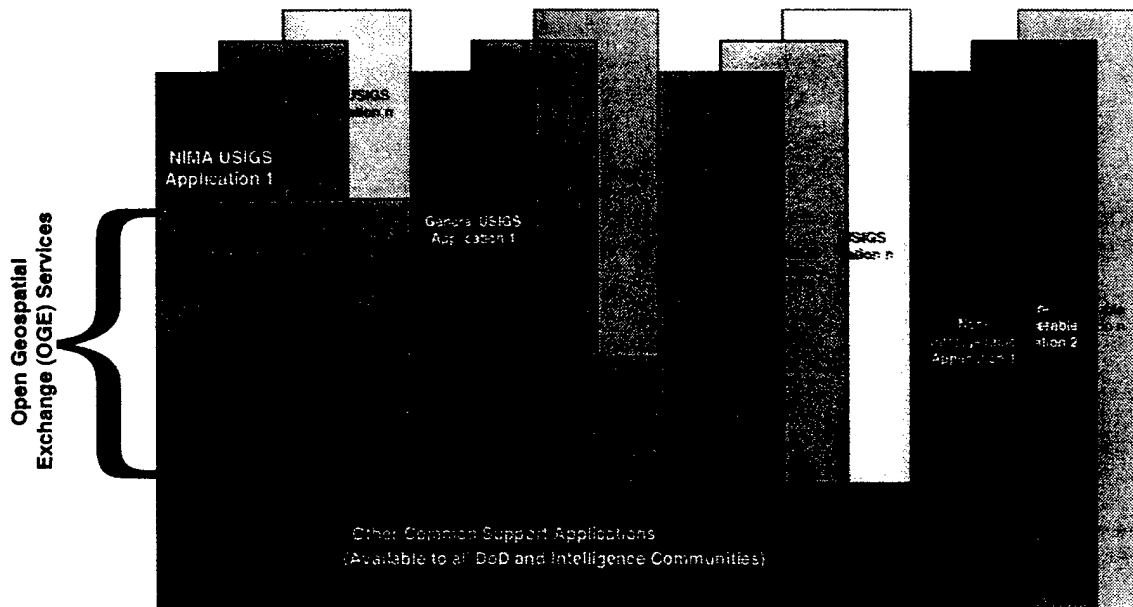


Figure 2-6. Common Support Application Applicability Layers

2.2.3 Common Facilities

The Common Facilities (Figure 2-7) fulfill key requirements of the USGS Technical Architecture. They are likely to be developed by other organizations such as OMG. As the Interface Design Language (IDL) specifications for each of these facilities are completed and published, they will be thoroughly evaluated, and those that are found to meet the requirements for the USGS will be adopted as components.

A description of each common facility, as currently defined by the OMG, follows.

- **Automation and Scripting Facility** — Defines conventions and interfaces that allow access to the key functionality of an object from another object. The design goal of this facility is to support user visible objects that are larger grained than the typical ORB object. The typical object acted upon by the Automation and Scripting Facility would be a document, a paragraph, a spreadsheet cell, and so forth. The emphasis of the facility is for objects to expose enough of their capabilities so they may be driven by scripts and macros.
- **Common Management Facility** — Provides a set of utility interfaces for system administration functions. These abstract basic functions such as control, monitoring, security management, configuration, and policies that are needed to perform systems management operations, such as adding new users, setting permissions, installing software, and so forth.

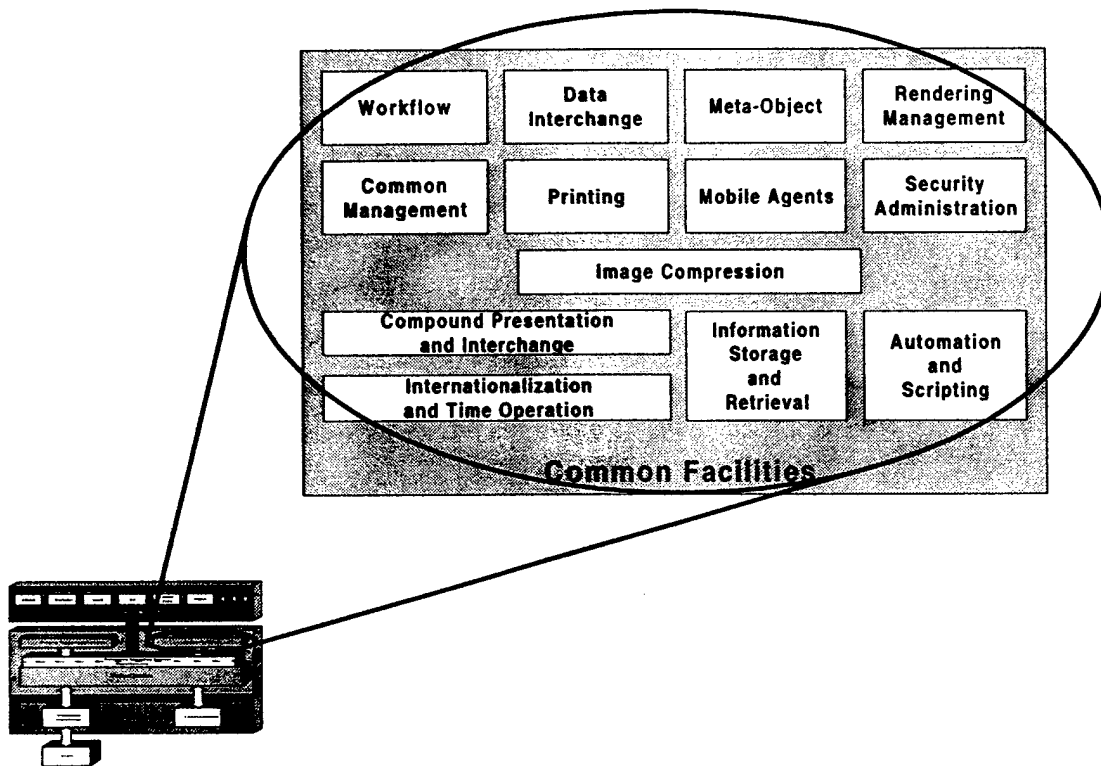


Figure 2-7. Common Facilities in the UTRM

- **Compound Presentation and Interchange Facility** — Enables the creation of cooperative component software that supports compound documents, that can be customized, that can be used collaboratively, and that is available across multiple platforms. Also provides for the storage and interchange of data objects, and roughly maps to the persistent storage subsystem of a compound document architecture.
- **Data Interchange Facility** — Allows for the exchange of information across networks of heterogeneous computer systems by providing a common information model and a common way of encoding information within that model. Encoding must support not only character data, but other sorts of data as well, including imagery, graphics, multimedia documents, and electronic mail. Enables objects to interoperate through exchange of data, and can be used for many forms and kinds of data transfer, such as: bulk transfer; interchange of formatted data such as TIFF, GIF, EPS, NITF, etc.; structured data transfer such as ISO IDL specified data types; interchange of domain-specific object representations; and the data interchange between objects and encapsulated software (legacy applications).

- **Imagery Compression Facility** — Defines a set of interfaces to generalized services for imagery compression and decompression, and for conversion between internal representations and standardized representations of such data
- **Information Storage and Retrieval Facility** — Comprises the higher level storage and retrieval specifications for distributed applications. These specifications will be applicable to a wide range of information services, including data base access and information highways.
- **Internationalization and Time Operations Facility** — Enables developers to use an information system or application in their own language using their own cultural conventions. In addition, this technology will allow the developer to use a culture's numeric and currency conventions, and keep track of time zones.
- **Meta-Object Facility** — Defines the interfaces and sequencing semantics needed to create, store and manipulate object schemas that define the structure, meaning, and behavior of other objects within the OMG Object Management Architecture. These objects may be application objects, common business objects, objects representing analysis and design models of applications, or objects providing the functionality of Common Facilities and Common Services. The Meta-Object Facility can be used in an information system (such as a repository) that enables an enterprise to specify and manage a wide variety of information assets with a common, integrated set of services. The use of a common meta-object facility for specifying the schemas of the information assets will play a key role in helping to achieve data and process integration by enabling tools and processes to share information and coordinate activities.
- **Mobile Agents Facility** — Supports the need to create massively distributed information systems over Wide Area Networks. Agent technology efforts range from building these massively distributed systems to mobile information systems, intelligent workflow systems, and agile corporation information structures.
- **Printing Facility** — One component of a coordinated set of facilities and standards needed to satisfy the printing requirements of the modern distributed office. Together, the capabilities provided must enable users to create and produce high-quality documents in a consistent and unambiguous manner within a distributed object environment. The Printing Facility should be able to meet a range of printing requirements from simple one document, one copy printing, all the way up to high volume production printing, which might involve several documents, several copies, several printers.

- **Rendering Management Facility** — Provides facilities to present information for output on devices such as screens, printers, plotters and sound and speech output devices. It also handles user input from a variety of hardware devices such as a mouse, keyboard, scanner, speech recognition device, digital camera, and security devices. Rendering management includes support for window management, class libraries for user interface objects, user interface dialog objects, and abstractions of the many different input/output devices.
- **Security Administration Facility** — Provides standard interfaces, as well as the necessary control mechanisms, to facilitate required security protections, including provisions for:
 - User registration, password maintenance, permissions maintenance
 - Access control, authentication, and audit trail maintenance
 - Resource registration
 - Security classification downgrading
 - Encryption key management
 - Discretionary and mandatory access control.
- **Workflow Facility** — Provides management and coordination of objects that are part of a work process (for example, purchase orders). This facility will provide support for production-based workflow in the form of structured, pre-defined processes that are governed by policies and procedures, as well as ad-hoc, or coordination-based workflows, including evolving workflows defined by one or more people to support the coordination of knowledge workers.

2.2.4 Distributed Computing and Object Services

The Joint Technical Architecture (JTA) allows for the use of either the Distributed Computing Environment (DCE) standard or the Common Object Request Broker Architecture (CORBA) specification for distributed computing services. This choice of distributed computing environments is based upon a choice between procedural computing or object-oriented computing. NIMA has determined that the preferable paradigm for future USIGS application interoperability is the object-oriented paradigm and, therefore, that the distributed computing environment of choice is that based on the CORBA specification. This also implies the choice of Object Services (Figure 2-8), the APIs for which have been defined by the OMG.

Distributed Computing and Object Services are capabilities that permit procedures and objects to be invoked on remote hosts as though they were local to the calling module. In addition to these basic capabilities, the distributed computing component is accompanied by a variety of enabling services, such as security, time, persistence, and

naming; many of these services are required for the development of applications that are distributed.

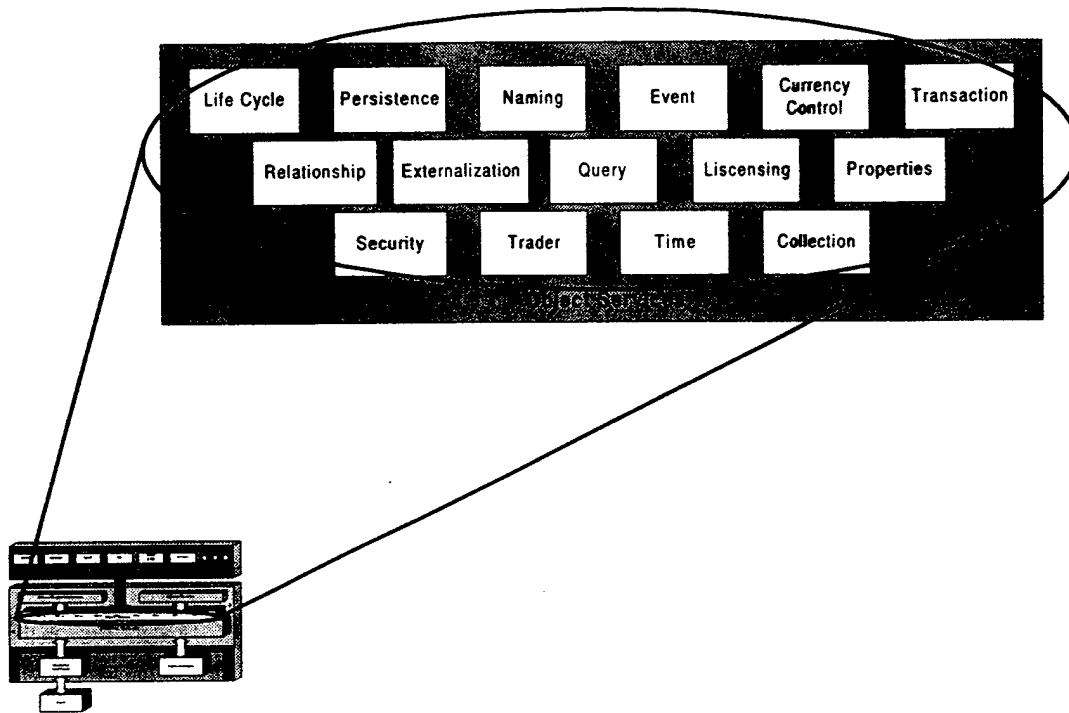


Figure 2-8. OMG Object Services in the USGS

The OMG Object Services are defined as follows:

- **Collections Service** – Provides a uniform way to generically create and manipulate the most common collections. Collections are groups of objects which, as a group, support some operations and exhibit specific behaviors related to the collection, such as stacks, queues, and lists.
- **Concurrency Control Service** – Enables multiple clients to coordinate their access to shared resources. Coordinating access to resources means that when multiple, concurrent clients access a single resource, any conflicting actions by the clients are reconciled so that the resource remains in a consistent state. The Concurrency Control Service consists of multiple interfaces that support both transactional and non-transactional modes of operation.
- **Event Service** – Provides basic capabilities that can be configured together in a very flexible and powerful manner. Asynchronous events (decoupled event suppliers and consumers), event “fan-in,” notification “fan-out,” and -- through appropriate event channel implementations -- reliable event delivery are supported. Both push and pull event models are supported i.e., consumers can

either request events or be notified of events, whichever is needed to satisfy application requirements.

- **Externalization Service** – Defines protocols and conventions for the externalization and internalization of objects. Externalizing an object is to record the object state in a stream of data (in memory, on a disk file, across a network, etc.) and then internalize it into a new object in the same or different process. The externalized object can exist for arbitrary amounts of time, be transported by means outside the ORB, and be internalized in a different, disconnected ORB.
- **Interface Type Versioning Service** – Provides for the management of the evolution of interfaces and their IDL descriptions. The service will provide the ability for a system to recognize that a new interface has evolved from an old one, allow multiple versions of the “same” interface to exist at the same time, allow for a choice of automatic or manually specified conversion to use of a new interface, and support the concept of a default version of an interface.
- **Licensing Service** – Provides a mechanism for producers to control the use of their intellectual property in a manner determined by their business and customer needs. This service offers fundamental usage control.
- **Life Cycle Service** – Defines services and conventions for creating, deleting, copying, and moving objects. Because Distributed Computing Environments support distributed objects, life cycle services define services and conventions that allow clients to perform life cycle operations on objects in different locations.
- **Messaging Service** – Provides interfaces that allow clients to make requests on an object without blocking the client execution thread. Some requests are not expected to be complete during the lifetime of the client execution environment, so mechanisms will be established to receive the response and process it appropriately. The service allows object servers to control the order in which incoming requests are processed.
- **Naming Service** – Provides the ability to bind a name to an object relative to a naming context. A naming context is an object that contains a set of name bindings in which each name is unique. To resolve a name is to determine the objects associated with the name are given context. Through the use of a “names library,” name manipulation is simplified and names can be made representation independent thus allowing their representation to evolve without requiring client changes.

- **Persistent Object Service** – Provides common interfaces to the mechanisms used for retaining and managing the persistent state of objects. The Persistent Object Service will be used in conjunction with other Object Service Interfaces, for example, naming, relationships, transactions, life cycle, etc. The Persistent Object Service has the primary responsibility for storing the persistent state of objects, with other services providing other capabilities.
- **Properties Service** – Provides the ability to dynamically associate named values with objects outside the static IDL type system. The interfaces provided by this service are used for defining, deleting, modifying, enumerating, and checking for the existence of properties. By using the interfaces defined by the Property Service, useful information can be associated with an object's state, for example, a title or a date.
- **Query Service** – Provides query operations on collections of objects. The queries are predicate-based and may return collections of objects. They may be specified using object derivatives of SQL and/or other styles of object query languages including direct manipulation query languages. Query operations include selection, insertion, updating, and deletion on collections of objects or data.
- **Relationship Service** – Allows entities and relationships to be explicitly represented. Entities are represented as objects. The service defines two new kinds of objects: relationships and roles. A role represents an object in a relationship. The Relationship interface can be extended to add relationship-specific attributes and operations. Similarly, the Role interface can be extended to add role-specific attributes and operations.
- **Security Service** – Protects an information system from unauthorized attempts to access information or interfere with its operation. For example, security services may include (but are not limited to) the following:
 - **Confidentiality:** information is disclosed only to users authorized to access it.
 - **Integrity:** information is modified only by users who have the right to do so and only in authorized ways. It is transmitted only between intended users and in intended ways.
 - **Accountability:** users are accountable for their security relevant actions. A particular case of this is non-repudiation where responsibility for an action cannot be denied.
 - **Availability:** Use of the system cannot be maliciously denied to authorized users.
- **Startup Service** – Enables requests to automatically start up when an Object Request Broker is invoked.

- Time Service – Maintains current time, ascertains order in which events occurred, and computes the interval between two events.
- Trader Service – Provides a matchmaking service for objects – registers availability of the service, provides parameters, distinguishing attributes, and names of operations to which it will respond. It also allows objects in different domains to negotiate and share services without losing control of their own policies and services.
- Transaction Service – Supports multiple models (flat and nested) of transactional behavior in a distributed heterogeneous environment. The Transaction Service brings the transaction paradigm, essential to developing reliable distributed applications, and the object paradigm, key to the productivity and quality in application development, together to address the business problems of commercial transaction processing.

2.2.5 Platform Services

Platform Services in the UTRM (pictured in two different ways in Figure 2-9) are derived from the DII COE reference model and include the operating system and primitive-level services that provide fundamental functionality to the platform in general. While Platform Services are of great significance in the development of software using traditional structured procedural techniques, as the USIGS migrates to a fully component based architecture based on CORBA, the specifics of the Platform Services will take on less and less importance. When the USIGS is completely migrated to a component based architecture based on CORBA, the choice of platform and services will depend only on performance characteristics and the meeting of minimal standards for network services.

Platform Services include:

- Data Interchange. Includes file formats and protocols required for the transfer of information among applications program.
- Data Management. Includes File Access, File Management, Database Access, and Database Management. Includes definition, storage, and retrieval of files, databases, and object bases distributed over the network. Includes data exchange facilities between users, computers, and databases.
- Graphics. Services that provide for device-independent rendering of both vector and raster based graphics, for purposes including, but not limited to: plotting, computer aided design manipulation and display, simulation, animation, scientific visualization, process control, and art. These services include graphical, attribute and input primitives; coordinate and systems clipping; and input and output model implementation.

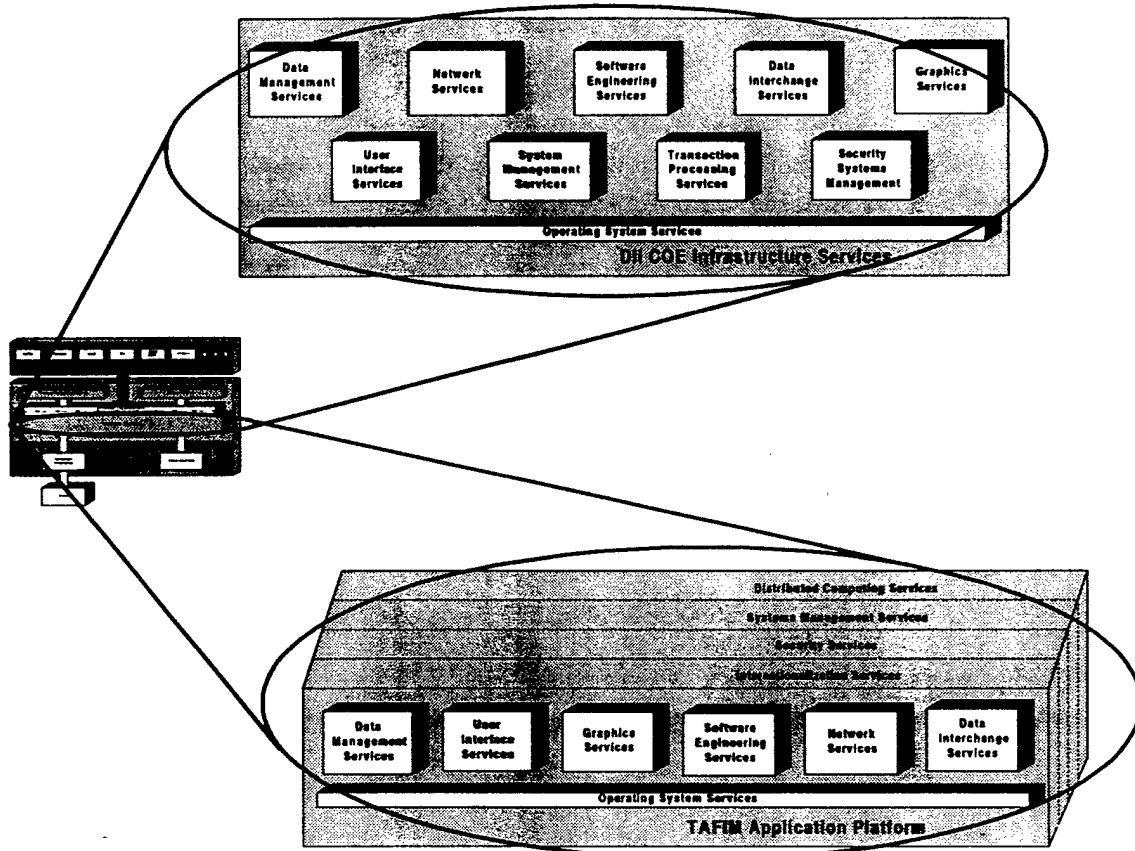


Figure 2-9. Platform Services in the UTRM

- **Network.** An infrastructure of coordinated services primarily supporting connectivity and data exchange between one mission application system or workstation and another. Network services provide the capability to send, receive, forward, and manage electronic and voice messages. They also provide real-time information exchange services in support of interpersonal conferences. These services include Personal Message Transfer, Organizational Message Transfer, enhanced telephony, shared screen, teleconferencing, and broadcast.
- **Operating System.** The core services required for the management and control of the hardware platform resources, including the processor (CPU), memory, physical file storage and retrieval, and generalized input and output. Services in this category include such platform management functions as: process, physical file, input/output, and memory management.

- **Security Systems Management.** Administrative tools required for the management of information and communications security within a single platform and between and among multiple platforms.
- **Software Engineering.** A collection of the basic services required to develop software for a given platform, including text editors, compilers, linkers, interpreters, and certain virtual machines (e.g., the Java virtual machine). **System Management.** Ability to manage all hardware and software resources in a heterogeneous, distributed information system. Includes network administration, and system administration. Includes four of the five System Management Functional Areas defined by the International Organization for Standardization (ISO): configuration management, fault management, performance management, and accounting management. Three levels of management have been defined for DII: global, campus, and site.
- **System Management.** Services required to effectively manage a wide variety of diverse resources (such as printers, software, users, processors) to achieve the goals of an open system environment. While the individual resources may differ widely, the abstraction of these resources as managed objects allows for treatment in a uniform manner. Service categories include state management, configuration control, performance monitoring, fault monitoring, user/group management, and usage monitoring.
- **Transaction Processing.** Services required to support transactional access to a single database manager on a single platform or on multiple platforms (i.e, a distributed database management system), transactional access to nondatabase resource managers (e.g., automated tellers), On-Line Transaction Processing (OLTP), and distributed transaction processing.
- **User Interface.** Services required for the exchange of information with a user. Specifically, services to display information, including rendered graphics, on a user's workstation, printer, or other display device and to accept information from a user through an input device.

2.2.6 External Entities

External Entities are defined in the *IEEE Draft Guide to the POSIX Open System Environment* (IEEE P1003.0) and, in the UTRM, are of two types: Information Interchange Entities and Communications Entities. Information Interchange Entities are those hardware devices with which the platform services exchange information. These include keyboards, displays, mass storage devices, joysticks, mice, etc. Communications entities are those hardware devices required to exchange information among platforms, basically the wires, switches, etc.

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3. Current Standards, Conventions, and Guidelines

3.1 Introduction

The USIGS standards mandates, operational conventions, and implementation guidelines are described in this section, beginning with the presentation of specifications for the service categories of the USIGS Technical Reference Model (UTRM). This is followed by a USIGS standards profile of the JTA. For each entry in the standards profile, a description of the standard or profile is then provided, including USIGS usage information as appropriate. The section concludes with the identification of conventions and guidelines that are applicable to the USIGS.

The USIGS Interoperability Profile [UIP97] defines the profile for software interface standards to be used to achieve interoperability between multiple clients and servers within the USIGS architecture. This framework will minimize coordination/interaction between developers by establishing a flexible, community wide framework based on a platform-independent distributed computing technology based on common interfaces between software components. The UIP is intended to define interoperability details of the key software interfaces required for the interaction within and among the Library and Exploitation elements of the USIGS architecture.

The scope of standards identified in this section consists of geospatial, imagery, and imagery intelligence among the services of the USIGS. Other standards and services (from the JTA) are cited for a complete list necessary for use within USIGS and NIMA.

The standards and conventions in this section are mandated for the USIGS community, while the guidelines are optional and may be defined differently for each organization.

3.2 USIGS Current Mandated Standards

3.2.1 USIGS Reference Model Specifications and JTA Standards Profile

Table 3-1 identifies specifications for the service categories and components from the UTRM: Mission Specific Applications, Common Support Applications, Common Facilities, Distributed Computing and Object Services, and Platform Services. With most of the Common Facilities, the facilities are still being developed or linked with emerging technology and will be addressed in Section 5. Each service category includes several services or components.

Table 3-2 provides a "USIGS profile" of the JTA, although it is not strictly a profile because some standards are added to those in the JTA. A standardized profile may be of two types: (1) a collection of standards into a single profile and (2) the standardized profile of a specific standard, wherein the specific options and parameters of a standard are specified. In each case, the profile is a tailoring of one or more standards to provide

specific functionality while enhancing the potential for interoperability. Examples of both of these standardized profile types can be found in the National Imagery Transmission Format Standard (NITFS). NITFS is itself a standardized profile that encompasses a collection of standards and standardized profiles. One of the standardized profiles that is included in NITFS is an NITFS-specific profile of the Computer Graphics Metafile (CGM) standard.

Table 3-2 is formatted to follow the JTA organization in [JTA97]. The base standards and profiles that apply to each function or service are identified by name and the document identifier assigned by the specification's issuing organization is given. The standards presented are primarily associated with the UTRM's Platform Services. The leftmost column is closely aligned with how the JTA is organized, and pointers to JTA sections are given in Column 2. Entries in the Profile or Base Standard columns augment or profile the corresponding JTA standards. In most cases, these standards are selected and specified as presented in the JTA. In some cases, such as with much of the data interchange standards, NIMA is the executive agent for geospatial and imagery standards within DOD, and additional information beyond what is in the JTA is provided in the description section that follows the table. Finally, there is a column for remarks relative to each standard or standardized profile. These remarks are provided for the convenience of the reader, so in some cases they may reflect information that can also be found in the descriptions of the standards found in Subsection 3.2.2. Additionally, the remarks column will be used to identify data formats applicable to each service area. This information will provide a common thread between the System and Technical Architectures as the System Architecture products evolve to map individual systems to services.

If no standard or profile is given for a service, this means that USIGS follows the standards in the indicated JTA section as is, with no additions, exceptions, or profiles. Occasionally, no reference to the JTA is presented in column 2, meaning the UTA is providing a standard that is necessary for USIGS but is not yet mandated in [JTA97]. These additional standards will be submitted for inclusion in a future version of the JTA.

Table 3-1. Reference Model Specifications

Service (Type)	Interface Spec.	Components	
Mission-Specific Applications	Not applicable	Information Discovery/Retrieval Information Viewing/Enhancement Information Exploitation/Analysis Information Integration/Fusion Information Production Management Information Reproduction/Replication	Order Entry/Tracking Information Production Information Delivery Customer Support Information Storage/ Retrieval
Common Support Applications (COE)	[COE97]	Alerts On-line Help Presentation Correlation	Developer's Kit Office Automation Message Processing
Common Support Applications (OGE)	[GLAS97] as profiled in [UIP97]	Geospatial Domain Access	
	To be developed	Geospatial Feature Manipulation Geospatial Information Extraction Geospatial Coordinate Transformation Geospatial Symbol Management Image Map Generation Image Understanding Facility Geospatial Feature Analysis	Geospatial Annotation Image Manipulation Feature Generalization Image Exploitation Geospatial Display Image Geometry Model Image Synthesis
Common Facilities	[CORBA97b]	Automation and Scripting Common Management Compound Presentation and Interchange Data Interchange Imagery Compression Information Storage and Retrieval Internationalization and Time Operations	Meta-Object Mobile Agents Printing Facility Rendering Management Security Administration Workflow Facility
Distributed Computing and Object Services	[CORBA97c]	Collections Concurrency Event Externalization Interface Type Versioning Licensing Life Cycle Messaging Naming	Persistent Object Properties Query Relationship Security Startup Time Trader Transaction
Platform Services	See Table 3-2*	Data Interchange Data Management System Management Services Security Systems Management Software Engineering	Graphics Network Operating System Transaction Processing User Interface

* Differences with JTA service names will be reconciled as the UTA and JTA evolve.

Table 3-2. USIGS Profile of the JTA

		Profile of a Standard		Base Standard		
Service	JTA Section	Name(s)	Document Identifier(s)	Name(s)	Document Identifier(s)	Remarks
Software Engineering Services	2.2.2.2.1.1					
User Interface Services	2.2.2.2.1.2 and 2.5					
Data Management Services	2.2.2.2.1.3					
Data Interchange Services	(See components below)					
(Document)	2.2.2.2.1.4.1					
(Graphics Data)	2.2.2.2.1.4.2	Computer Graphics Metafile (CGM) Implementation Standard for the NITFS	MIL-STD-2301	Computer Graphics Metafile	ANSI/ISO 8632	
				Common Warfighting Symbology	MIL-STD-2525A w/ Change #1 15 Apr 1997	
(Geospatial Data)	2.2.2.2.1.4.3			Vector Product Format (VPF)	MIL-STD-2407	

Profile of a Standard							Base Standard	
Service	JTA Section	Name(s)	Document Identifier(s)	Name(s)	Document Identifier(s)	Remarks		
(Imagery Data) [Still Imagery]	2.2.2.2.1.4.3			Raster Product Format (RPF)	MIL-STD-2411			
	2.2.2.2.1.4.3			World Geodetic System 84 (WGS-84)	MIL-STD-2401 11 Jan 1994			
	2.2.2.2.1.4.4			National Imagery Transmission Format (NITF 2.0)	MIL-STD-2500A w/notice #1 Feb 1997	NITF is a part of the more inclusive National Imagery Transmission Format Standard (NITFS)		
	2.2.2.2.1.4.4	Computer Graphics Metafile (CGM) Implementation Standard for the NITFS	MIL-STD-2301 w/ notice #1 12 Oct 1994	Computer Graphics Metafile	ANSI/ISO 8632			
	2.2.2.2.1.4.4	JPEG as profiled for NITFS	MIL-STD-188-198A w/ notice #1 12 Oct 94	JPEG	ANSI/ISO 10918-1	Note: not interoperable with JFIF		
				NITFS Compression and Guidelines Document	NIMA # N0106			

		Profile of a Standard		Base Standard		Remarks
		Name(s)	Document Identifier(s)	Name(s)	Document Identifier(s)	
Service	2.2.2.2.1.4.4			Vector Quantization (VQ)	MIL-STD-199 w/ notice #1 27 Jun 1996	
	2.2.2.2.1.4.4	Bi-level Compression	MIL-STD-188-196 w/ notice #1 27 Jun 1996	Group 3 Facsimile	ITU-T Recommendation T.4	This standard to be used for compressing and decompressing NITF files (for NITFS)
				Adaptive Recursive Interpolated Differential Pulse Code Modulation (ARIDPCM)	MIL-STD-188-197A 12 Oct 1994	This standard to be used for decompressing ARIDPCM compressed files (for NITFS)
(Product Data)	2.2.2.2.1.4.5					No standards - addressed in future versions of the JTA; <i>Geospatial product specifications are listed in USIGS Guidelines section</i>
(Audio Data)	2.2.2.2.1.4.6					
(Motion Imagery)	2.2.2.2.1.4.7					
IR Systems				(TBD)		
SAR Systems				(TBD)		
Video Systems (Video Intelligence)...				Video Standards Profile (VSP)	USIGS VSP version 1.1 26 Sep 1997	(USIGS VSP Ver. 1.0, 12 Jun 97)

Profile of a Standard			Base Standard			
Service	JTA Section	Name(s)	Document Identifier(s)	Name(s)	Document Identifier(s)	Remarks
(Atmospheric Data)	2.2.2.2.1.4.8					
(Oceanographic Data)	2.2.2.2.1.4.9					
Graphics Services	2.2.2.2.1.5					
Communications services	2.2.2.2.1.6 and 2.3					
Operating Systems Services	2.2.2.2.1.7					
Internationalization Services	2.2.2.2.2.1					
Security Systems	2.2.2.2.2.2 and 2.6					
Systems Management Services	2.2.2.2.2.3					
Distributed Computing Services	2.2.2.2.4			CORBA 2.1	OMG document formal/97-09-01 [CORBA97b/c/d]	URL: http://www.omg.org/corba USIGS implements distributed object computing (2.2.2.2.4.2)
Information Transfer	2.3					
Information Modeling and Information Stds	2.4.2.2			Geopolitical Country Codes	FIPS PUB 10-4, Apr 1995	Available at SHADE Reusable Reference Data Set URL: http://diides.ncr.disa.mil/shade.html

Profile of a Standard			Base Standard			
Service	JTA Section	Name(s)	Document Identifier(s)	Name(s)	Document Identifier(s)	Remarks
				USIGS Data Model	(USIGS-DM) 18 Jul 1997	http://www.nima.mil/org/se/seid/usigs.html
Human-Computer Interfaces	2.5					
(Symbology)	2.5.2.3		Common Warfighting Symbology		MIL-STD-2525A w/ Change #1 15 Apr 1997	
Systems Security Services	2.6					

3.2.2 USIGS Standards and Profile Descriptions

This section provides brief descriptions of the standards and profiles identified in the USIGS standards profile. They are provided as organized in Table 3-2. Each description includes the following information, as appropriate:

- A directive statement which describes the nature of the standards for USIGS and applicable functional areas or customers.
- Implementation or application specifics as applicable. Known constraints that may affect implementing the standard or profile.
- Administrative responsibility or ownership type information providing how or where to locate the standard.
- A brief description of the standard or standardized profile.

3.2.2.1 Graphics Data Interchange

The two standards described below are provided for clarity and direction for USIGS developers and should not conflict with the JTA. Graphics data interchange is associated with NITFS. MIL-STD-2301 had its basis in FIPS 128-1 which is also a profile of the ANSI/ISO 8632 standard. The symbology standard is mandated by JTA in the Human-Computer Interfaces Section.

3.2.2.1.1 Computer Graphics Metafile (CGM) Implementation Standard for the NITFS - MIL-STD-2301

Operational graphics data interchange within USIGS is to be consistent with that used for the interchange of operational imagery data. See CGM discussion below in Section 3.2.2.3.2.

3.2.2.1.2 Common Warfighting Symbology - MIL-STD-2525A

Common Warfighting Symbology, MIL-STD-2525A, specifies a common set of warfighting symbols, with the intent to enhance DoD's joint warfighting interoperability. MIL-STD-2525A contains a set of common warfighting symbols used in two-dimensional and electronic display system Command, Control, Communications, Computer, and Intelligence (C4I) for the Warrior environments. It also specifies basic application and display rules for Department of Defense (DoD) C4I system operations, system development, and training. MIL-STD-2525A is the standard symbol set for all future DoD C4I for the Warrior symbology applications.

The symbols must be compliant with the National Imagery Transmission Format Standards (NITFS) Computer Graphic Metafile (CGM) implementation. On-going work

will expand symbology standardization to mapping, charting, weather, cockpit display, and engineering design.

3.2.2.2 Geospatial Data Interchange

3.2.2.2.1 Vector Product Format (VPF) - MIL-STD-2407

The vector product format (VPF) is a standard format, structure, and organization for large geographic databases that are based on a geo-relational data model and are intended for direct use. VPF is designed to be compatible with a wide variety of applications and products. VPF allows application software to read data directly from computer-readable media without prior conversion to an intermediate form. VPF uses tables and indexes that permit direct access by spatial location and thematic content and is designed to be used with any digital geographic data in vector format that can be represented using nodes, edges, and faces. VPF defines the format of data objects, and the geo-relational data model provides a data organization within which software can manipulate the VPF data objects. A product specification corresponding to a specific database product determines the precise contents of feature tables and their relationships in the database. In this context, each separate product or application is defined by a product specification and implemented by using VPF structures.

3.2.2.2.2 Raster Product Format (RPF) - MIL-STD-2411

RPF (MIL-STD-2411) is a standard data structure for rectangular arrays of pixels. Most often used for geospatial databases in compressed or uncompressed form. MIL-STD-2411-1 is an accompanying standard that defines registered data values to be used in RPF files. It is intended for data interchange and is designed to require no manipulation of the data, other than possible decompression, in order to use or display it.

3.2.2.2.3 Department of Defense World Geodetic System (WGS 84)

Department of Defense World Geodetic System (WGS 84) – MIL-STD-2401, 11 January 1994 – specifies a standard global coordinate system for representation of positional information and methods for transferring to/from other geodetic systems. WGS 84 is the official DoD positional reference system.

NIMA Technical Report 8350.2, referenced in 2401 as DMA TR 8350.2, has been updated and is currently in review with the CINCs/Services/Agencies. 8350.2 provides additional technical information needed to implement WGS 84.

When to Implement the Standard: CJCSI 3900.01 (21 March 1994) mandates the use of WGS 84 as a coordinate reference (unless preexisting circumstances preclude its use) for all joint operation and recommends the use of WGS 84 in multinational and unilateral operations after coordination with allied commands. This guidance replaces the JCS MOP 45 reference in 2401, which is canceled.

This standard applies to all DoD systems and products which require use of a world geodetic system, i.e., a consistent global coordinate system which allows an unambiguous representation of positional information. Navigation solutions from the NAVSTAR Global Positioning System (GPS) and the Navy Navigation Satellite System (NNSS) are referred to this system.

A WGS 84 ellipsoid provides a reference surface upon which coordinates are calculated and is particularly applicable to inertial systems. WGS 84 Earth Gravitational Model (EGM) provides necessary force models for accurate global operation of strategic weapons, navigation, and satellite systems. Many MC&G products produced by other agencies and governments (and NIMA products not yet placed on WGS 84) are not referred to the WGS 84. Parameters to transform these products to WGS 84 are part of this standard.

3.2.2.3 Imagery Data Interchange (Still Imagery)

3.2.2.3.1 *National Imagery Transmission Format (NITF 2.0) - MIL-STD-2500A*

NITF is a part of the more inclusive National Imagery Transmission Format Standard (NITFS). It is a format used for transmission of still imagery and associated data. NITF is the core of the NITF Suite of standards, and is coupled with additional standards for compression, graphics, and communications. It is mandated for all C4I systems disseminating secondary imagery, and is required for interoperability within the USIGS.

The Assistant Secretary of Defense for Command, Control, Communications and Intelligence (ASD(C3I)) has mandated compliance with the NITFS. The National Imagery and Mapping Agency (NIMA) oversees the NITFS Certification Test and Evaluation (CTE) Program that determines compliance with the NITFS. The Defense Information System Agency's (DISA) Joint Interoperability Test Command (JITC), located at Fort Huachuca, Arizona, serves as NIMA's Executive Agent for execution of NITFS test-related activities. The JITC has established a NITFS CTE Facility that supports certification testing of NITFS capable systems, validation testing of proposed additions to NITFS, and other test activities related to NITFS. A register of NITFS certified systems is also maintained at the CTE Facility. Detailed information concerning the NITFS Certification Test and Evaluation Program, including the established certification test criteria, is contained in DISA/JIEO Circular 9008.

3.2.2.3.2 *Computer Graphics Metafile (CGM) Implementation Standard for the NITFS*

MIL-STD 2301 is required for any C4I Systems exchanging NITFS files with overlaid graphics or for any systems implementing war fighter symbology, as defined in MIL-STD 2525A. To ensure interoperability of graphics data throughout systems in the USIGS, it is recommended that all systems implementing CGM implement MIL-STD 2301. NIMA SES is the technical manager of this document. It is configuration managed by the NITF Technical Board and ISMC.

The CGM Military Standard facilitates the storage of vector graphic data, principally for presentation purposes, and is the commercially accepted standard for storage, exchange and output for a wide range of graphical pictures. Its data storage supports vector graphic presentation and overlay on maps and images. As a graphic service, it provides a toolkit for the processing of vector graphics data at the presentation layer.

MIL-STD 2301 is a profile of the ISO/IEC Standard, "Information Technology - Computer Graphics Metafile for the Storage and Transfer of Picture Description". This is a commercially accepted standard to promote organized picture information storage on a graphical software system, facilitate its transfer between different graphical software systems, and enable its transfer between graphical devices and different computer graphics installations. It was based on the FIPS 128-1 document, but has since superseded it in terms of utility, commercial acceptance, and DoD implementation. The ISO/IEC CGM Standards are:

ISO/IEC 8632-1:1994	Information Technology - Computer Graphics Metafile for the Storage and Transfer of Picture Description format - Part 1: Functional Specification
ISO/IEC 8632-2:1994	Information Technology - Computer Graphics Metafile for the Storage and Transfer of Picture Description format - Part 2: Character Encoding
ISO/IEC 8632-3:1994	Information Technology - Computer Graphics Metafile for the Storage and Transfer of Picture Description format - Part 3: Binary Encoding
ISO/IEC 8632-4:1994	Information Technology - Computer Graphics Metafile for the Storage and Transfer of Picture Description format - Part 4: Clear Text Encoding

The MIL-STD is the mandated USIGS profile for interchange of graphical elements. It will be superseded by a new profile, which expands the flexibility and capability of the exiting military standard. This profile, tentatively named "The Basic Imagery and Mapping Annotations" (BIMA) will be submitted to ISO/JTC1 for formal approval and registration by the appropriate ISO registration authority. The submittal is currently planned to be in the 4Q98 timeframe. This new profile will not be documented as a military standard, but will be documented as a NIMA-controlled document, and will be the required profile for NITFS CGM and MIL-STD 2525A Symbology.

3.2.2.3.3 JPEG as profiled for NITFS

MIL-STD 188-198A (JPEG) is the mandated Lossy compression for 8-bit and 12-bit NITFS imagery within the USIGS. This Military standard is a profile of the ISO/IEC standard for JPEG, ISO/IEC 10918-1:1994, "Information technology - Digital compression and coding of continuous-tone still images : Requirements and guidelines".

JPEG was designed for lossy image compression algorithm of 8 or 12 bit grayscale or 24 bit color images that uses a discrete cosine transform (DCT) to preprocess image data. The requirements specified in this standard are intended to enable the interchange of 8- and 12-bit gray scale imagery and 24-bit color imagery compressed with the JPEG algorithm.

The NITFS lossless JPEG profile has been developed and is documented in the NITFS Compression Standards and Guidelines Document, NIMA N0106 (Draft), until it is formally approved and registered by ISO JTC1/SC29/WG1 and the appropriate SC29 Registration authority (expected 1Q99). This capability complements the current Lossy JPEG compression algorithm by providing for the down-sampling (and up-sampling) of an NITF image, prior to JPEG compression (or after decompression). Point of contact for this document is NIMA.SES. See NITFS Program Plan -DRAFT (NIMA Document NNPP) for more information.

3.2.2.3.4 Vector Quantization (VQ) - MIL-STD-199

Vector Quantization (VQ) MIL-STD-199 is the mandated standard for decompressing NITF files compressed with VQ compression. It will be superseded in the 1999 timeframe with an identical document that will be the USIGS profile of the ISO Standard for VQ - currently being developed in the BIIF standardization effort. See NITFS Program Plan -DRAFT (NIMA Document NNPP) for more information.

3.2.2.3.5 Bi-level Image Compression - MIL-STD-188-196

Bi-level Image Compression, MIL-STD-188-196, is required for Bi-level (i.e., 1 bit per pixel, or black and white) lossless image compression as defined within the NITFS standard. For image data greater than one bit pixel, other NITFS specified compression algorithms should be used.

This standard describes the one-dimensional and two-dimensional image data compression strategy articulated in International Telecommunication Union (ITU), CCITT Recommendation T.4, Standardization of Group 3 Facsimile Apparatus for Document Transmission, (Geneva, 1980, amended at Malaga-Torremolinos, 1984 and Melbourne, 1988) and establishes its application within the NITFS. The requirements specified in this standard are intended to ensure commonality between encoding (compressing) and decoding (decompressing) one bit pixel imagery.

3.2.2.3.6 The Adaptive Recursive Interpolated Differential Pulse Code Modulation Image Compression (ARIDPCM)

The Adaptive Recursive Interpolated Differential Pulse code Modulation Image compression (ARIDPCM), removed as a required compression for the NITF 2.1, is now only required for use with decompressing legacy files (NITF 1.1, 2.0) that implement it. Hence, MIL-STD 188-197A will continue to be the authoritative standard until such time

that these legacy imagery products have been converted to other accepted compression alternatives (JPEG, No compression, etc.).

ARIDPCM, MIL-STD-188-197A, is used for image compression. It provides lossy compression for 8- and 11-bit grayscale images. It was designed for adequate performance on a PC AT, the "benchmark" computing platform of the early 1990s; today's "benchmark" is much faster than the PC AT, so more advanced compression algorithms can be used, such as JPEG. ARIDPCM predates the adoption of JPEG compression by NITFS, and NITF 2.0 only requires systems to decompress ARIDPCM for backward-compatibility.

3.2.2.4 Motion Imagery Systems

3.2.2.4.1 Motion IR

Standards are TBD.

3.2.2.4.2 Motion SAR

Standards are TBD.

3.2.2.4.3 Video Systems

Four general classes of Video Systems are noted as in use and or in planning stages for use across the Department of Defense/Intelligence Community (DoD/IC) and related Federal Communities.

- 1) Video Intelligence Systems (all USIGS systems that create, process, transmit, manipulate, exploit, store, archive and disseminate (both for real-time and other end-user wide area product distribution) VIDEO signals in support to Intelligence, Surveillance, and Reconnaissance (ISR) applications).
- 2) Video Teleconference Systems (systems used for "face to face" meetings between remote locations). When video teleconference systems are used as alternate Video Intelligence data dissemination systems then the requirements and provisions of Video Intelligence systems apply.
- 3) Video Telemedicine (systems used in support of biomedical applications only).
- 4) Video Support (traditional studio and or field video production, not associated with theater and or deployed DoD/IC Operations and Exercises). Video Support includes traditional activities such as preparation and dissemination of video based training; feature presentations or news gathering (unless part of ISR activities); AFRTS operations; or other CONUS only, non-critical functions that will not be mobilized for war fighting or contingency operations support.

The standards and usage directives for each class of video application are noted in the subsections that follow.

3.2.2.4.3.1 Video Intelligence

The "USIGS Video Standards Profile (VSP)," Version 1.1, 26 September 1997 [Video97b] (and as amended in the future), prepared and managed by the DoD/IC Video Working Group, mandates the minimum set of standards and guidelines for the acquisition of all DoD systems that produce, use, or exchange Video Intelligence information within the USIGS community. To support world-wide interoperability and exchange of Video Intelligence, all USIGS component systems that create, process, transmit, manipulate, exploit, store, archive and disseminate (both for real-time and other end-user wide area product distribution) VIDEO signals in support to Intelligence, Surveillance, and Reconnaissance (ISR) applications) are required to comply with the Standards and Profiles contained in VSP. All USIGS video systems should comply with VSP Recommended Practices.

The VSP is applicable to all DoD/IC video systems that form component parts of the USIGS Technical Architecture. For point of clarification, such systems are referred to VIDEO INTELLIGENCE systems. All new Video Intelligence systems are required to be compliant with provisions of the VSP as soon as practical. Program Offices should begin development of migration strategies and compliance planning effective 12 June 1997. All analog video systems are considered to be Legacy systems as of 12 June 1997 and all new systems are required to be digital video technology based, in accordance with standards in the VSP.

By specific reference, other classes of video uses and community systems (Video Teleconference Systems, Video TeleMedicine, Video Support) are specifically excluded from the requirements of the VSP. However, these other video communities are encouraged to review the applicability of the standards given in the VSP and if deemed practical, implement VSP standards and recommended practices to foster broader interoperability across the entire DoD/IC/Federal spectrum. These separate communities are specifically invited to join the DoD/IC VWG and merge their requirements into the ongoing development of the DoD/IC VSP document.

The Department of Defense/ Intelligence Community (DoD/IC) Video Working Group (VWG), under the umbrella of the Geospatial Standards Management Committee, Imagery Standards Management Committee (GSMC-ISMC), is designated as the lead organization (executive agent) to formulate baseline standards for video within the U.S. Government, consistent with the United States Imagery Geospatial and Information System (USIGS) 2000 architecture.

The "USIGS Video Standards Profile" (VSP) is the master baseline document prepared and managed by the VWG. VSP Version 1.00 was approved by the GSMC-ISMC on 12 June 1997. VSP Version 1.10 is scheduled for review by GSMC-ISMC on 26 September 1997. Future updates and revisions can be expected every three to six months. All

DoD/IC organizations that use video technologies are encouraged to participate in VWG activities and represent their specific requirements and issues.

It is the intent of the VSP to give users a consolidated, clear and concise view of the standards they will need to build and operate Video Intelligence systems. No single commercial video standard provides all of the guidance necessary to build interoperable systems for use across the diverse missions of DoD/IC. Therefore, the VSP is a collection of standards and descriptions of how component parts based on such standards can interconnect and provide interoperable service to users. It is useful to consider the VSP to be a specific technology (video) architecture document that defines concepts necessary for building interoperable, end-to-end Intelligence, Surveillance, and Reconnaissance (ISR) systems that use video technology. The VSP includes guidance on uncompressed, compressed, and related video waveforms; video time standards, video metadata standards, interconnections, and common language descriptions of video system parameters.

Where the VSP term STANDARD is used, the VSP item (chosen by specific VWG adoption, and approved by the GSMC-ISMC) mandates binding technical implementation policy, and as such, should be identified in Government procurement actions as a mandatory compliance item in order for vendor offerings to be accepted by the Government.

Where the VSP term PROFILE is used, the VSP item documents an extension to a STANDARD developed or specified to meet DoD/IC unique mission requirements not normally covered by commercial standards. VSP PROFILES (chosen by specific VWG adoption, and approved by the GSMC-ISMC) mandate binding technical implementation policy, and as such, should be identified in Government procurement actions as a mandatory compliance item in order for vendor offerings to be accepted by the Government.

Where the VSP term RECOMMENDED PRACTICE is used, the VSP item documents a recommended implementation or practice that further clarifies the implementation of a STANDARD or PROFILE in order to insure interoperability across DoD/IC systems. Recommended Practices chosen by specific VWG adoption (as approved by the GSMC-ISMC), should be considered to be a technical implementation policy, and as such, may be identified in Government procurement actions as a mandatory compliance item in order for vendor offerings to be accepted by the Government.

Where the VSP term STUDY is used, the VSP identifies a preliminary version of an anticipated STANDARD or PROFILE or RECOMMENDED PRACTICE where the primary initial parameters are outlined and understood but additional coordination or engineering analysis is required. Such items will be forwarded to the appropriate VWG sub-group or ad-hoc committees for action item work-off, with completion suspense dates to be determined. At the time of formal adoption, the STUDY will become a standard, profile, or recommended practice, using the same VSP identification number. Until formally adopted by the VWG and GSMC-ISMC there is no requirement to implement any portion of any STUDY item.

Note that all of the technology outlined in the VSP document is based on commercially available (or very near term available) systems and components. The VSP identifies commercial standards to define interoperability for high image quality environments and systems (such as common control vans, interconnections nodes, and DoD/IC command centers), including high bandwidth transmission of uncompressed and compressed video signals. The VSP also identifies approaches for interoperability between high bandwidth and low bandwidth systems but it does not, as of VSP Version 1.00, completely define an architecture for interoperability for extremely low bandwidth systems. Such extremely low bandwidth applications will be defined in future VSP document releases.

3.2.2.4.3.2 Video Teleconference

Video Teleconference Systems (systems used for "face to face" meetings between remote locations). When video teleconference systems are used as alternate Video Intelligence data dissemination systems then the requirements and provisions of Video Intelligence systems apply. Video Teleconferencing standards are addressed in the JTA (Section 2.3).

3.2.2.4.3.3 Video Telemedicine

Video Telemedicine (systems used in support of biomedical applications only).

3.2.2.4.3.4 Video Support

Video Support (traditional studio and or field video production, not associated with theater and or deployed DoD/IC Operations and Exercises). Video Support includes traditional activities such as preparation and dissemination of video based training; feature presentations or news gathering (unless part of ISR activities); AFRTS operations; or other CONUS only, non-critical functions that will not be mobilized for war fighting or contingency operations support.

3.2.2.5 Distributed Computing Services

Section 2 of the UTA discusses a reference model which is based on distributed object computing. More specifically, it is based on OMG's Common Object Request Broker Architecture (CORBA).

CORBA is a common object request broker architecture based on the Object Management Architecture use of object technologies. The object services associated with CORBA 2.0 and 2.1 are commonly referred to as CORBAServices. They currently include Naming Service, Event Service, Life Cycle Service, Persistent Object Service, Transaction Service, Concurrency Control Service, Relationship Service, Externalization Service, Query Service, Licensing Service, Property Service, Time Service, and Security Service. The entire specification for the 13 services [CORBA97c] can be obtained at <http://www.omg.org/corba/sectrans.htm>.

3.2.2.6 Information Modeling and Information Standards

USIGS developers will refer to the JTA for this service area. See [JTA97] Section 2.4.2.2 as it describes applicable DoD Data Standardization Procedures (DoD Manual 8320.1-M-1). However, there are two USIGS additions to the standards in the JTA: Geopolitical country codes and the USIGS data model. These are discussed in the subsections that follow.

3.2.2.6.1 Geopolitical Country Codes - FIPS PUB 10-4

This publication directs the data element and representation codes for the interchange of information among Federal departments and independent agencies identifying countries, dependencies, areas of special sovereignty, and their principal administrative divisions. This standard is intended for applications involving the interchange of international data associated with the mission of the Department of State and national defense programs.

The Secretary of Commerce is the approving authority and the currency of the geographic names were from an approved list maintained by the United States Board on Geographic Names (BGN) under Public Law 80-242.

The standard provides a list of basic geopolitical entities in the world, together with the principal administrative divisions that comprise each entity. The basic geopolitical entities are represented by two-character codes (primarily alphabetic) with each primary administrative division identified by an additional two-character code (primarily numeric).

Note that tables for the two-character codes for Geopolitical Country Codes are available for download by developers via the WWW on the DISA SHADE homepage, URL: <http://diides.ncr.disa.mil/shade.html>.

3.2.2.6.2 USIGS Data Model

DoD Directive 8320.1 directs DoD agencies to standardize data elements and established the DDDS (Defense Data Dictionary System). Data element submission and acceptance to the DDDS requires that the candidates be modeled. NIMA is committed to a seamless integration of all of its imagery and geospatial holdings. The United States Imagery and Geospatial Information Data Model (USIGS/DM) defines support data for use throughout the USIGS Community. In addition, the Imagery View describes a conceptual framework that links imagery and geospatial information within the context of the DoD Data Model (DDM). As such, it is a significant step in meeting NIMA's overall mission to seamlessly integrate imagery and mapping information for DoD.

The USIGS Data Model will:

- Document customer requirements
- Map a consistent approach to representing and storing information.
- Define a framework for cataloguing and sharing geospatial data.

- Identify the data requirements for new system procurements.
- Provide the blueprint for effective and secure use of NIMA's resources.
- Define that portion of the DoD Enterprise Data Model concerning geospatial and imagery data

The data model also provides DoD with an inclusive concept of dataset metadata -- the data about data. The DoD Data Model has focused on individual elements of data -- roads, budgets, missions, facilities, ships and thousands of other objects of interest to the Defense community. Different views (e.g., Imagery View) describes the full context of dataset identification, fitness for use, process, lineage and security. NIMA will be the first organization to present dataset metadata for DoD standardization.

The USIGS data model is under control of the NIMA Configuration Control Board (RFC NO1-0002 established the initial USIGS data model baseline). However, the modeling effort is a continual process. The latest status and project information can be found on the NIMA website (URL: <http://www.nima.mil/org/sc/seid/usigs.html>).

3.2.2.7 Human-Computer Interfaces

USIGS developers will refer to the JTA for this service area. See [JTA97] Section 2.5. The following paragraph profiles MIL-STD-2525A for USIGS.

3.2.2.7.1 Common Warfighting Symbolology - MIL-STD-2525A

MIL-STD-2525A is the standard symbol set for all future DoD C4I for the Warrior symbolology applications. The symbols must be compliant with the National Imagery Transmission Format Standards (NITFS) Computer Graphic Metafile (CGM) implementation.

3.3 USIGS Conventions

Interoperability cannot be achieved by the implementation of standards alone. It is necessary to augment the selected standards profile with USIGS-wide conventions for processes and procedures. Therefore, a convention is a non-standardized but binding specification of practices typically used to maximize interoperability. This subsection defines an initial set of conventions for the USIGS. Candidate conventions are contained in Subsection 4.3. Conventions will continue to evolve as the USIGS is implemented. The only conventions currently identified and discussed in this section are:

- *Server, Directory, and File Name* - To enable interoperability, it is necessary that files be named using a consistent format and with specific rules for the contents of file name.
- *Video Recommended Practices*

3.3.1 Naming Conventions

Naming conventions in the USIGS are necessary in order to ensure interoperability and aid in the discovery and retrieval of information within the USIGS. Naming conventions for the USIGS are based upon those of the Intelink.

3.3.1.1 Server Names

Server names within the USIGS must be easily identifiable and accessible. Therefore, the names of servers are tentatively proposed (this proposal is TBR) to be in the form:

server type.site id.network id.domain name

server type is a recognized server type within the USIGS. As the USIGS architecture evolves, additional servers will be specified. Examples include the Image Product Libraries (IPLs), the Command Image Libraries (CILs), and National Image Library (NIL). The convention should be expanded to also include softcopy exploitation work group servers and others developed and implemented within USIGS.

site id is a an identifier that is unique to each site at which a USIGS server is to be found.

network-id is an identifier for specific wide area and local area networks.

domain name is an organizational designation . The *site id*, *network id*, and *domain name* conventions are centrally managed for the SCI classified networks (INTELNET). The process for assigning these identifiers are contained in the *Communications Systems Architecture for the INTELNET*, dated 22 April 1997, and identifiers are registered and assigned through the Network Information Center (InterNIC).

An example notation of the IPL at Building 213 of NIMA could be represented as:

IPL.B213.nima.ic.gov

3.3.1.2 Directory and File Names

Conventions for directory and file naming are stipulated in the DII COE Integration and Run Time Specification (I&RTS) [I&RTS97]. The I&RTS describes the disk directory structure for application software developed and implemented to comply with the segmentation guidelines of the document. The disk directory structure is described in I&RTS Section 5.2. Additionally, I&RTS also contains data store/file standards and guidance for physical storage of databases and data objects in Section 4.3.

3.3.2 Video Recommended Practices

Recently the ISMC/GSMC approved the *USIGS Video Standards Profile* [Video97a] for use and implementation within USIGS. Section 2 of that document contains a number of

recommended practices necessary for seamless implementation of video within the USIGS architecture.

3.4 USIGS Guidelines

USIGS Guidelines provide the final part of the framework to facilitate the successful implementation of the USIGS. Guidelines are not requirements for implementation, but rather constitute "recommended practices" among members of the USIGS community. Whenever possible, USIGS Guidelines will be aligned with the guidelines from larger communities, to which the USIGS belongs.

3.4.1 Use of Legacy Standards

In conjunction with the DoD Joint Technical Architecture, this document specifies the mandatory standards necessary to ensure interoperability and to provide economic benefits in software development. For completeness, many legacy standards must be used until systems or segments migrate to those specified here and in the JTA. The intent here is not to identify all legacy standards implemented within USIGS, but only those that are more visible or used in environments external to USIGS. For example, GIF and TIFF are common graphics and imagery formats, and may still be used for Internet/Intelink browsing.

3.4.1.1 Graphics Interchange Format (GIF)

GIF was developed by CompuServe to provide a compressed image format for platform-independent raster graphics interchange. A GIF image's pixels are stored sequentially from top left to bottom right and the image is compressed with the LZW algorithm.

GIF files can also hold multiple, sequentially-stored images. Although it is not suitable for transmitting large or high-resolution imagery, it is used for the transmission of small- to medium-sized images. It is often used to embed images in HTML, SGML, or DSSSL documents.

In the past, GIF was regarded as a de facto standard for the exchange of 8- or 16-bit per pixel imagery. CompuServe Inc. had provided royalty-free limited-use license to users. The LZW compression algorithm is patented by IBM and Unisys Corporation, however, and Unisys has decided to exercise its patent rights. CompuServe has responded with a proposal for a new format to replace GIF, the PNG format.

3.4.1.2 PostScript (PS)

PostScript is an interpreted language that converts formatted text files with embedded vector and raster graphics into a format suitable for printing. It has powerful built-in graphics primitives, a page-description language, raster output device (displays and printers) control system, and, in some cases, an interchange format. PostScript Level 2

introduced several new features, including dictionaries, memory management, images, resources, filters, binary encoding, user paths, forms, color spaces, and patterns.

PostScript is an Adobe Systems Inc. proprietary standard. It is essentially the de facto standard for controlling raster output devices, especially printers. Recent PostScript driver performance improvements may improve market penetration.

3.4.1.3 Tagged Image File Format (TIFF)

TIFF is an image description, storage and transmission format. Typically, the images that are included in a TIFF file are from scanners, frame grabbers, paint programs, and photo-retouching programs, among others. It is feature rich, yet relatively easy to use, due to the small number of required fields, but the large number of optional fields can cause interoperability problems. TIFF is capable of describing bi-level, greyscale, palette-color and full-color image data. It uses a variety of compression methods ranging from simple run length encoding to JPEG compression. It is also both device independent and portable.

3.4.1.4 Tape Format Requirements Document (TFRD)

TFRD is a classified configuration-controlled legacy document that defines all aspects of media-based imagery dissemination formats. TFRD addresses the physical tape cassette, use of headers and catalogs, the format of the imagery files, and references underlying bandwidth compression algorithms. TFRD applies to the formats transmitted on digital tape cassettes and the formats employed to transfer the data electronically. The compression schemes identified include the two-dimensional Differential Pulse code Modulation (DPCM) and Discrete Cosine Transform (DCT) used for intelligence and mapping communities.

3.4.2 USIGS Product Specifications and Standards

Table 3-3 presents a collection of NIMA product specifications and standards used to document the format and content of NIMA generated products intended for both hardcopy generation or for digital media replication such as CD ROM, tape formats and also physical database formats. These product specifications can be used as human interface guidelines for the display of specific types of information. The standards should not be interpreted for the format and content standards because many do not currently reflect the selected standards in the preceding paragraphs of this document. Also listed below are draft specifications and standards under development and are provided for information purposes only. Summaries for many of these publications can be found on the NIMA home page (URL: <http://164.214.2.59/publications/specs/index.html>)

Table notation:

AC NIMA Aerospace Center
AF Air Force

AFMC Air Force Materiel Command
NV Navy
TI NIMA Technology & Information Directorate
SC NIMA Systems Center

**CLASSIFIED unavailable thru TeleSpecs

Table 3-3. Product Specifications

Document#	Title	Preparing Activity	Document Date
MIL-A-89007	Arc Digital Raster Graphic (ADRG)	AC	22-Feb-90
MIL-D-89009	Digital Chart of the World (DCW)	SC	13-Apr-92
MIL-D-89010	Digital Bathymetric Data Base (DBDB) 5 minute	SC	4-Mar-94
MIL-D-89011	Digital Cities Data Base (DCDB)	SC	2-Jul-90
MIL-W-89012	World Vector Shoreline (WVS)	TI	27-Jul-90
MIL-R-89013	Relocatable Target Assessment Data (RTAD)**	SC	13-Apr-90
MIL-I-89014A	Interim Terrain Data/Planning Interim Terrain Data (ITD/PITD)	TI	1-Jun-94
MIL-F-89018	Firefinder Elevation Data (FFED)	AC	1-Oct-92
MIL-PRF-89020	Digital Terrain Elevation Data (DTED)	AC	19-Apr-96
MIL-D-89021	Digital Landmass Blanking (DLMB)	TI	15-Jun-91
MIL-D-89029	Digital Bathymetric Data Base (DBDB 0.1' & 0.5')	NV	27-Jan-95
MIL-V-89033	Vector Smart Map Level 1 (VMAP1)	SC	1-Jun-95
MIL-C-89038	Compressed ADRG (CADRG)	AFMC	6-Oct-94
MIL-V-89039	Vector Smart Map Level 0 (VMAP0)	PR	9-Feb-95
MIL-PRF-89040	Vector Product Interim Terrain Data (VITD)	AT	8-May-95
MIL-C-89041	Controlled Image Base (CIB)	AF	15-May-95
MIL-J-89100 (DMA)	Joint Operations Graphic A/G	AT	28-Feb-95
MIL-T-89101 (DMA)	Tactical Pilotage Chart (TPC)	AT	31-Jan-95
MIL-O-89102 (DMA)	Operational Navigation Chart (ONC)	AT	31-Jan-95
MIL-G-89103	Gridded Installation Photomap (GIP)	AC	6-May-94
MIL-G-89106	Gridded Airfield Photomap (GAP)	AC	6-May-94
MIL-B-89200	Bathymetric Navigation Planning Chart (BNPC)**	AT	21-Apr-90
MIL-H-89201A (DMA)	Harbor, Approach and Coastal (HAC)	AT	29-Apr-95
MIL-H-89201/1	Harbor, Approach and Coastal (HAC) 1	AT	29-Apr-95

Document#	Title	Preparing Activity	Document Date
MIL-H-89201/2	Harbor, Approach and Coastal (HAC) 2	AT	29-Apr-95
MIL-H-89201/3	Harbor, Approach and Coastal (HAC) 3	AT	29-Apr-95
MIL-H-89201/4	Harbor, Approach and Coastal (HAC) 4	AT	29-Apr-95
MIL-H-89201/5	Harbor, Approach and Coastal (HAC) 5	AT	29-Apr-95
MIL-H-89201/6	Harbor, Approach and Coastal (HAC) 6	AT	29-Apr-95
MIL-H-89201/7	Harbor, Approach and Coastal (HAC) 7	AT	29-Apr-95
MIL-H-89201/8	Harbor, Approach and Coastal (HAC) 8	AT	29-Apr-95
MIL-H-89201/9	Harbor, Approach and Coastal (HAC) 9	AT	29-Apr-95
MIL-C-89202A (DMA)	Combat Chart	AT	29-Apr-95
MIL-V-89300	Video Disc	TI	22-Feb-91
MIL-T-89301A (DMA)	1:50 Topographic Line Map(1:50 TLM)	AT	28-Feb-95
MIL-C-89303	City Graphics	TI	30-Nov-90
MIL-T-89304	Tactical Terrain Analysis Data Base (TTADB)	TI	30-Nov-90
MIL-P-89305A (DMA)	Planning Terrain Analysis Data Base (PTADB) 2nd Ed	TI	1-Jul-94
MIL-T-89306 (DMA)	Topographic Line Map 1:100K	AT	28-Feb-95
MIL-A-89400 (DMA)	Air target Chart, Series 200	AT	31-Jan-95
MIL-J-89401 (DMA)	Joint Operations Graphic-Radar (JOG-R)	AT	31-Jan-95
MIL-N-89404	Non-SIOP Option	AC	15-Aug-90
MIL-P-89406	Point Positioning Data Base (PPDB)**	SC	28-May-93
MIL-V-89408	Video Point Positioning Data Base (VPPDB)**	SC	30-Jul-91
MIL-W-89500	World Magnetic Model (WMM)	SC	18-Jun-93

4. Candidate Standards, Conventions, and Guidelines

4.1 Introduction

This section identifies candidate standards, conventions, and guidelines for USIGS. Each candidate will satisfy one of two criteria: (1) a standard, convention, or guideline that may be proposed for, but is not yet included in, the appropriate USIGS profile or (2) a standard, convention, or guideline that may be proposed as a direct replacement for one that has previously been included in the appropriate USIGS profile.

4.2 Candidate Standards

Standards are based on services. A service may have multiple candidate standards and profiles of standards associated with it. In some cases, multiple candidates will indicate that there is a choice to be made; however, this is not always the case. It is quite often the case that multiple standards must be implemented to satisfy the requirements of a service.

Consistent with the Secretary of Defense's direction, NIMA expects to take advantage of the standards currently being developed using a consortium-based methodology. Further, USIGS may also benefit from a trend to standardize the interfaces to ISO IDL allowing for a more seamless API supported by object-oriented technologies.

The following paragraphs provide descriptions of the standards, profiles, and technologies designated as candidates for inclusion in the USIGS Standards Profile. In some cases, such as BIIF and JPEG 2000, it is obvious which standards presented earlier in Section 3 may be replaced. Other candidates may indicate the latter stages in the maturation of a standard or specification, especially those in the geospatial domain. Still others may be needed to deliver and develop the services identified in Sections 2 and 3.

4.2.1 Basic Imagery and Mapping Annotation Graphics (BIMA)

The Computer Graphics Metafile (CGM) provides a file format suitable for the storage and retrieval of picture information. The file format consists of a set of elements that can be used to describe pictures in a way that is compatible between systems of different architectures and devices of differing capabilities and design.

The BIMA profile, which will be described in an ISP (ISO/IEC xxxxx), defines a subset of CGM elements, sets limits and generation and interpretation behavior according to the rules for profile definition defined in ISO/IEC 8632. The BIMA profile defines a Version 1 CGM suitable for use in annotation of digital imagery such as that defined by BIIF DIS/IEC 12087-5: 1997.

Information on BIMA is available from the NITFS Technical Board's website colocated on the ISMC/GSMC home page (<http://www.ismc.itsi.disa.mil/ntb/ntb.html>).

peripheral (monitor, printer) limitations. Third party application developers may purchase licensing and a Software Development Kit through Kodak.

4.2.5 JPEG 2000

JPEG 2000 is the title given to the follow-on to the currently defined JPEG standard, but which will most likely be a wavelet based solution. A key feature of this compression is that it will be based on a "modular" architecture framework. This facilitates insertion of new technologies in the future, provides for flexibility, and facilitates the potential to "swap" modules based on compression requirements (quality, rate, etc.) of individual users.

There is currently a "Call for Contributions" process, "whose goal is to: gather algorithms, components of algorithms, and architectural frameworks; and to organize algorithm components into a single architecturally based standard. An architecturally based standard has the potential of allowing the JPEG 2000 standard to evolve and integrate new algorithm components without requiring a new standards definition." Once all contributions are evaluated based on an available set of criteria, actual technical development of the standard begins.

A few additional requirements of this new algorithm include: Improved performance (greater compression rates); Improved image quality flexibility to support different types of imagery (visible, IR, Multicomponent, etc.); ability to support tiling, and very small and large sized imagery. The current schedule of activities for JPEG 2000 is provided below:

- | | |
|--|----------------|
| • Submission of algorithm contributions | September 1997 |
| • Submission of architecture contributions | October 1997 |
| • Second experimental results and convergence | March 1998 |
| • Working Draft to Committee Draft (CD) | July 1998 |
| • CD to final CD | March 1999 |
| • Submit CD for Draft International Standard (DIS) | November 1999 |
| • DIS submitted for International Standard | March 2000 |
| • International Standard | November 2000 |

Profile development of the JPEG 2000 standard could potentially begin once it is accepted as a Draft International Standard (DIS). As details of the document are available, and schedules are clearly defined, this strategic plan will provide information regarding implementation into the NITFS/BIIF suite of standards.

4.2.6 Unified Modeling Language

The Unified Modeling Language (UML) is a language for specifying, constructing, visualizing, and documenting the artifacts of a software-intensive system.

The Unified Modeling Language fuses the concepts of Booch's object-oriented design method, Rumbaugh's Object Modeling Technique (OMT), and Jacobson's Object-Oriented Software Engineering (OOSE). The result is a single, common, and widely usable modeling language for users of these and other methods. In particular, the UML contains elements that address the modeling of concurrent, distributed systems. UML focuses on a standard modeling language, not a standard process.

UML has been adopted by OMG, and is rapidly gaining acceptance by the CASE tool vendor community.

4.3 *Candidate Conventions*

No candidate conventions for USIGS are currently identified.

4.4 *Candidate Guidelines*

No candidate guidelines for USIGS are currently identified.

5. Emerging Technology Standards

This section describes and discusses a variety of emerging standards and technologies expected to result in new standards that have a significant affect on the Geospatial Information System (GIS) environment. This section is not intended to be a comprehensive analysis of technology trends in general.

Technologies addressed in this section are:

- Distributed Processing
- GIS Componentware (Geospatial Exchange Technologies)
- Collaborative Computing
- Security in a distributed multi-domain environment

Each of these will be discussed relative to their status at the time that this document was completed, expectations for the near future, and their specific affects on the GIS environment, in general, and the USIGS, in particular.

5.1 Distributed Processing

At the time of this writing there existed four predominant technologies for implementing distributed processing, one of which is oriented toward procedural distributed processing (but which supports distributed object computing, or DOC) and three that are oriented toward DOC. All are discussed in the following paragraphs.

5.1.1 Distributed Procedural Computing

Distributed procedural computing is predominantly accomplished using the Open Group defined Distributed Computing Environment (DCE). It is important in the context of this discussion because DCE services are often used with an object-oriented "wrapper" as a quick way to provide CORBA services. In particular the Domain Name Service (DNS) and the Security Service (based on Kerberos) are often used by CORBA vendors to provide a quick solution, while taking more time to develop "pure CORBA" implementations. The DCE Transaction Service is also sometimes used in CORBA service implementations.

Also important to note is that the Microsoft Distributed Common Object Model (DCOM) protocol (see 5.1.2.1 below) is based on the DCE Remote Procedure Call (RPC) and that this same RPC is an allowable, but not recommended, wire protocol in CORBA implementations.

5.1.2 Distributed Object Computing (DOC)

5.1.2.1 Microsoft ActiveX

Microsoft ActiveX contains within it a wire protocol for distributed processing known as the Distributed Computing Object Model (DCOM). This particular protocol is an extension of the DCE RFC that is intended to allow for distributed processing using the Common Object Model (COM) supported by Microsoft. This particular protocol is quite acceptable for a small closed environment distributed processing capability, but has several serious liabilities when used in a Wide Area Network (WAN), particularly with respect to security. Thus, beyond limited use in a workgroup environment, it is not particularly suited to use within the USIGS (NOTE: This does not mean that other elements of ActiveX should not be used.).

It is known, however, that Microsoft is working on a replacement for the DCOM that is expected to be available for use in 1998 or 1999. It is too early, however, to speculate on its form and functions.

With respect to the DCOM effect on the standards environment, a specification for DCOM was submitted by Microsoft as an informational Request for Comment (RFC) to the Internet Engineering Task Force (IETF) in 1996. This type of RFC has a six month lifetime, after which it is no longer available as an IETF document. Microsoft has allowed the RFC to expire and had not superseded it with any other specification by the time of this writing.

5.1.2.2 OMG Common Object Request Broker Architecture (CORBA)

The Object Management Group (OMG), a consortium of nearly 800 members (including Microsoft and Sun), has been developing the specifications for CORBA and its environment since 1989. The OMG has recently been approved as a Publicly Available Specification (PAS) submitter by the International Organization for Standardization (ISO)/International Electronics Commission (IEC) Joint Technical Committee 1 (JTC1). This allows the OMG to submit specifications directly to JTC1 and its subcommittees, without going through any national body and without being edited by any subcommittee or working group of the JTC1. By being submitted as a PAS, a specification will take on a status equivalent to a Draft International Standard (DIS) and may be balloted by any JTC1 subcommittee. If such a specification completes balloting successfully, it will become an International Standard (IS).

The OMG is considering its options, but it appears that the first OMG specification to be submitted to the JTC1 will be the subset of the CORBA version 2.1 specification (OMG document formal/97-09-01: CORBA/IIOP 2.1 Specification) [CORBA97d] that defines the Internet Inter-Orb Protocol (IIOP). IIOP is the protocol that allows Object Request Brokers (ORBs) to interoperate.

IIOP was initially designed to provide interoperability between ORBs by passing object references between the ORBs. This enabled a client application to invoke objects on a server rather than on the client. The IIOP specification is being augmented with a "pass-by-value" capability that will allow for the transfer of objects between ORBs, alleviating several problems including easing the communications load associated with the transfer of collections of fine-grained objects. It is also expected that client-side garbage collection will be added to the IIOP specification in 1998. Other refinements (Table 5-1) can be expected over time, but it is unlikely that there will be other revisions in the near future.

A subset of the CORBA version 2.0 specification [CORBA97a] has already reached the IS status, the Interface Definition Language (IDL). In ISO, it is known as the Reference Model - Open Distributed Processing (RM-ODP) IDL (ISO/IEC IS 14750). RM-ODP IDL is syntactically and semantically identical to CORBA IDL, although the documents themselves differ slightly.

Table 5-1. Enhancements to the CORBA Specification

CORBA Enhancement	Status
Java Language Mapping (from IDL)	Completed in early 1997 and included in CORBA version 2.1 specification.
Messaging (asynchronous)	Expected completion in late 1997 or early 1998.
Minimum CORBA	Expected completion in mid-1998.
Java to IDL Mapping	Expected completion in late 1997 or early 1998.
DCE/CORBA Internetworking	Expected completion in mid-1998.
Multiple Interfaces and Composition	Expected completion in late 1997 or early 1998.
COM/CORBA Internetworking, Part A	Completed and available as OMG document orb/96-01-05: COM/CORBA Part A. Revisions are expected in late 1997 or early 1998.
COM/CORBA Internetworking, Part B	Expected completion in late 1997.

The CORBA environment includes both CORBAServices [CORBA97c] and CORBAfacilities [CORBA97b] at the time of this writing (the components of each category are discussed in this document in Sections 2.2.4 and 2.2.3, respectively). There have been 14 CORBAServices specified (Table 5-2) and one other (Collection Service) identified but not defined, but at the time of this writing, only a few were available as products from CORBA vendors and several were being reconsidered by OMG. Specifically, the Naming, Event, Transaction, Trader, and Security services were

available as products from most, if not all, of the ORB vendors and the Persistence Service specification was in the process of being replaced by a more implementable specification with resulting products becoming available in the 1998-1999 timeframe. Others, such as the Security and Relationship Service specifications, are expected to be enhanced in the 1997-1998 timeframe with resulting products becoming available in the 1998-1999 timeframe. The longer term future should see refinement of the various service specifications, but there are no additional services envisioned as of the time of this writing.

Table 5-2. CORBAServices

CORBAService	Specification Status
Collection	Completed and available as OMG document os/96-02-04: Revised Collection Service Submission
Currency Control	Completed and available as OMG document formal/97-02-12: CORBAServices - Concurrency Service
Event	Completed and available as OMG document formal/97-02-09: CORBAServices - Event Management Service
Externalization	Completed and available as OMG document formal/97-02-13: CORBAServices - Externalization Service
Lifecycle	Completed and available as OMG document formal/97-02-11: CORBAServices - Lifecycle Service
Licensing	Completed and available as OMG document formal/97-02-17: CORBAServices - Licensing Service
Naming	Completed and available as OMG document formal/97-02-08: CORBAServices - Naming Service
Persistence	Completed and available as OMG document formal/97-02-10: CORBAServices - Persistent Object Service This service will be superseded in mid-1998 by the Persistent State Service, Version 2.0.
Properties	Completed and available as OMG document formal/97-02-18: CORBAServices - Property Service
Query	Completed and available as OMG document formal/97-02-16: CORBAServices - Query Service
Relationship	Completed and available as OMG document formal/97-02-14: CORBAServices - Relationships Service. This service is expected to be enhanced in 1998.
Security	Completed and available as OMG documents formal/97-02-20: CORBAServices - Security Service Part I and formal/97-02-21: CORBAServices - Security Service Part II.

CORBA service	Specification Status
	Augmentation of these specifications is expected in 1998 or 1999 to provide for greater levels of assurance.
Time	Completed and available as OMG document formal/97-02-22: CORBA services - Time Service
Trader	Completed and available as OMG document formal/97-05-01: CORBA services - Trader Service (NOTE: This is also the ISO RM-ODP Trader Function)
Transaction	Completed and available as OMG document formal/97-02-15: CORBA services - Transactions Service

CORBA facilities are a bit more problematic. There have been 12 common facilities (Table 5-3) planned to date and the expectation is that at least one more will be added in 1997.

Table 5-3. CORBA facilities

CORBA facility	Specification Status
Analysis and Design	Expected completion in late 1997. Unified Modeling Language Specification is available as OMG document ad/97-08-11: OA&D CORBA facility
Automation and Scripting	Scripting technology RFP has been issued (OMG document orbos/97-06-13: CORBA Scripting Language RFP) Adoption of technology is expected in early 1998.
Common Management	Completed and available as OMG documents formal/97-06-08: CORBA facilities - System Management Common Facilities and formal/97-06-09: CORBA facilities - Task Management Common Facilities formal/97-06-08: CORBA facilities - System Management Common Facilities is also to Open Group document X/Open G207: Systems Management: Reference Model
Compound Presentation and Interchange	Completed and available as OMG document 1995/95-12-30 This is effectively the specification for OpenDOC, and will be replaced by the CORBA Component Model which is the subject of an OMG RFP with the OMG document number of orbos/97-06-12. Technology adoption is expected in early 1998.
Common Business Object and Business Object Facility	Expected completion in late 1997.

CORBAfacility	Specification Status
Data Interchange	
Firewall	Technology RFP has been issued and adoption of a specification is expected in early 1998.
Image Compression	Not currently on the OMG roadmap. However, a draft RFP is in development and an adopted specification should be available by the end of 1998.
Information Storage and Retrieval	
Internationalization and Time Operation	Completed and available as OMG document cf/97-06-16
Meta-Object	Expected completion in late 1997.
Mobile Agents	Expected completion in late 1997.
Printing	Expected completion in late 1997.
Rendering Management	
Security Administration	
Workflow	Expected completion in early 1998.

OMG also has a number of Task Forces addressing specific information domains including electronic commerce, finance, manufacturing, medicine, telecommunications, and others. These Task Forces will adopt domain specific specifications for the CORBA environment.

5.1.2.3 Remote Method Invocation (RMI)

The third prominent distributed object capability is the Java Remote Method Invocation (RMI). The Sun Microsystems JavaSoft Division has defined the JavaSoft-proprietary RMI wire protocol to enable the interoperability between Java objects (applets). This protocol is meant for Java to Java interoperability only and is both more and less than CORBA IIOP. It is more than IIOP in that it includes client-side garbage collection. It is less than IIOP, because it lacks some of the functionality of IIOP and does not support languages other than Java. JavaSoft has stated an intention to continue the development of RMI to provide functionality found in IIOP and not in RMI, while OMG will be enhancing IIOP to include client-side garbage collection. JavaSoft will then include both in the Java Development Kit (JDK), with RMI to be used for Java-to-Java interoperability and IIOP to be used for Java-to-everything-else interoperability.

5.2 Geospatial Information System Componentware

The Open GIS Consortium (OGC) (for more information on the OGC, please see their WWW page at <http://www.opengis.org/>) is in the process of defining an object-based architecture for geospatial services and structures. This architecture is fundamentally the same as the USIGS OGE Services architecture, although there are some differences. The following paragraphs discuss those service categories and services that are in common to USIGS and the OGC. Table 5-4 identifies the priorities for interface development as defined for both USIGS (TBD) and OGC.

Table 5-4. OGC and USIGS Priorities and Dates

Service Category/Service	OGC Priority	Est. Spec. Date	USIGS Priority
Geospatial Domain Access Services	Very High		
Feature Generalization Services	Low		
Geospatial Information Extraction Services	Medium		
Geospatial Coordinate Transformation Services	Very High		
Geospatial Annotation Services	Very Low		
Image Manipulation Services/Simple Pixel Manipulation	Very High		
Image Manipulation Services/Geometric Pixel Manipulation	Medium		
Feature Manipulation Services/Feature Registration	Very High		
Feature Manipulation Services/Quality Control	High		
Feature Manipulation Services/Deconflict Features	Low		
Feature Manipulation Services/Data Edit	Low		
Feature Manipulation Services/Metadata Edit	Medium		
Image Exploitation Services	Very High		
Geospatial Analysis Services	High		
Image Geometry Model Services	High		
Geospatial Symbol Management Services	Very Low		
Image Map Generation Services	Medium		
Image Synthesis Services	Very Low		
Image Understanding Services	Very Low		
Geospatial Display Services	Low		

Throughout this subsection, there are figures that show the USIGS OGE Services that relate to the various OGC Service Architecture components. The intent is to illustrate the cooperation and dialog that has been developed between NIMA and the OGC in aligning

their architectures. At the time of this writing, this was an ongoing process, so both models are expected to progress with the highest possible level of commonality.

5.2.1 Geospatial Domain Access Services

Geospatial Domain Access Services (GDAS) defines a set of interfaces for locating and retrieving selected geospatial information for storage, deletion, or modification. Figure 5-1 illustrates the USIGS technical architecture elements related to the GDAS.

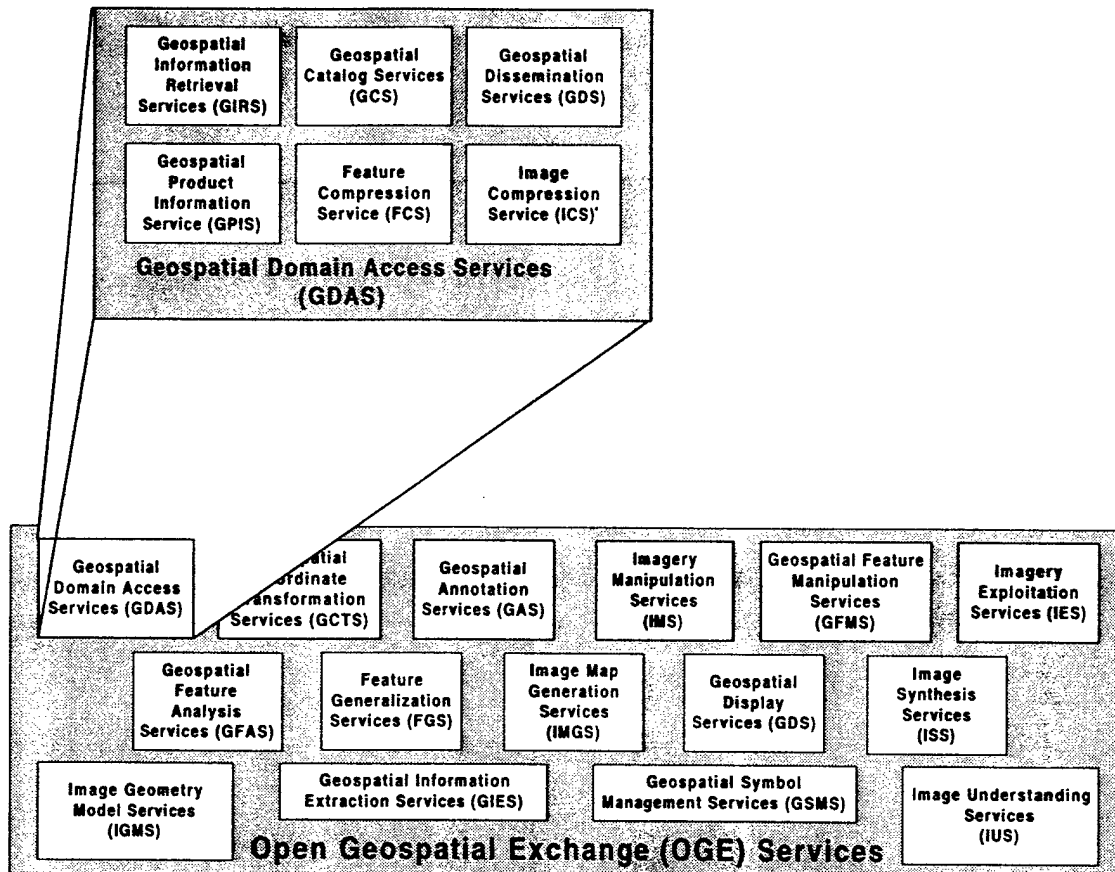


Figure 5-1. USIGS Geospatial Domain Access Services

5.2.1.1 Geospatial Information Retrieval Services

Geospatial Information Retrieval Services (GIRS) comprise four specific services required for retrieving selected geospatial information for the purposes of storage, deletion, modification, and/or display. It is intended primarily for client storage and retrieval of geospatially referenced information of all kinds to/from a library (data server) that may be remotely located relative to the client. The GIRS is provides for the following basic capabilities:

- Retrieval of selected geospatial information, including the capability to request dissemination to client and third-party clients. (Thus, this operation supports a form of push-mode transfer through a third-party request.) The retrieval process must support retrieval of features (including images and gridded information) that are contained within a boundary defined by a rectangle or ellipse. Thus, retrieval of portions of one or more images must be supported.
- Storage of geospatial information in a library
- Monitoring the status of submitted requests, for both storage and retrieval, and for canceling incomplete requests when desired
- Conversion of retrieved data from its current structure or format to a different structure or format, as in converting raster to vector, VPF to SDTS, etc.

5.2.1.2 Geospatial Product Information Service

The Geospatial Product Information Service (GPIS) provides for the retrieval and storage of whole products (predefined feature collections and metadata subsets) as a GIAS specialization interface and allows the client to retrieve some properties specifically associated with an object without going to the catalog. The GPIS Interface provides for robust references to arbitrary information products in a distributed environment through the use of library location information and file path names. Since the product reference is expected to contain all of the necessary information for retrieval, distributed processing can be handled transparently. The product references are specialized in the GPIS for use by libraries and include support for parameters.

5.2.1.3 Geospatial Catalog Services

The Geospatial Catalog Services (GCS) provide for a set of common software services to support both local and global geospatial information discovery, property (metadata) retrieval, geospatial information browsing, and geospatial information cataloging and indexing. Types of retrieval that are required include:

- Ordinary catalog search queries by accepting Boolean Query Syntax expressions as input and returning a set of query hits matching the expression.
- Polygonal query capability enabling ordinary catalog search queries by supplementing Boolean queries with the specification of a polygonal shape. Geospatial information that overlaps any portion of the polygon should satisfy the query if the product properties also satisfy the Boolean query expression.
- Elliptical query capability enabling Boolean catalog search queries combined with the specification of an elliptical shape. The ellipse should be defined by its center point, major and minor axes, and the azimuth rotation from North of

the major axis and returns geospatial information that provides coverage of any portion of the ellipse while satisfying the Boolean Query Syntax expression.

- Point query capability to supplement Boolean queries by specifying a geographic point. Image products returned by this query should combine the Boolean Query Syntax expression and coverage of the specified point.
- Get_More_Results capability to access invocations of the GCS operations unable to return entire sets of query hits in the allocated area for query results. A QueryId value is returned and used with the "get_more_results" operation to obtain the remaining query hits.
- Capability to inform the catalog server that the client does not intend to retrieve additional results from the list provided by the catalog, allowing the catalog server to free any resources allocated for the client's query results.
- Ability to add and remove catalog entries.

5.2.1.4 Geospatial Dissemination Services

Geospatial Dissemination Services (GDS) include the interfaces required to receive, prepare (i.e., reformat, compress, decompress, etc.), prioritize, and transmit geospatial products. They also include interfaces to support product distribution management and to enable dissemination of geospatial information to 3rd parties.

5.2.1.5 Feature Compression Service

The Feature Compression Service (FCS) provides for conversion of vector and gridded portions of a feature collection to and from compressed form.

5.2.1.6 Image Compression Service

The Image Compression Service (ICS) provides for conversion of an image to and from compressed form.

5.2.2 Feature Generalization Services

The Feature Generalization Services (FGS), shown in Figure 5-2, are a category of services that modify the characteristics of a feature collection to increase the effectiveness of communication by counteracting the undesirable effects of data reduction. These services include capabilities to:

- Select to display or extract only those features that match certain criteria
- Suppress the display or extraction of features that match certain criteria

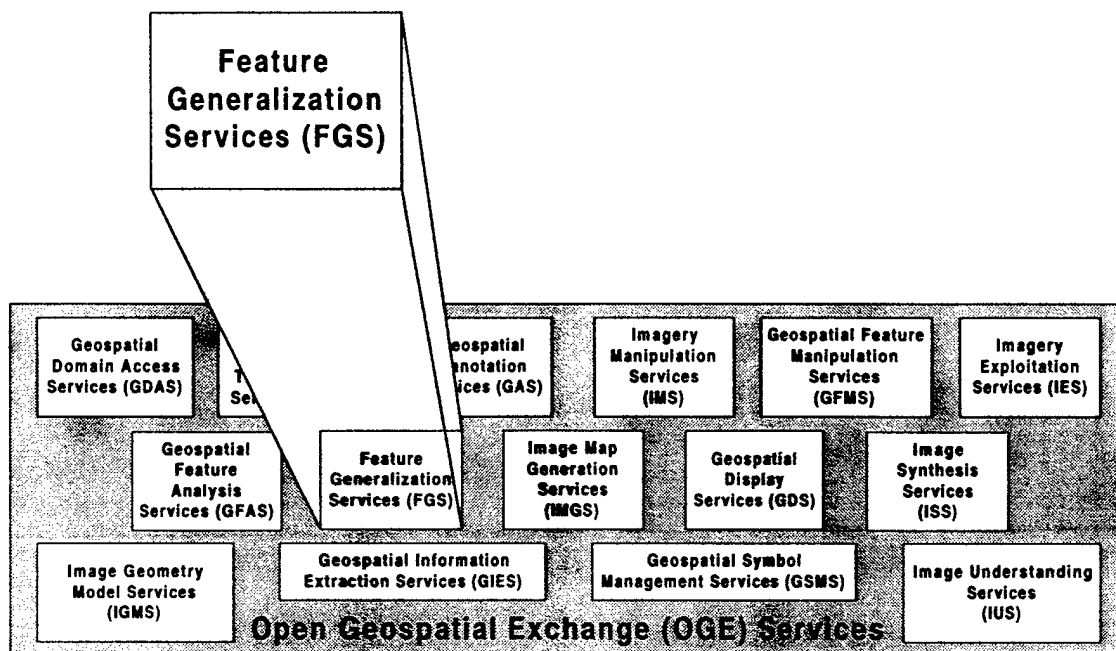


Figure 5-2. USIGS Feature Generalization Services

- Aggregate clusters of point features and create a smooth enclosed polygonal perimeter outline
- Replace the current representation of a feature with a larger, more detailed representation
- Reduce the sinuosity of line features or the perimeter of area features to avoid cluttering in a display window
- Reduce the number of features selected or displayed in a region to present a more pleasing representation of the region, based on a set of properties and/or criteria that are used as a prioritized filter
- Adjust the connectivity relationships of line segments in line, area, or volume features
- Classify features by assigning values to feature properties
- Replace any feature type with another feature type to adjust for changes in resolution of the Feature Collection (for example, replace an area feature with a point or line feature, or a volume feature with a point, line, or area feature, or the inverse of any of these.)
- Remove excessive variations in ridge/course line values to present a more pleasing representation of the ridge/course line skeleton

- Remove excessive variations in surface property values to present a more pleasing representation of the surface

5.2.3 Geospatial Information Extraction Services

Geospatial Information Extraction Services (GIES), shown in Figure 5-3, are a category of services that support the extraction of feature and terrain information from remotely sensed and scanned images. These services include capabilities to:

- ingest existing feature collections
- digitize and/or convert softcopy maps and charts to produce a feature collection
- create the geometry and associated feature collection from a subset of another feature collection (e.g., extracting portions of map files to a specified area of interest (AOI), creating a coverage subset of feature information from Feature Collections from databases, capturing textual (Line, Area) properties and metadata, etc.)
- create a duplicate copy of an existing feature, set of features, or Feature Collection for the purpose of modifying that data or including it in a different set of data

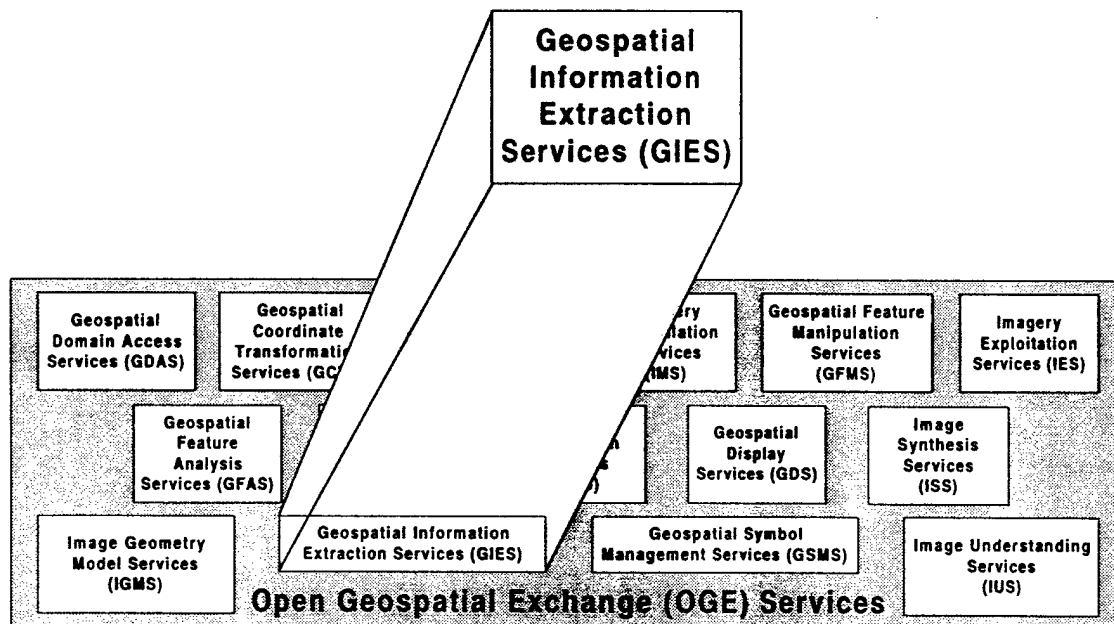


Figure 5-3. USGS Geospatial Information Extraction Services

5.2.4 Geospatial Coordinate Transformation Services

Geospatial Coordinate Transformation Services (GCTS), shown in Figure 5-4, comprise capabilities for converting geospatial coordinates from one reference system to another. This includes the ability to:

- adjust the features in a Feature Collection using one datum and register them to another Feature Collection using a different datum
- transform geographic coordinate values from one coordinate system to another
- perform a point location search from user-entered coordinates according to user-specified coordinate types (i.e., UTM, geographic coordinates and image coordinates)
- apply standard, custom, or computer generated grids over all imagery types

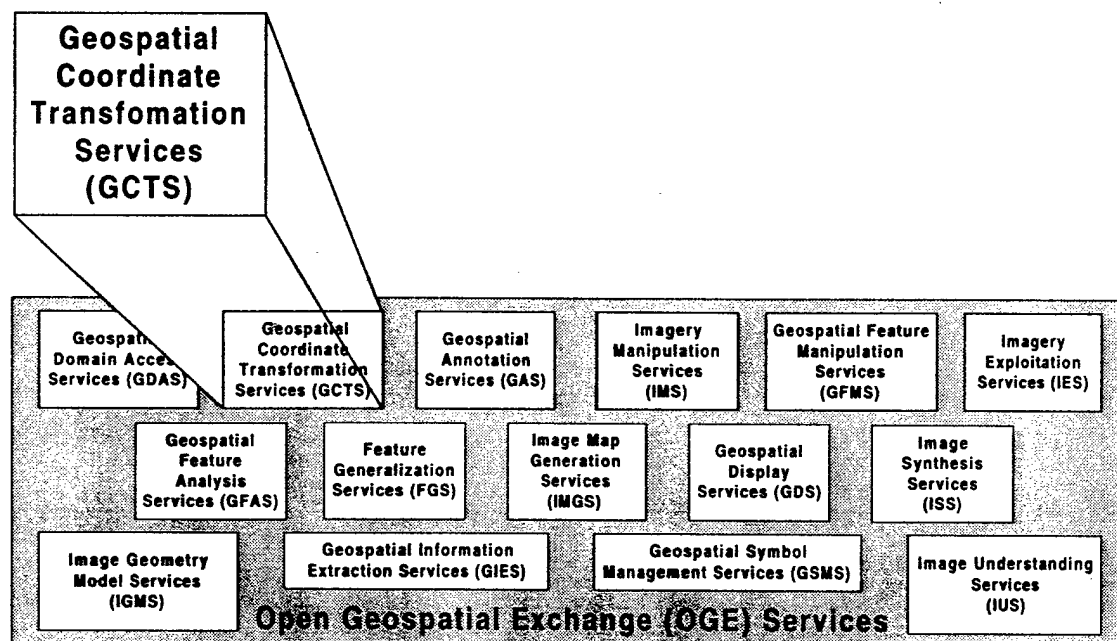


Figure 5-4. USIGS Geospatial Coordinate Transformation Services

5.2.5 Geospatial Annotation Services

Geospatial Annotation Services (GAS), shown in Figure 5-5, add ancillary information to an image or a feature in a Feature Collection (e.g., by way of a label, a hot link, or an entry of a property for a feature into a database) that augments or provides a more complete description. More specifically the Image Annotation Service (IAS) provides for standard interfaces to software tools that enable symbols, graphics, text, and other

media types to be overlaid upon, or attached to, images to highlight significant content. Capabilities of this service will include:

- Superimposition of annotations on an image allowing for the exhibition of the annotation overlay, the image itself, or both
- Selection of icons and other symbols from a standardized catalog for placement on an overlay
- Retention of an annotation elements' position relative to the underlying image regardless of the action or manipulation performed on the image
- Registration of annotations to user-specified points on the display of the image.

Similarly, the Feature Annotation Service (FAS) provides for the capability to add ancillary information to a feature in a Feature Collection (e.g., by way of a label, a hot link, or an entry of an attribute for a feature into a database) that augments or provides a more complete description of the feature.

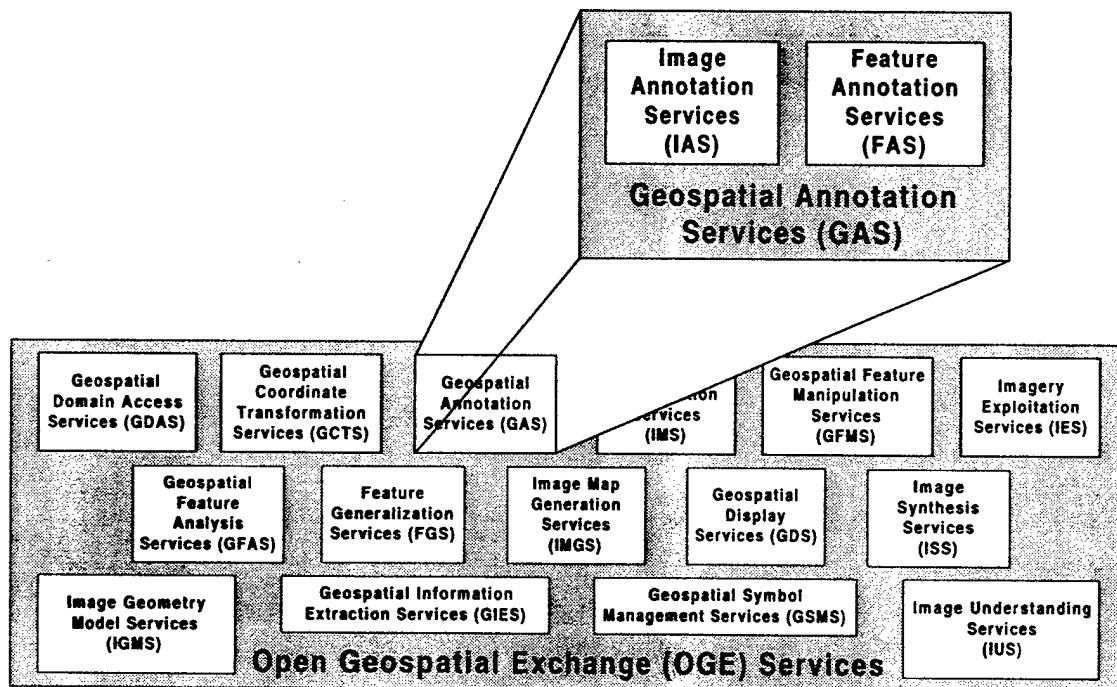


Figure 5-5. USIGS Geospatial Annotation Services

5.2.6 Image Manipulation Services

Image Manipulation Services (IMS), shown in Figure 5-6, provide for manipulating images (resizing, changing color and contrast values, applying various filters, manipulating image resolution, etc.) and for conducting mathematical analyses of image

characteristics (computing image histograms, convolutions, etc.) These services include services to:

- Provide image enhancements that increase the analyst's ability to distinguish between similar appearing areas of a scene
- Perform geometric operations that change the digital image geometry in a controlled way, so that objects in the resultant image are **displaced** from their original positions (Note: These are basic image geometry service(s) used by applications and other services, defined elsewhere in this section)
- Manage the manipulation and display of images including the ability to pan, zoom, rotate, and display image histogram characteristics, local pixel properties, and display lookup tables

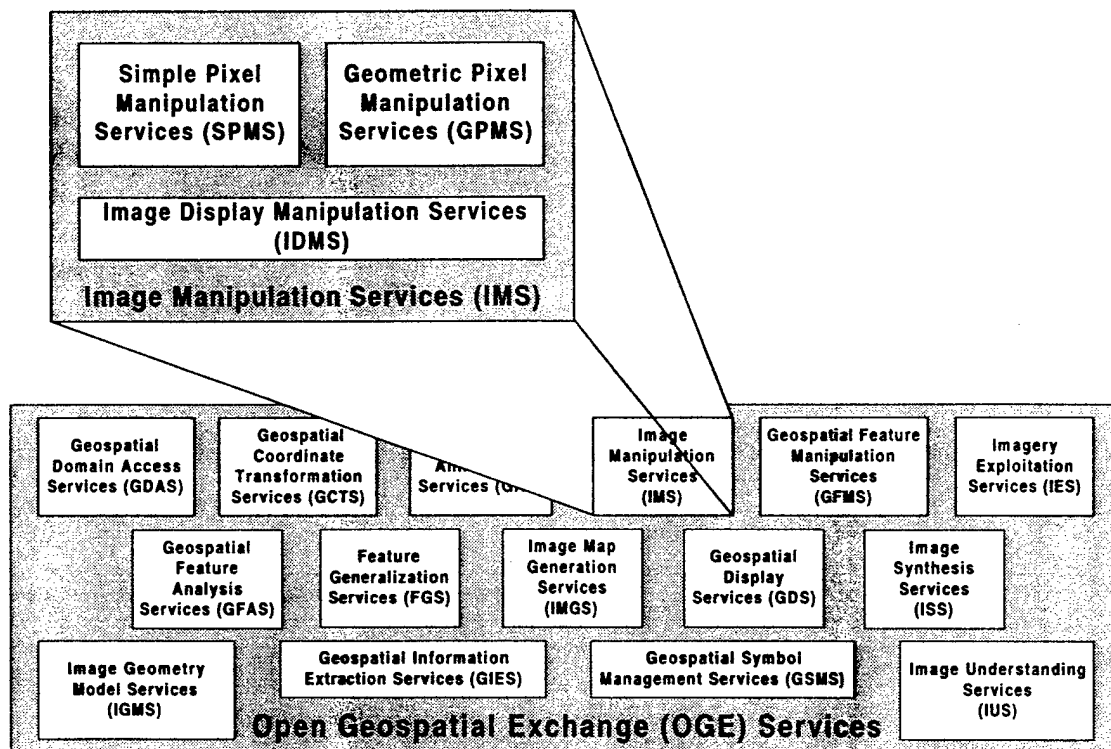


Figure 5-6. USGS Image Manipulation Services

5.2.7 Feature Manipulation Services

Feature Manipulation Services (FMS), shown in Figure 5-7, are a category of services that support creation, quality control methods, analysis, display, and generalization of feature collections of interest to an end user. They include capabilities to:

- Register one feature to another, an image, or another data set or coordinate set; correcting for relative translation shifts, rotational differences, scale differences, and perspective differences
- Examines the internal correctness and consistency of features and their properties as represented in a Feature Collection. This includes the ability to:
 - Adjust the locations of features that have portions of a whole feature separately represented in adjacent Feature Collections to ensure that the feature portions are properly aligned
 - Verify that all features in the Feature Collection are topologically consistent according to the topology rules of the Feature Collection, and identifies and/or corrects any inconsistencies that are discovered
 - Verify that all pixels or grid post values in a Coverage or Feature Collection are reasonable, identifies and/or corrects any inconsistencies that are discovered

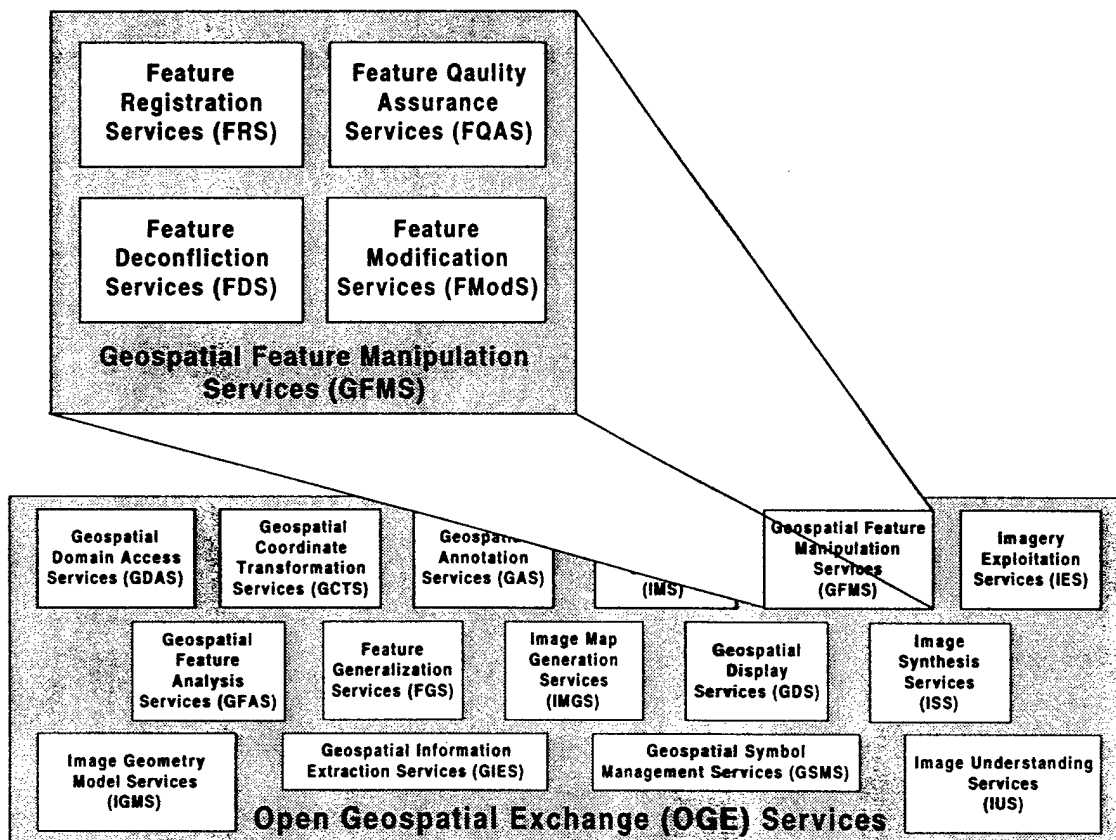


Figure 5-7. USIGS Geospatial Feature Manipulation Services

- Deconflict features by applying mediative measures to resolve conflicts in data integrity or representation between or among different Feature Collections that contain similar information for a given area
- Modify values of a feature
- Modify the values of metadata elements describing a feature

5.2.8 Image Exploitation Services

Image Exploitation Services (IES), shown in Figure 5-8, are required to support the photogrammetric analysis of remotely sensed and scanned imagery, the generation of reports with respect to the results of the analysis, and other products that ultimately reach policy and decision makers and other consumers of the results of photogrammetric analysis. These services measure the spatial characteristics of objects appearing within images, including geometric measurements from monoscopic and stereoscopic imagery, under a variety of acquisition conditions.

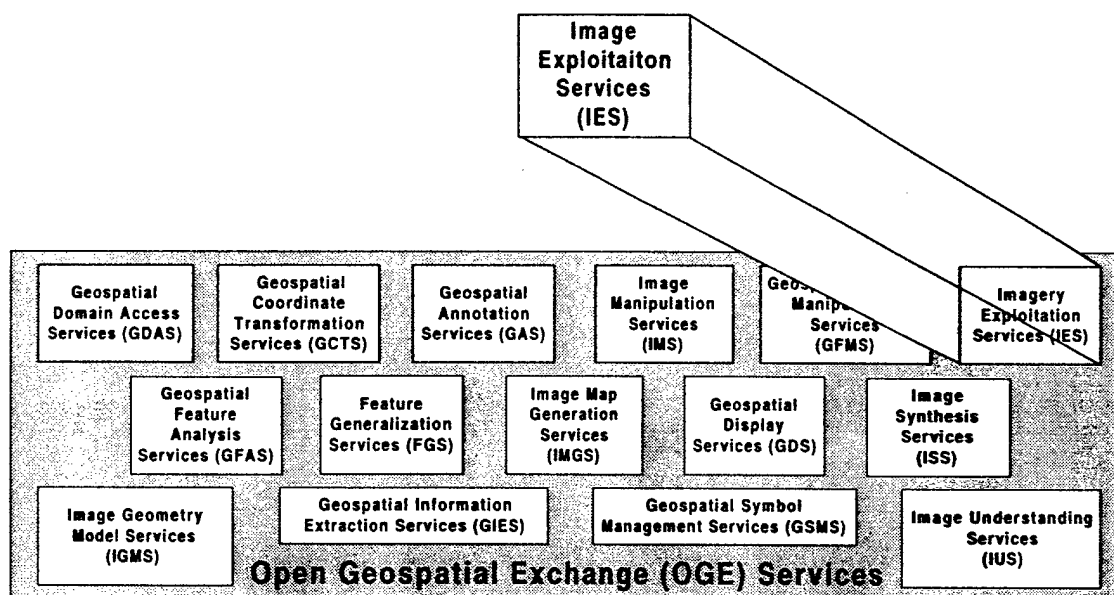


Figure 5-8. USGS Image Exploitation Services

5.2.9 Geospatial Analysis Services

Geospatial Analysis Services (GAS), shown in Figure 5-9, are a category of services that exploit information available in a Feature or Feature Collection to derive application-oriented quantitative results that are not available from the raw data itself. These services include, but are not limited to, the following capabilities:

- Buffering to create a proximity zone of a specified width around the geometry of a feature or set of features in a Feature Collection or Coverage
- Boolean operations to perform binary operations on two or more features or feature collections including, but not limited to:
 - Union operations to compare features from two or more Feature Collections and return non-redundant features that are found in either Feature Collection.
 - Intersection operations to compare features from two or more Feature Collections and return those features that those Feature Collections have in common.
 - Fusion operations to merge two or more features or Feature Collections into an aggregate feature or Feature Collection composed of the formerly distinctly separate parts.
 - Operations to compare two Feature Collections and return the differences between them.

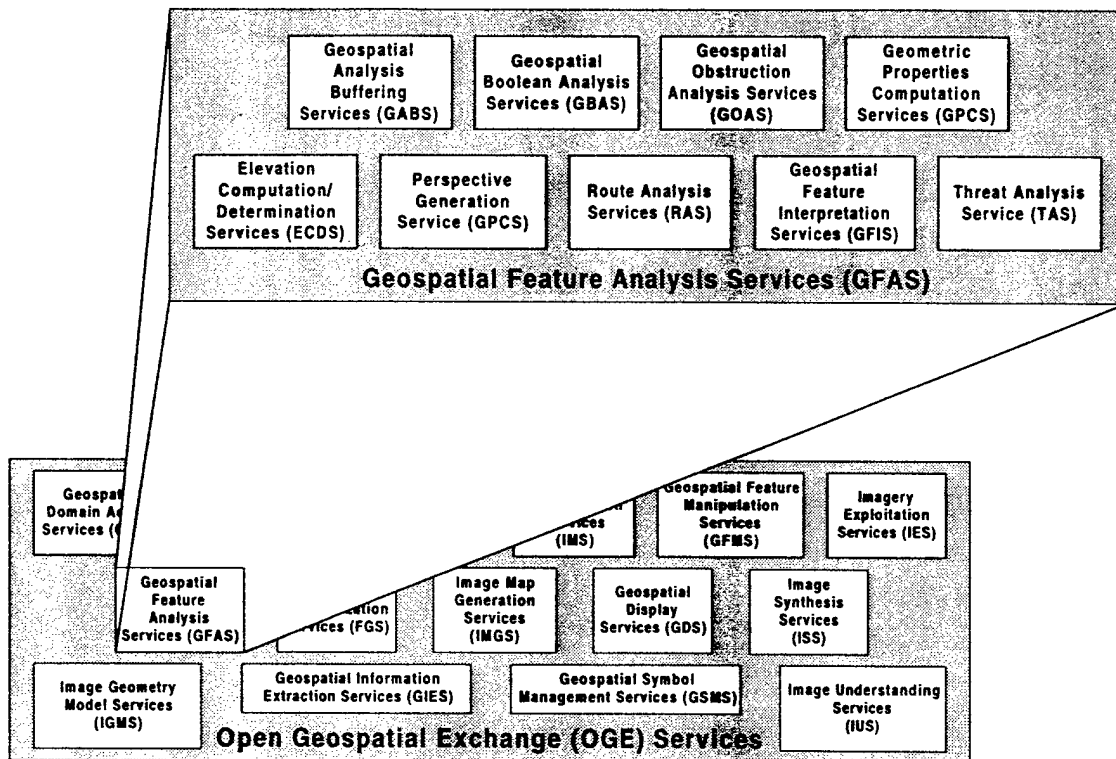


Figure 5-9. USIGS Feature Analysis Services

- Capability to determine if any features in the Feature Collection obstruct the path of a designated vehicle based on the properties of the features and those of the vehicle.
- Capability to compute non-stored geometric properties, including relative and absolute error, of a feature from the geometry including, but not limited to, capabilities to:
 - Determine the size of an area feature.
 - Determine the length of a line feature or a straight line connecting two different points of a feature
 - Determine the angular orientation of a feature, or a line connecting two different points or features, as measured from a standard vector (usually True North).
 - Determine the angular variation of a feature, or a line connecting two different points or features, as measured from a horizontal plane.
 - Transform feature geometry and/or attribute data values from one measurement system to their equivalent value representation in another measurement system.
- Computation services for exploiting elevation coverages and certain other coverages including, but not limited to, capabilities to:
 - Estimate the elevation of a specified point based on its position relative to a set of known elevation values.
 - Determine the average elevation of a Feature Collection based on grid post elevations as input.
 - Identify the highest and lowest property values of a surface in a Feature Collection
 - Create a terrain profile object derived from an elevation-based Feature Collection.
 - Create a set of lines of equivalent values based on the information available in the Feature Collection.
 - Determine the angle of ground slope from the horizontal at specified points.
 - Determine those ground areas visible and those areas that are hidden as viewed from a specified point.
 - Calculate whether a specified feature is visible from a specified observation point

- Convert surface representations between any pair of Grid/TIN/Contour elevation coverage types
- Capability to create a geospatial model of one or more related Feature Collections using visual cues to give the impression of depth as viewed from a specified angle.
- Capability to interpret feature properties
- Computation services for exploiting transportation routes recorded as a Feature Collection, such as determination of:
 - The optimal path between two specified points based on the desired input parameters and properties contained in the Feature Collection.
 - Additional paths, other than the optimal path, between two specified points based on the desired input parameters and properties contained in the Feature Collection.
 - The measured distance between two points along a specified path based on the properties supported in the Feature Collection.
 - The length of time it takes to follow a route through the geospatial data in the Feature Collection.
- Services for computing threats using geospatial data recorded as a feature collection, such as:
 - Synthesis of the results of all previously calculated threat fans to arrive at a composite area that is vulnerable to attack.
 - Determination of whether a specified feature is detectable from a specified observation point.
 - Determination of the perimeter of an area feature that is subject to attack based on the properties of a weapon at a known geographic position.
 - Specification of the threat parameters to be used to filter the information in the Feature Collection when performing a threat analysis.

5.2.10 Image Geometry Model Services

Image Geometry Model Services (IGMS), shown in Figure 5-10, are a category of services that support using mathematical models of image geometries. The geometries relate image positions to corresponding real-world (e.g., ground) positions. These services include, but are not limited to, the capability to:

- Use image geometry mathematical models to support image exploitation and manipulation (including supporting various other services that handle images), such as:

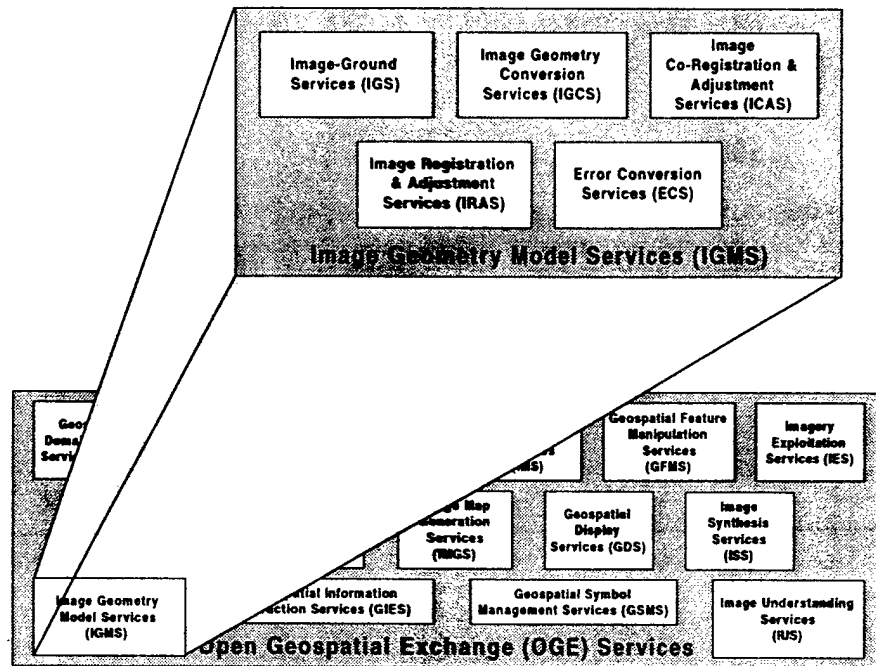


Figure 5-10. USGS Image Geometry Model Services

- Computation of estimated total ground position error between two points, including the effects of image support data errors, image position measurement errors, height uncertainty, and computation errors.
- Computation of estimated total image position error, at one ground position, including the effects of image support data errors, ground position errors, and computation errors.
- Retrieval of the list of current values of image geometry model parameters.
- Change of current values of specified image geometry model parameters.
- Change of current values of image transformation parameters (from named value list format). This image transformation relates one version of an image to the original image. A version may be a reduced resolution data set, a simply warped image, and/or a part of the original image.
- Retrieval of definitions of image parameters, including all information needed to allow display of parameter values and interactive modification of changeable values.
- Convert image geometry mathematical models into different but equivalent geometry models. These geometry models include image geometry parameter values in various specific, image-support, data formats. Operations on geometry models include, but are not limited to, the capability to:

- Fit a new image geometry model to an existing image geometry model, including computing the estimated errors in the new image geometry model.
- Receive and check image support data in a specific known format, for one or more images.
- Retrieve and check the image support data for a specified image, and use this data to create an Image Geometry Use object.
- Retrieve and check image support data for two or more stereoscopic images, and use this data to create multiple Image Geometry Use objects.
- Convert image support data from an Image Geometry Use object to external format, including check and store converted data.
- Convert image support data from two or more Image Geometry Use objects to external format, including check and store converted data.
- Produce image support data in specified external format from previously entered data, for one or more images. Also, check the image support data and return a list of any “errors” or missing data detected.
- Change current values of conversion service option parameters (in named value list format).
- Retrieve current values of conversion service option parameters (in named value list format).
- Adjust one or more image geometry mathematical models to better match other images and/or known ground positions. Adjust geometry models based on corresponding ground and image positions and/or corresponding positions in multiple images, with the estimated errors in these positions and in the original image geometry parameters. Adjustments include, but are not limited to, the capability to:
 - Adjust the values of selected adjustable image geometry parameters for the current set of images, using position data for the current set of points.
 - Add an additional image to the current set of images to be adjusted.
 - Remove a specified image from the current set of images to be adjusted.
 - Add an additional point to the current set of points to be used in image adjustment.
 - Remove a specified point from the current set of points to be used in image adjustment.
 - Change data for a specified point in the current set of points to be used in image adjustment.

- Change current values of image geometry adjustment service option parameters (in named value list format).
- Retrieve current values of image geometry adjustment service option parameters (in named value list format).
- Retrieve data for first point in current set of points to be used in image adjustment.
- Retrieve data for next point in current set of points to be used in image adjustment, after last point retrieved by Get Next Point or by Get First Point.
- Retrieve data for a selected point in set of points to be used in image adjustment.
- Retrieve summary data for first image in current set of images to be adjusted.
- Retrieve summary data for next image in current set of images to be adjusted, after last image retrieved by Get Next Image or by Get First Image.
- Support adjustment of image geometry parameters, such as:
 - Retrieve names of all parameters of the image geometry model that could be adjusted.
 - Retrieve names of parameters of the image geometry model that are recommended to be adjusted.
 - Retrieve covariance matrix of the current expected errors in and among a specified list of image geometry model parameters.
 - Compute partial derivatives of the image coordinates relative to specified list of adjustable image geometry model parameters, evaluated at a specified ground position.
 - Compute partial derivatives of the image coordinates relative to the three ground coordinates, at a specified ground position.
 - Change values of specified list of parameters of the image geometry model, by the specified value changes.
 - Change covariance matrix of the expected errors in and among a specified list of image geometry model parameters.
 - Compute list of image positions corresponding to specified list of ground positions.
 - Compute list of ground positions corresponding to specified list of image positions. The ground heights are either input as specific values, input as

an elevation model, or computed using positions in two or more stereoscopic images.

- Convert estimated errors between covariance matrix form and Circular Error (CE) plus Linear Error (LE) forms. These conversions include, but are not limited to:
 - Conversion of a 3-D covariance matrix to horizontal CE and vertical LE estimates.
 - Conversion of a 2-D covariance matrix to horizontal CE estimate.
 - Conversion of a 2-D covariance matrix to image CE estimate.
 - Conversion of a horizontal CE and vertical LE estimates to 3-D covariance matrix.
 - Conversion of a horizontal CE estimate to 2-D covariance matrix.
 - Conversion of an image CE estimate to 2-D covariance matrix.
 - Changes of current values of accuracy conversion service option parameters. These options include the confidence probability used for CE and LE.
 - Retrieval of current values of accuracy conversion service option parameters.

5.2.11 Geospatial Symbol Management Services

Geospatial Symbol Management Services (GSMS), shown in Figure 5-11, are those services required for the management of symbol libraries, such as:

- Management of symbol libraries, the linking of symbol types to specific features for display, and the representation of symbols as proxies for features in legends and portions of Feature Collections displayed on a screen or printed hardcopy.
- Creation of a taxonomy of symbols from a set of graphic objects to populate one or more symbol libraries.

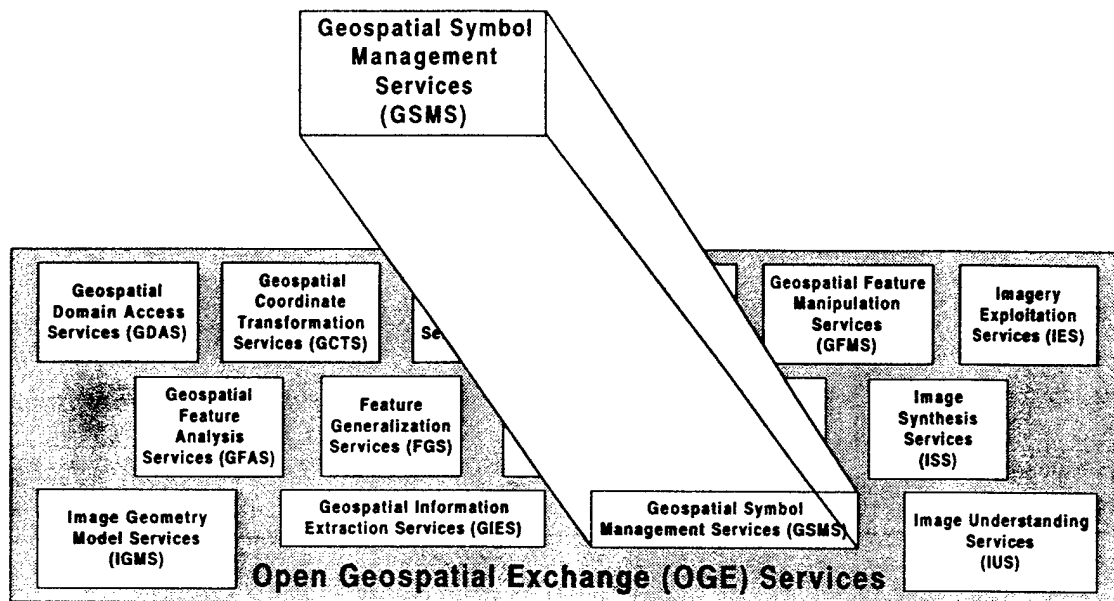


Figure 5-11. USGS Geospatial Symbol Management Services

5.2.12 Image Map Generation Services

Image Map Generation Services (IMGS), shown in Figure 5-12, are a collection of services for manipulating and combining images for use as image maps and other uses. These services include, but are not limited to, the capability to:

- Merge multiple images with abutting and/or overlapping spatial coverages to form a single composite with greater spatial coverage.
- Match and blend the radiometric values of corresponding or adjacent pixels from abutting and/or overlapping spatial coverages to form a smooth visual transition.
- Combine information from more than one image into a single image product (e.g., combining one image from SPOT 10m. resolution panchromatic coverage with one of LANDSAT 30m. resolution multi-spectral coverage).
- Adjust transparency of images so when two images are overlaid one upon the other, adjustment is made to common pixel values to allow lower layered images to be observed through higher layered images. This capability is typically used to combine images from different sensors with different imaging characteristics, such as combining a panchromatic image and a thematic mapper image into a single color image that allows thematic classifications to be viewed "through" the panchromatic image.

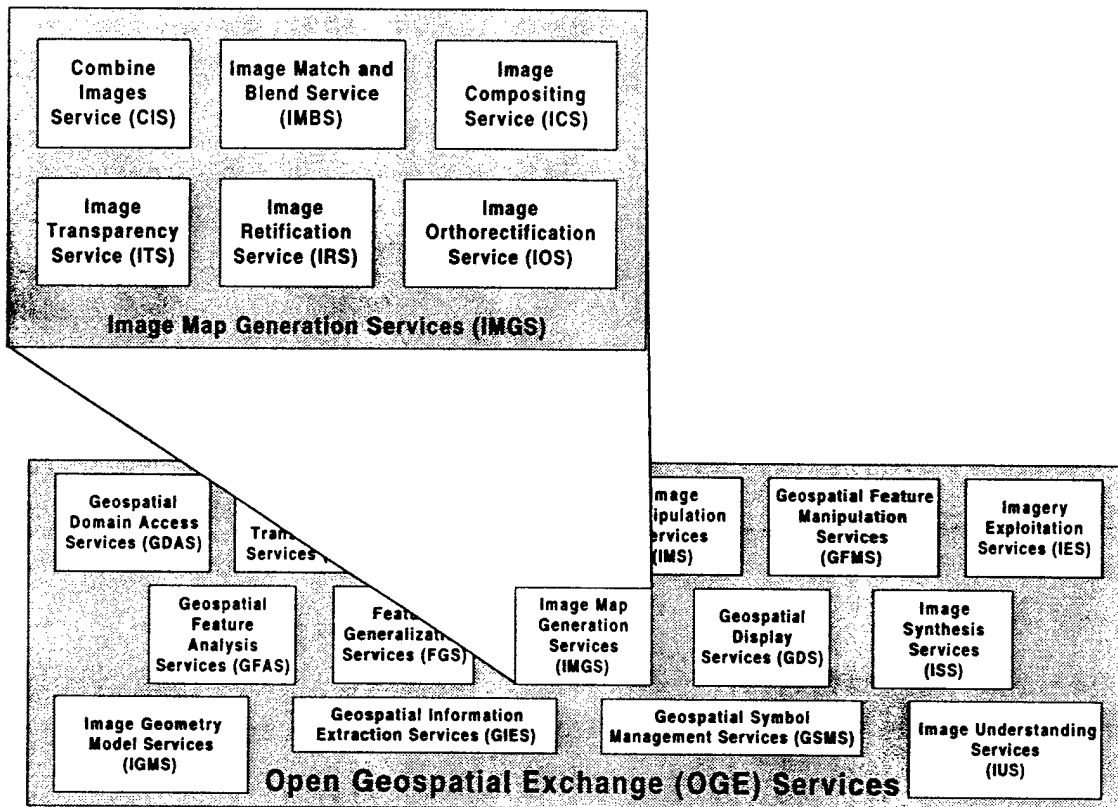


Figure 5-12. USGS Image Map Generation Services

- Transformation of the geometry of images to remove the effect of obliquity and/or rotation in the image acquisition (known as rectification). This capability includes epipolar rectification for stereoscopic viewing.
- Transformation of the geometry of images to remove the effect of obliquity in image acquisition and also remove lateral displacement due to terrain relief (known as orthorectification).

5.2.13 Image Synthesis Services

Image Synthesis Services (ISS), shown in Figure 5-13, are a category of services for creating or transforming images using computer-based spatial models, perspective transformations, and manipulations of image characteristics to improve visibility, sharpen resolution, and/or reduce the effects of cloud cover or haze. These computations include, but are not limited to, the capability to create:

- CAD or other models of elements and objects within an imaged scene.
- A new image from an existing image to simulate changes in acquisition conditions such as illumination, atmospheric effects, sensor geometry.

- An image as though taken from a location other than that of the original image. Generally, this uses a three dimensional scene model
- A series of images with perspective centers changing with observation time as though taken from an aircraft (for example) flying over the scene.

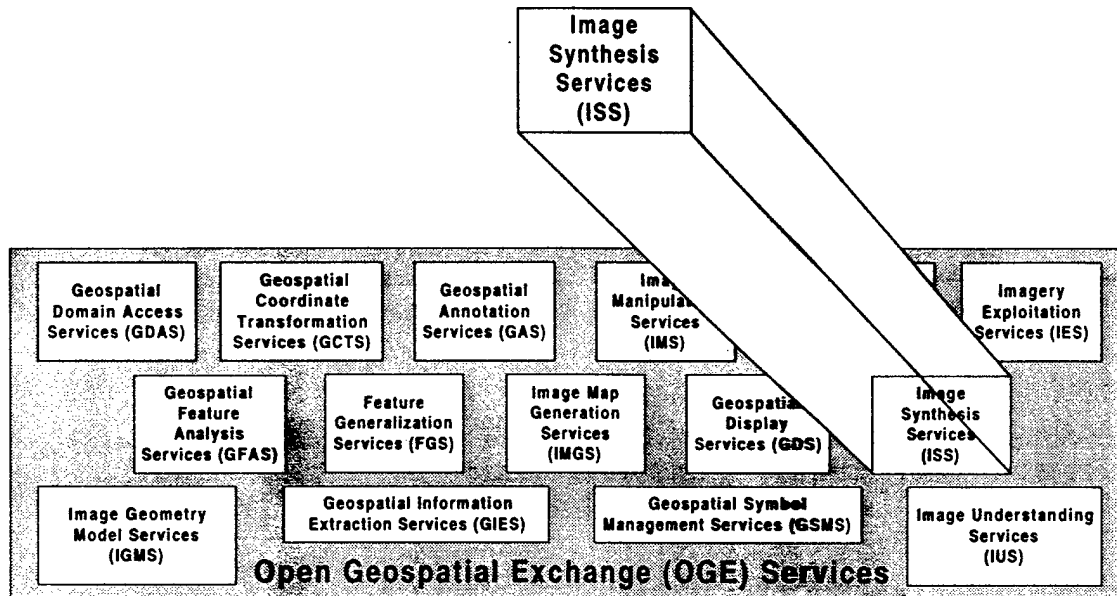


Figure 5-13. USIGS Image Synthesis Services

5.2.14 Image Understanding Services

Image Understanding Services (IUS), shown in Figure 5-14, are a category of services that provide automated image change detection, registered image differencing, significance-of-difference analysis and display, and area-based and model-based differencing. Capabilities included in this category include, but are not limited to:

- Comparison of multiple images taken at different times, highlighting areas where significant change has occurred: e.g., the absence of an aircraft where one previously was parked.
- Pattern recognition on an image. Pattern recognition is a capability that detects the existence of a pre-defined or learned pattern, such as edges joined in right angles.
- Identification and classification of objects in an image. Object recognition is based on fully automated or computer assisted recognition of patterns, from which detection of a known class of object can be inferred (based on prior classification).

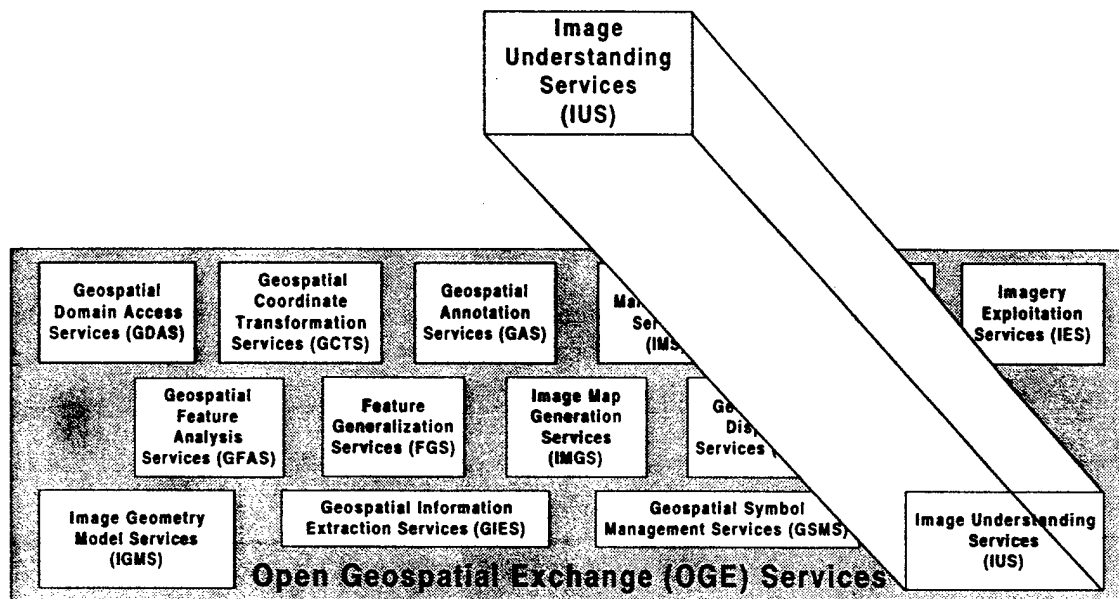


Figure 5-14. USIGS Image Understanding Services

- Extract of features from an image based on object recognition. Feature extraction implies the detection and identification of an object but further includes the abstraction (or symbolization) of the feature. For instance, detecting, extracting, and abstracting a feature such as a road into a spatial data base or map.
- Display, extraction, and analysis of terrain data. Examples of terrain data of interest are: elevation data, soil types, vegetation classes, and drainage patterns. An example of terrain analysis is the use of digital elevation data with images to generate obscuration profiles, showing visual or signal obscuration between selected points.
- Automatic and interactive negation (determination of origin) of changes detected in objects and relations (e.g., performs site analysis using knowledge-based analytical methods).
- Automatic and interactive detection and counting of objects and relations required for an exploitation task (e.g., perform automatic target recognition).
- Automatic and interactive trend analysis for objects and relations of interest in an exploitation task (to include spatial inference from evidence of as-yet unseen, occluded, or otherwise obscured objects, as well as model analysis using time-series and machine learning techniques).

- Automatic and interactive analysis of sensor line-of-sight, terrain and cultural feature classifications (including standard map features and point target types), vehicle- and unit-level location probabilities, mobility analysis, etc.

5.2.15 Geospatial Display Services

Geospatial Display Services (GDS), shown in Figure 5-15, is comprised of services that prepare and render one or more Feature Collections or Coverages to an output device. The output device may be a (temporary) electronic display or (permanent) hardcopy printer (e.g., printing a map or chart). The services include, but are not limited to capabilities that:

- Manipulate one or more Feature Collections or Coverages to display over a base Feature Collection that is already displayed (this includes such applications as distributed collaborative computing).
- Create associations, either temporary or permanent, between or among features in a Feature Collection, symbols in an overlay, etc., for the purpose of their display manipulation as a related unit.
- Introduce detail into a feature to augment or emphasize a particular characteristic.
- Interactively select and highlight a feature or features displayed on the display device.

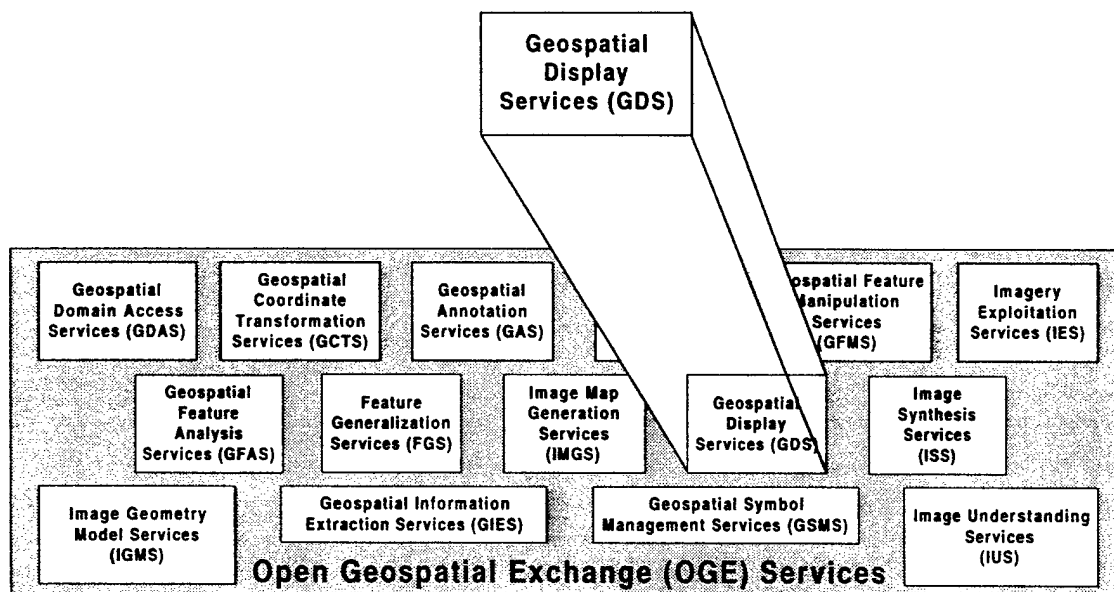


Figure 5-15. USGS Geospatial Display Services

- Link symbol types from symbol libraries to specific features in a Feature Collection for representation on the output device.
- Render a Feature Collection that has been encoded with symbolized information, to an output device or media.
- Place textual information during the rendering process to provide a more complete description of a feature or set of features.
- Associate ancillary information for a feature or feature collection for display with the feature or feature collection on the output device.
- Manage the output of hardcopy facsimiles of the Feature Collection via a device such as a printer or plotter.
- Display a map inset containing a smaller-scale map to which the geographic position of the displayed map or area of interest is referenced.
- Convert the features in the Feature Collection from one projection system to another to enable their accurate rendering to an output device.
- Control how the Feature Collection is manipulated in a display screen window.
- Specify the Feature Collection, or portion of the Feature Collection (the subset usually resulting from the application of an Area Of Interest as a filter), to be displayed as a map background.
- Specify the scale at which to display the Feature Collection on the output device.
- Instruct the display to lighten the illumination intensity of the feature or Feature Collection in the screen display window.
- Specify in which direction the feature or Feature Collection is to be moved in the screen display window.
- Reposition the Feature Collection in the screen display window in relation to a specified center point that is different from the center point used in the current display of the Feature Collection.
- Specify an angular measure by which the feature or Feature Collection are to be turned about a specified center point.
- Specify a zoom factor for redisplay of the feature or Feature Collection on the screen.

- Stack features, Feature Collections, or Coverages in a specified order for output to a display device.
- Adjust the position of a feature to avoid overlap with other features that would cause cluttering in the display window.

5.3 Collaborative Computing

Collaborative computing is typified by the capability of one or more individuals and/or applications programs to share information in a timely manner. This section discusses these aspects of collaborative computing:

- Introductory description of the technology
- Geospatial requirements for this technology
- Standards that currently exist
- Available products that conform to the standards
- Status and future directions

5.3.1 Description

Examples of collaborative computing include the following:

- Simple file sharing (FTP, file sharing, etc.)
- Electronic mail (e-mail)
- Concurrent editing (e.g., shared whiteboard)
- Desktop audio teleconferencing
- Desktop video teleconferencing
- Data conferencing

Today, in a client/server environment, most collaborative computing takes place through the sharing of textual or formatted data that is exchanged via a file, database, or electronic mail server. Only occasionally does the information being shared take the form of image, graphic, audio, or video formatted data. This does not, for the most part, occur in real-time or anywhere near it, although some networks provide the capability for individuals to converse using text messages.

Elements of Internet and Java are now being incorporated into collaborative computing. The technology is reaching the point where it allows sharing information of all data types. The technology is emerging that will economically provide users on a network the ability to sit at their workstations and communicate via video and audio in real-time. In effect, a group of users will be able to create a virtual conference room, with the ability to share all forms of communication and information on demand.

Data conferencing is a relatively new form of collaborative computing. It is also called audiographics. Forms of data conferencing include shared whiteboard, document

conferencing, and application sharing. Like other forms of teleconferencing, data conferencing is characterized by real-time communications, which differentiates it from "over-time conferencing" such as e-mail, newsgroups, and Lotus Notes.

5.3.2 Geospatial Requirements

Exploitation and Analysis is a key USIGS function that will make use of collaborative computing. Collaborative Exploitation and Analysis includes the sharing or the assisted performance of imagery/geospatial exploitation/analysis tasks in two basic modes:

- Within peer group: Collaboration among a dynamically-defined analytical peer group, distributed organizationally and geographically
- Across functions: Collaboration in support of the collection/analysis tasking, data management, analysis refinement, information generation, and end-user feedback.

Collaborative exploitation and analysis includes workgroup-capable analysis, documentation applications, collaborative workspaces, intelligent agents to mediate, shared digital light tables, virtually-shared whiteboards, and collaborative planning/editing/production tools.

The vision for collaborative exploitation and analysis within the imagery/geospatial community includes these elements:

- A worldwide network of imagery/geospatial data repositories that enable the sharing of imagery/geospatial data and metadata across the community
- Worldwide, dynamically-formed workgroups of analysts, providers and consumers to address time-sensitive issues
- Cooperation of individual imagery/geospatial analysts on joint exploitation tasks in real-time
- Access to imagery/geospatial expertise
- Near real-time cooperation between analysts and end users for update
- The use of intelligent agents capable of browsing the imagery/geospatial network and repositories for metadata information to support particular exploitation/analysis tasks ("pull")
- Automated, adaptive user profiling for data mining ("push") for the analysts
- The use of advanced visualization tools to achieve a "ubiquitous computing" environment.

5.3.3 Standardization

The Joint Technical Architecture, Version 2 Draft [JTA97], lists the following emerging standards that relate to collaborative computing:

- The ISO 13818-4, MPEG-2 is an interchange format used for full motion video and associated audio data for data rates of 1.5 Mbits/s - 6.0 Mbits/s. MPEG-4 is under development for video conferencing at very low bit rates for the Internet.
- The Virtual Reality Markup Language (VRML) is developing into a commercial standard with capabilities for 3-D representation of data.

There are two main families of standards supporting collaborative computing: H.320 and T.120. H.320 is a family of video conferencing standards adopted by the ITU-T (the United Nations International Telecommunications Union) that run over a variety of communications lines (T1, F-T1, ISDN BRI or PRI, Switched 56). The H.320 standards describe the frame structure and terminal procedures for multimedia communication multiplexed over one or more digital channels.

T.120 is a newer family of standardized communications and application protocols that provide support for real-time, multi-point data communications. It supports many kinds of multimedia data: images with real-time annotation, application sharing, and file transfer. These multi-point facilities are the building blocks for a new range of collaborative applications.

5.3.4 Products

Many products and tools exist for audio conferencing; shared whiteboard, video conferencing, and session management. For example, Compression Labs Inc., PictureTel, VTEL, British Telecom, Tandberg, Hitachi, Panasonic, and Mitsubishi all provide products that are H.320 standards compliant. The T.120 standard is implemented in products from DataBeam, PictureTel, VTEL, British Telecom, Intel, Apple, Polycom, Vivo, Sony, Sun microsystems, GPT Video, Microsoft, and many more. The T.120 market leaders are PictureTel (Live PCS 50 and PCS 100) and Intel (ProShare Video System 200).

5.3.5 Status and Directions

A combination of audio-, video-, and data-conferencing is a feasible alternative today, in terms of cost, quality, and effectiveness. The technology does not yet provide an ideal solution in any of these areas, but it provides an adequate one. There are still a number of deficiencies to be noted:

- Scalability of virtual workplace tools to very large, distributed information environments remains an open question, both from time responsiveness and avoidance of overload
- More work is needed in integration of tools, to move from tool to tool and combine the analysis results. Collaborative tools need to be integrated with search and retrieval tools.

- Adaptation and integration of collaboration technologies for use by imagery/geospatial analysts are unproven within the community
- Audio and video conferencing tools provide limited interoperability
 - Limited support for standards-based codecs
 - Limited support for the same codecs across audio and video tools
 - Announcements for future support for T.126 (Still Image Exchange) from many vendors, but not here yet
- Some audio conferencing tools only support point to point conferencing between two people; awaiting third party MCUs for multipoint capability

One problem with interoperability is that even if vendors follow the standards, there is no assurance that solutions from different vendors will interoperate out-of-the-box. Some work is being done to address this issue. Building on the ITU open video-conferencing recommendations of the H.320 and T.120 families, the Versit H.320 Implementors' Agreement has been developed which interprets and clarifies the ITU H.320 Recommendation. Many companies reviewed and contributed to this agreement. The development of this agreement is an important step in achieving the interoperability that will enable the collaborative working environment.

Future directions

The general trend in collaborative computing may be summarized as follows:

- Conferencing will be built into general applications
 - A combination of application sharing and distributed document/object technologies will be used
 - Applications will be conferencing aware and provide new features for group collaboration
- Standards will become increasingly important for application internetworking
- There will be smooth integration of real- and over-time
- The use of LAN, telecom, and Internet will be transparent.

5.4 Security

The combination of a distributed object environment along with the variety of envisioned USIGS customer/user types introduces significant architectural challenges for USIGS security. The issues are being identified and documented in a separate study [Usec97], and therefore will not be delineated here.

6. Technology Gaps

This section is TBR. It will address needed technology where USIGS and the Geospatial community must be proactive to facilitate technology development.

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Appendix A: UTA Context Information

This Appendix extends the introductory context given in Section 1. The following DoD initiatives and programs will be discussed:

- Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) Architecture Framework
- Technical Architecture Framework for Information Management (TAFIM)
- Information Technology Standards Guidance (ITSG)
- Defense Information Infrastructure (DII) Common Operating Environment/ Shared Data Environment (COE/SHADE), including the Integration and Runtime Specification (I&RTS)

C4ISR Framework. The Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) Architecture Framework [C4ISR96] defines the term architecture and then defines three generic architecture types: operational, systems, and technical. In addition, a data view is defined in terms of a set of core products that cross all three architecture types. The detailed architecture definitions in [C4ISR96] are as follows:

Architecture

The structure of components, their relationships, and the principles and guidelines governing their design and evolution over time. (IEEE STD 610.12) {Note: This refers to the IEEE Standard Glossary of Software Engineering Terminology. However, the most recent version of this Standard is [IEEE91], which defines architecture as "The organizational structure of a system or component."}

Operational architecture

A description (often graphical) of the operational elements, assigned tasks, and information flows required to support the warfighter. It defines the type of information, the frequency of exchange, and what tasks are supported by these information exchanges.

Tenets of Operational Architecture

- Primary Purpose of an Operational Architecture:
 - Defines activities and information exchange requirements
- Operational Architecture Characteristics
 - Operational architectures start with doctrine and assigned tasks, which in turn drive the definition of the activity model.

- Activity descriptions are essential for defining the data model and information exchange requirements.
- Information exchange requirements may cross organizational boundaries.
- Activities may cross organizational boundaries.
- Operational architectures should not be systems-dependent.
- Activity descriptions are not based on organizational models or force structure.

Systems architecture

Defines the physical connection, location, and identification of key nodes, circuits, networks, warfighting platforms, etc., and specifies system and component performance parameters. The systems architecture is constructed to satisfy operational architecture requirements per standards defined in the technical architecture. The systems architecture shows how multiple systems within a subject area link and interoperate, and may describe the internal construction or operations of particular systems within the architecture.

Tenets of Systems Architecture

- Primary Purpose of an Systems Architecture:
 - Enables or automates operational activities through physical processes.
- Systems Architecture Characteristics
 - Operational architectures drive associated systems architectures.
 - Systems architectures map systems with their associated platforms, functions, characteristics, and data elements back to the operational architecture.
 - Systems architectures identify system interfaces and define the connectivity between systems.
 - Systems architectures define system constraints and bounds of system performance behavior.
 - The systems architecture shows systems interconnectivity from sensor-to-shooter/ decision-maker through the system components.
 - Systems architectures are technology-dependent, show how multiple systems within a subject area link and interoperate, and may describe the internals of particular systems.
 - Systems architectures support multiple command organizations and missions; the clustering of system functions and data stores shown in the systems architecture should not be based on current organizational models, force structures, or fielded technologies.

Technical architecture

The technical architecture identifies the services, interfaces, standards, and their relationships. It provides the technical guidelines for implementation of systems upon which engineering specifications are based, common building blocks are built, and product lines are developed.

Tenets of Technical Architecture

- **Primary Purpose of a Technical Architecture:**
 - Defines the set of rules that govern systems implementation and operation.
- **Technical Architecture Characteristics**
 - Technical architectures are based on requirements defined in the operational architecture and analyses of possible enabling technologies.
 - Information system paradigms of processing, database and communications are identified and strongly influence the technical architecture.
 - Technical architectures account for the requirements of multiplatform and network interconnections among all systems that produce, use, or exchange information electronically.
 - Definitions and corresponding technical criteria for system capabilities, services, and interfaces are provided in the technical architecture.
 - Technical architectures accommodate new technology, evolving standards, and the phasing out of old technology.
 - The rules of technical architectures are defined in terms of nonproprietary specifications and therefore reduce reliance on proprietary technologies.

TAFIM. The Technical Architecture Framework for Information Management (TAFIM) provides a more detailed technical architecture context. TAFIM is described in [DIIMP96, p. GL-15]: "The TAFIM is a set of documents produced by DISA for the OSD [Office of the Secretary of Defense] to guide DOD information systems toward an open systems architecture. It provides the services, standards, design concepts, components, and configurations that can be used to guide the development of technical architectures that meet specific mission requirements."

TAFIM comprises eight volumes [TAFIM95]:

- Volume 1: Overview
- Volume 2: Technical Reference Model
- Volume 3: Architecture Concepts and Design Guidance
- Volume 4: DoD Standards-Based Architecture Planning Guide

- Volume 5: Program Manager's Guide for Open Systems
- Volume 6: DoD Goal Security Architecture
- Volume 7: Adopted Information Technology Standards (AITS)
- Volume 8: DoD Human Computer Interface (HCI) Style Guide

ITSG. ITSG is the Information Technology Standards Guidance, which describes itself as follows [ITSG96, p. 1-1]: "The Information Technology Standards Guidance (ITSG) is a tool. Its purpose is to define the DOD Open System Environment (OSE) and provide guidance to meet the requirement for consistent selection of base standards for profiles for DOD Information Technology (IT) acquisitions. It does this by defining the DOD OSE and the target group of IT standards that DOD systems are to use in implementations. The specification of the DOD OSE and the IT standards contained within that environment using the ITSG will guide system convergence toward the DOD-consensus target environment."

The ITSG is the foundation document for TAFIM Volume 7, the Adopted Information Technology Standards. The ITSG serves as a foundation by being used to track activity in emerging standards that may someday appear in the TAFIM [ITSG96, p. 1-1]. The ITSG provides detailed information about standards.

Table A-1 relates the ITSG major service areas to service areas defined in the NIST APP and the POSIX OSE reference model [IEEE95].

Table A-1. ITSG Comparison With NIST APP and IEEE OSE/RM

ITSG Major Service Area	NIST APP Service Area	POSIX OSE Reference Model Service Category
Software Engineering Services	Software Engineering Services	Application Software Development Support Services (Sub-category of Human/Computer Interaction Services)
Operating System Services	Operating System Services	System Services
User Interface Services	User Interface Services	Human/Computer Interaction Services
Graphics Services	Graphics Services	
Data Management Services	Data Management Services	Information Services
Data Interchange Services	Data Interchange Services	
Network Services	Network Services	Communications Services

DII COE/SHADE: The Defense Information Infrastructure (DII) Common Operating Environment (COE) is mandated by the JTA. The COE brings the abstractions of the other architectures and reference models closer to the reality of platforms and software products. The DII COE is defined in [DIIMP96, p. GL-3]: "The DII COE establishes an integrated software infrastructure which facilitates the migration and implementation of functional mission applications and integrated databases across information systems in the Defense Information Infrastructure. The DII COE provides architecture principles, guidelines, and methodologies that assist in the development of mission application software by capitalizing on a thorough, cohesive set of infrastructure support services. The DII COE specification is derived from the complete TAFIM." The COE specification is presented in [COE97].

The DII COE I&RTS describes the technical requirements for using the DII COE and SHADE to build and integrate systems [I&RTS97]. It provides implementation details that describe, from a software development perspective, the following:

- the COE approach to software reuse
- the COE runtime execution environment
- the definition and requirements for achieving DII compliance
- the process for automated software integration
- the process for electronically submitting/retrieving software components to/from the DII repository.

DII compliance is closely associated with interoperability, and for this reason systems are increasingly being measured by the degree to which they meet requirements described in this document. OSD has issued a directive that all new military systems, excepting weapons control systems, shall use the DII COE/SHADE.

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Appendix B: UTA Standards Summary

Table B-1 summarizes current (shaded), candidate, and declining standards as a USGS profile of the JTA. JTA sections not listed in this table are accepted as is.

Table B-1. Time-Phased Standards Summary

Sponsor	Use Status	Standard	Standard Reference	Life-Cycle Status
Graphics Data				
ISO	Recommended	Annotation Graphics Module (AGM) and Annotation Standard	ISO 15924-2:1997	Approved
ISO	Recommended	Geographic Information Interchange	ISO 15924-3:1997	Approved
ISO	Candidate	Basic Imagery and Mapping Annotation Graphics (BIMA) Profile to CGM	ISO/IEC xxxxx	Draft
Geospatial Data				
FGD	Recommended	Vector Product Format (V) Interchange Standard	MIL-STD-2407-1996	Approved
NIMA	Recommended	Basic Geospatial Interchange	MIL-STD-2407	Approved
NIMA	Recommended	Global Workstation Standard	ISO Technical Report	Approved
FGDC	Candidate	Spatial Data Transfer Standards (SDTS)	FIPS 173-1	
Imagery Data (Still Imagery)				
NIMA	Recommended	National Imagery Transmission Standard (NITF)	MIL-STD-2500A w/notice 1	Approved
NIMA	Recommended	Adaptive Recursive Interpolated Differential Pulse Code Modulation (ARIDPCM)	MIL-STD-168-12	Approved
NIMA	Recommended	SDTS Extension for the NITF	MIL-STD-168-12A w/notice #1 12 Oct 1994	Approved
NIMA	Recommended	Vector Quantization (VQ)	MIL-STD-169 w/notice #1 June 1996	Approved
NIMA	Recommended	Block Compression	MIL-STD-168-12B w/notice #1 27 June 1996	Approved
NIMA	Recommended	Adaptive Recursive Interpolated Differential Pulse Code Modulation (ARIDPCM)	MIL-STD-168-197A/12 Oct 1994	Approved
NIMA	Candidate	USIGS ISP of the Basic Image Interchange Format (BIIF)	ISO/IEC 12087-5	Draft

Sponsor	Use Status	Standard	Standard Reference	Life-Cycle Status
Eastman Kodak	Candidate	FlashPix	FlashPix Format Specification V1.0	Limited-use license
ISO	Candidate	JPEG 2000		Emerging
Compu-Serve	Declining	Graphics Interchange Format (GIF)		Royalty-Free Limited-use license
Adobe Systems, Inc.	Declining	Post-Script (PS)		Royalty-Free use
	Declining	Tagged Image File Format		Royalty-Free use
	Declining	Tape Format Requirements Document		DoD Classified use
Video Systems (Video Intelligence)				
USIGS	Recommended	USIGS Standard Video Format	USIGS VSP Version 1.0, Sep 1997	Approved
Distributed Computing Services				
OMG	Recommended	Common Object Request Broker Architecture (CORBA) 2.1	OMG Document Formal/97-09-01	Approved
Information Modeling and Information Standards				
USIGS	Recommended	Geopolitical Country Codes	USIGS PUB 10-4, Apr 1995	Approved
NIMA	Recommended	USIGS Data Model	USIGS-DM, 18 Jul 1997	Draft
OMG	Candidate	Universal Modeling Language	UML V1.1, 21 July 1997	Approved
Symbology				
DISA	Candidate	Common Warfighting Symbology	MIL-STD-2525A, Change #1, 15 Apr 1997	Approved

Appendix C: UTA as JTA Annex for Geospatial and Imagery Domain

Part 1. Overview

1.1 Introduction

The Joint Technical Architecture (JTA) provides the most direct architectural context for the USIGS Technical Architecture (UTA). Both represent technical architecture products of the C4ISR Architecture Framework. Since the JTA "identifies a common set of mandatory information technology standards and guidelines to be used in all new and upgraded C4I acquisitions across DoD," the UTA uses the JTA as its foundation. The standards and guidelines in the JTA are the result of collaboration among the Services, Joint Staff, USD(A&T), ASD(C3I), DISA, DIA, and other elements of the Intelligence Community. Version 1.0 of the JTA [JTA96] is mandated for use by the ASD(C3I). Version 2.0 is in development; the latest draft of Version 2.0 is dated July 18, 1997 [JTA97]. *The standards for USIGS are those that are defined in [JTA97], as profiled and augmented in this UTA annex.*

1.2 Organization

The organization of this appendix attempts to mirror the organization of the JTA version 2.0. Where the JTA standards sufficiently support USIGS, "No change to JTA mandated standards" is stated. In some cases, the mandated standards necessitate further "profiling" to provide enough direction to USIGS developers; in others, additional guidance is needed to augment JTA mandates to provide USIGS services.

1.3 Configuration Management

Since both the JTA and UTA are viewed as living documents, standards and specifications that may appear in a version of the UTA (as they apply to common services), but are not in the current JTA, will be submitted for consideration by the JTA Development Group (JTADG). Additionally, NIMA envisions a more frequent update cycle for the UTA to adequately support the USIGS development.

Part 2. Information Technology Standards

2.1 Overview

If imagery and geospatial information is to be used effectively, it must be accurate and accessible across organizations, even across the world. This means that CPUs must be intimately linked to the networks of the world and be capable of freely passing and receiving information. Therefore, Information Technology (IT) standards, as outlined in the JTA, will enable "new systems to be born joint and interoperable, and existing systems will have a baseline to move towards"; a situation presently relevant with

USIGS. Furthermore, the USIGS community needs to exploit the emerging paradigm of distributed or cooperative computing. The intelligence and DoD communities are defining a common computing environment based predominantly on commercially developed technology and standards. A key element of the approach to the UTA is to exploit commercial technology, including standards and tools based on open distributed systems to achieve interoperability. The Object Management Architecture (OMA) defined by the Object Management Group [OMG97] is a primary driver of the USIGS Technical Reference Model. This model identifies the components, interfaces, and protocols that enable clients and objects to communicate in a distributed environment.

2.2. Information Processing Standards

2.2.1 Introduction

2.2.1.1 Purpose

This section of the annex provides the UTA profile for information processing standards. Where the primary mechanism for software reuse and API development in the DII is the COE, USIGS will comply but go further in using COTS products associated with maturing object technologies. Also, while this section may cite standards already in the JTA, additional information pertinent to the geospatial domain is provided for USIGS essentials.

2.2.1.2 Scope/Background/ Year 2000 (Y2K) Compliance

USIGS follows the JTA mandate for Y2K Compliance.

2.2.2 Mandates

The following subsections provide applicable mandates for USIGS selection of COTS and GOTS software. The fact that DII COE has identified CORBA 2.0 as a standard may affect the software segmentation compliance rules as defined in the DII COE I&RTS. Although the USIGS Systems Architecture is still being developed, achieving the functional equivalent of level 8 compliance is still the objective. Progress to an expanded set of compliance rules must be accomplished through a JTADG or joint coordination process.

2.2.2.1 Application Software Entity

The JTA mandates identification of common support applications and mission area applications. USIGS identifies these in the USIGS Technical Reference Model.

2.2.2.2 Application Platform Entity

The JTA references TAFIM common services. The USIGS Technical Architecture is based on the USIGS TRM, which emphasizes distributed object computing. However,

the USIGS TRM also addresses platform services, which correspond to many of the subsections that follow.

2.2.2.2.1 Service Areas

2.2.2.2.1.1 Software Engineering Services - No change to JTA mandated standards.

2.2.2.2.1.2 User Interface Services - No change to JTA mandated standards.

2.2.2.2.1.3 Data Management Services - No change to JTA mandated standards.

2.2.2.2.1.4 Data Interchange Services

2.2.2.2.1.4.1 Document Interchange - No change to JTA mandated standards.

2.2.2.2.1.4.2 Graphics Data Interchange - The two standards described below are provided for clarity and direction for USIGS developers and should not conflict with the JTA. Graphics data interchange is associated with NITFS. MIL-STD-2301 had its basis in FIPS 128-1 which is also a profile of the ANSI/ISO 8632 standard. The symbology standard is mandated by JTA in the Human-Computer Interfaces Section.

2.2.2.2.1.4.2.1 Computer Graphics Metafile (CGM) Implementation Standard for the NITFS - MIL-STD-2301

Operational graphics data interchange within USIGS is to be consistent with that used for the interchange of operational imagery data. See CGM discussion below in Section 2.2.2.2.1.4.4.2.

2.2.2.2.1.4.2.2 Common Warfighting Symbology - MIL-STD-2525A

Common Warfighting Symbology, MIL-STD-2525A, specifies a common set of warfighting symbols, with the intent to enhance DoD's joint warfighting interoperability. MIL-STD-2525A contains a set of common warfighting symbols used in two-dimensional and electronic display system Command, Control, Communications, Computer, and Intelligence (C4I) for the Warrior environments. It also specifies basic application and display rules for Department of Defense (DoD) C4I system operations, system development, and training. MIL-STD-2525A is the standard symbol set for all future DoD C4I for the Warrior symbology applications.

The symbols must be compliant with the National Imagery Transmission Format Standards (NITFS) Computer Graphic Metafile (CGM) implementation. On-going work will expand symbology standardization to mapping, charting, weather, cockpit display, and engineering design.

2.2.2.2.1.4.3 Geospatial Data Interchange

2.2.2.2.1.4.3.1 Vector Product Format (VPF) - MIL-STD-2407

The vector product format (VPF) is a standard format, structure, and organization for large geographic databases that are based on a geo-relational data model and are intended for direct use. VPF is designed to be compatible with a wide variety of applications and products.

2.2.2.2.1.4.3.2 Raster Product Format (RPF) - MIL-STD-2411

RPF (MIL-STD-2411) is a standard data structure for rectangular arrays of pixels. Most often used for geospatial databases in compressed or uncompressed form. MIL-STD-2411-1 is an accompanying standard that defines registered data values to be used in RPF files. It is intended for data interchange and is designed to require no manipulation of the data, other than possible decompression, in order to use or display it.

2.2.2.2.1.4.3.3 Department of Defense World Geodetic System (WGS 84)

Department of Defense World Geodetic System (WGS 84) – MIL-STD-2401, 11 January 1994 – specifies a standard global coordinate system for representation of positional information and methods for transferring to/from other geodetic systems. WGS 84 is the official DoD positional reference system.

This standard applies to all DoD systems and products which require use of a world geodetic system, i.e., a consistent global coordinate system which allows an unambiguous representation of positional information. Navigation solutions from the NAVSTAR Global Positioning System (GPS) and the Navy Navigation Satellite System (NNSS) are referred to this system.

2.2.2.2.1.4.4 Imagery Data Interchange

2.2.2.2.1.4.4.1 National Imagery Transmission Format (NITF 2.0) - MIL-STD-2500A

NITF is a part of the more inclusive National Imagery Transmission Format Standard (NITFS). It is a format used for transmission of still imagery and associated data. NITF is the core of the NITF Suite of standards, and is coupled with additional standards for compression, graphics, and communications, briefly outlined below. It is mandated for all C4I systems disseminating secondary imagery, and is required for interoperability within the USIGS.

The assistant Secretary of Defense for Command, Control, Communications and Intelligence (ASD(C3I)) has mandated compliance with the NITFS. The National Imagery and Mapping Agency (NIMA) oversees the NITFS Certification Test and Evaluation (CTE) Program that determines compliance with the NITFS.. Detailed information concerning the NITFS Certification Test and Evaluation Program, including the established certification test criteria, is contained in DISA/JIEO Circular 9008.

2.2.2.2.1.4.4.2 Computer Graphics Metafile (CGM) Implementation Standard for the NITFS

MIL-STD 2301 is required for any C4I Systems exchanging NITFS files with overlaid graphics or for any systems implementing war fighter symbology, as defined in MIL-STD 2525A.

MIL-STD 2301 is a profile of the ISO/IEC Standard, it was based on the FIPS 128-1 document, but has since superseded it in terms of utility, commercial acceptance, and DoD implementation. The ISO/IEC CGM Standards are:

ISO/IEC 8632-1:1994	Part 1: Functional Specification
ISO/IEC 8632-2:1994	Part 2: Character Encoding
ISO/IEC 8632-3:1994	Part 3: Binary Encoding
ISO/IEC 8632-4:1994	Part 4: Clear Text Encoding

The MIL-STD is the mandated USIGS profile for interchange of graphical elements. It will be superseded by a new profile, tentatively named "The Basic Imagery and Mapping Annotations" (BIMA) will be submitted to ISO/JTC1 for formal approval and registration by the appropriate ISO registration authority. The submittal is currently planned to be in the 4Q98 timeframe. This new profile will not be documented as a military standard, but will be documented as a NIMA-controlled document, and will be the required profile for NITFS CGM and MIL-STD 2525A Symbology.

2.2.2.2.1.4.4.3 JPEG as profiled for NITFS

MIL-STD 188-198A (JPEG) is the mandated Lossy compression for 8-bit and 12-bit NITFS imagery within the USIGS. This Military standard is a profile of the ISO/IEC standard for JPEG, ISO/IEC 10918-1:1994,. See NITFS Program Plan -DRAFT (NIMA Document NNPP) for more information.

2.2.2.2.1.4.4.4 Vector Quantization (VQ) - MIL-STD-199

Vector Quantization (VQ) MIL-STD-199 is the mandated standard for decompressing NITF files compressed with VQ compression. It will be superseded in the 1999 timeframe with an identical document that will be the USIGS profile of the ISO Standard for VQ - currently being developed in the BIIF standardization effort. See NITFS Program Plan -DRAFT (NIMA Document NNPP) for more information.

2.2.2.2.1.4.4.5 Bi-level Image Compression - MIL-STD-188-196

Bi-level Image Compression, MIL-STD-188-196, is required for Bi-level (i.e., 1 bit per pixel, or black and white) lossless image compression as defined within the NITFS standard. For image Data greater than one bit pixel, other NITFS specified compression algorithms should be used.

2.2.2.2.1.4.4.6 The Adaptive Recursive Interpolated Differential Pulse Code Modulation Image Compression (ARIDPCM)

The Adaptive Recursive Interpolated Differential Pulse code Modulation Image compression (ARIDPCM), removed as a required compression for the NITF 2.1, is now only required for use with decompressing legacy files (NITF 1.1, 2.0) that implement it. NITF 2.0 only requires systems to decompress ARIDPCM for backward-compatibility.

2.2.2.2.1.4.5 Product Data Interchange - JTA mandated standards for this area are yet to be developed. When they are developed, NIMA will profile the standards for the geospatial and imagery domain.

2.2.2.2.1.4.6 Audio Data Interchange - No change to JTA mandated standards.

2.2.2.2.1.4.7 Video Data Interchange - Video, and more specifically "video intelligence", is classified as motion imagery in the USIGS Technical Architecture. The goal will be to incorporate the Video Standards Profile [Video97a, Video97b] as briefly described in the following paragraphs.

2.2.2.2.1.4.7.1 Video Intelligence

The "USIGS Video Standards Profile (VSP)," Version 1.1, 26 September 1997 [Video97b] (and as amended in the future), prepared and managed by the DoD/IC Video Working Group, mandates the minimum set of standards and guidelines for the acquisition of all DoD systems that produce, use, or exchange Video Intelligence information within the USIGS community. To support world-wide interoperability and exchange of Video Intelligence, all USIGS component systems that create, process, transmit, manipulate, exploit, store, archive and disseminate (both for real-time and other end-user wide area product distribution) VIDEO signals in support to Intelligence, Reconnaissance, and Surveillance (ISR) applications) are required to comply with the Standards and Profiles contained in VSP. All USIGS video systems should comply with VSP Recommended Practices.

By specific reference, other classes of video uses and community systems (Video Teleconference Systems, Video TeleMedicine, Video Support) are specifically excluded from the requirements of the VSP. However, these other video communities are encouraged to review the applicability of the standards given in the VSP and if deemed practical, implement VSP standards and recommended practices to foster broader interoperability across the entire DoD/IC/Federal spectrum. These separate communities are specifically invited to join the DoD/IC VWG and merge their requirements into the ongoing development of the DoD/IC VSP document.

Note that all of the technology outlined in the VSP document is based on commercially available (or very near term available) systems and components. The VSP identifies commercial standards to define interoperability for high image quality environments and systems (such as common control vans, interconnections nodes, and DoD/IC command centers), including high bandwidth transmission of uncompressed and compressed video

signals. The VSP also identifies approaches for interoperability between high bandwidth and low bandwidth systems but it does not, as of VSP Version 1.00, completely define an architecture for interoperability for extremely low bandwidth systems. Such extremely low bandwidth applications will be defined in future VSP document releases.

2.2.2.2.1.4.7.2 Video Teleconference

Video Teleconference Systems (systems used for "face to face" meetings between remote locations). When video teleconference systems are used as alternate Video Intelligence data dissemination systems then the requirements and provisions of Video Intelligence systems apply. Video Teleconferencing standards are addressed in the JTA (Section 2.3).

2.2.2.2.1.4.7.3 Video Telemedicine

Video Telemedicine (systems used in support of biomedical applications only). No standards are cited in the UTA or JTA for DoD applications; this is provided as a placeholder until addressed in the JTA.

2.2.2.2.1.4.7.4 Video Support

Video Support (traditional studio and or field video production, not associated with theater and or deployed DoD/IC Operations and Exercises). Video Support includes traditional activities such as preparation and dissemination of video based training; feature presentations or news gathering (unless part of ISR activities); AFRTS operations; or other CONUS only, non-critical functions that will not be mobilized for war fighting or contingency operations support. No standards are cited in the UTA or JTA for DoD applications; this is provided as a placeholder until addressed in the JTA.

2.2.2.2.1.4.8 Atmospheric Data Interchange - No change to JTA mandated standards.

2.2.2.2.1.4.9 Oceanographic Data Interchange - No change to JTA mandated standards.

2.2.2.2.1.5 Graphic Services - No change to JTA mandated standards.

2.2.2.2.1.6 Communications Services - No change to JTA mandated standards.

2.2.2.2.1.7 Operating System Services - No change to JTA mandated standards.

2.2.2.2.2 Application Platform Cross-Area Services - No change to JTA mandated standards.

2.2.2.2.2.1 Internationalization Services - No change to JTA mandated standards.

2.2.2.2.2.2 Security Services - No change to JTA mandated standards.

2.2.2.2.2.3 System Management Services - No change to JTA mandated standards.

2.2.2.2.2.4 Distributed Computing Services - In the area of distributed computing, USIGS has designated CORBA 2.1 as the environment in which it will deliver these services. The Object Management Architecture (OMA) aligns well with the USIGS Technical Reference Model (TRM) in depicting services, software component relationships, and interoperability through software reuse and standard interfaces.

2.2.2.2.2.4.1 Remote Procedure Computing - Although the USIGS profile for distributed computing services profiles CORBA 2.1, there is current work developing interfaces between both DCE and OLE/COM and CORBA.

2.2.2.2.2.4.2 Distributed Object Computing - USIGS will comply with the JTA in using CORBA and the associated IIOP standard, although USIGS specifies CORBA 2.1 instead of the CORBA 2.0 specified in [JTA97]. But beyond the JTA mandate, NIMA will use both a consortium standards development process as well as the ANSI/ISO model to advance Open Geospatial Exchange Services. Using the ISO IDL language, and in coordination with OMG and OGC, NIMA intends to define and formulate several standard interfaces which will deliver the Open Geospatial Exchange Service common support applications.

CORBA is a common object request broker architecture based on the Object Management Architecture use of object technologies. The object services associated with CORBA 2.0 and 2.1 are commonly referred to as CORBA services. They currently include Naming Service, Event Service, Life Cycle Service, Persistent Object Service, Transaction Service, Concurrency Control Service, Relationship Service, Externalization Service, Query Service, Licensing Service, Property Service, Time Service, and Security Service. The entire specification for the 13 services [CORBA97c] can be obtained at <http://www.omg.org/corba/sectrans.htm>.

2.2.3 Emerging Standards

The standards listed in this section are presented for three primary reasons. They are candidates to replace earlier identified standards; they are expected to be elevated to mandatory status in the JTA; or they warrant near term consideration.

2.2.3.1 Software Engineering Services

There are no emerging standards in addition to those presented in the JTA applicable to USIGS.

2.2.3.2 User Interface

There are no emerging standards in addition to those presented in the JTA applicable to USIGS.

2.2.3.3 Data Management

There are no emerging standards in addition to those presented in the JTA applicable to USIGS.

2.2.3.4 Data Interchange

2.2.3.4.1 Basic Imagery and Mapping Annotation Graphics (BIMA)

The Computer Graphics Metafile (CGM) provides a file format suitable for the storage and retrieval of picture information. The file format consists of a set of elements that can be used to describe pictures in a way that is compatible between systems of different architectures and devices of differing capabilities and design.

The BIMA profile, which will be described in an ISP, defines a subset of CGM elements, sets limits and generation and interpretation behavior according to the rules for profile definition defined in ISO/IEC 8632. The BIMA profile defines a Version 1 CGM suitable for use in annotation of digital imagery such as that defined by BIIF DIS/IEC 12087-5: 1997.

Information on BIMA is available from the NITFS Technical Board's website colocated on the ISMC/GSMC home page (<http://www.ismc.itsi.disa.mil/ntb/ntb.html>).

2.2.3.4.2 Spatial Data Transfer Standard (SDTS)

The SDTS (FIPS PUB 173-1) is to be used for the exchange of spatial data (vector and/or raster) between dissimilar hardware platforms with dissimilar operating systems. It is implemented via profiles that have been approved by the FGDC and the NIST. To date three profiles have been so approved. Two other profiles are currently out for review. Ownership of this standard falls to the FGDC. The initial version of the SDTS comprised three parts:

- Section 1 -- The logical specifications for a conceptual spatial data model, specifications for data quality reports, and a logical format for SDTS data sets
- Section 2 -- a model to define spatial features, attributes, and attribute values
- Section 3 -- the byte-level logical format for SDTS data sets.

The various profiles, once approved, become additional sections. The SDTS is the Federal Government's standard for transferring spatial data.

2.2.3.4.3 The USIGS ISP of Basic Image Interchange Format (BIIF)

NITF 2.0 will be superseded by NITF 2.1, MIL-STD 2500B, (approved 22 August 1997 by the ISMC), and by the USIGS ISP of BIIF (ISO/IEC 12087-5 DIS) in the 1999 timeframe. NITF is the core of the NITF Suite of standards, and is coupled with additional standards for compression, graphics, and communications. It is mandated for all C4I systems disseminating secondary imagery, and is required for interoperability within the USIGS. The ISP and NITF 2.1 are technically equivalent and will not require

software upgrades to maintain interoperability. See NITFS Program Plan –DRAFT (NIMA Document NNPP) for more information.

2.2.3.4.4 FlashPix Format Specification V1.0

FlashPix format delivers a convenient new imaging architecture and image file format designed to meet the needs of a wide range of applications, solutions, and users.

FlashPix is an imaging architecture (with an associated file format) that delivers a balanced set of features that are significant to the growth of digital photography at the consumer and small business levels. These features were chosen to optimize the dimensions of performance, usability, and consistency. Many of the advantages of FlashPix are based on the concepts of resolution independence, an image processing chain of viewing parameters, the metadata and extension mechanisms, and unambiguous color definitions.

Developed collaboratively by Eastman Kodak Company, Hewlett-Packard Company, Live Picture Inc. and Microsoft Corp., FlashPix format technology incorporates many features from existing architectures or image formats. A major design feature is the capability to provide a customized resolution service influenced by the software or peripheral (monitor, printer) limitations. Third party application developers may purchase licensing and a Software Development Kit through Kodak.

2.2.3.4.5 JPEG 2000

The following information augments the first sentence in JTA 2.2.3.4 which stated "Within Data Interchange Services, wavelet techniques are being reviewed for inclusion in the NITFS imaging standard."

JPEG 2000 is the title given to the follow-on to the currently defined JPEG standard, but which will most likely be a wavelet based solution. A key feature of this compression is that it will be based on a "modular" architecture framework. This facilitates insertion of new technologies in the future, provides for flexibility, and facilitates the potential to "swap" modules based on compression requirements (quality, rate, etc.) of individual users.

Profile development of the JPEG 2000 standard could potentially begin once it is accepted as a Draft International Standard (DIS). As details of the document are available, and schedules are clearly defined, this strategic plan will provide information regarding implementation into the NITFS/BIIF suite of standards.

2.3 Information Transfer Standards

As stated in 2.2.2.2.1.6 there is no change to JTA mandated standards.

2.4 Information Modeling and Information Standards

USIGS developers will comply with the JTA for this service area, with the addition of the documents cited below. See [JTA97] Section 2.4.2.2 as it describes applicable DoD Data Standardization Procedures (DoD Manual 8320.1-M-1).

2.4.1 Geopolitical Country Codes - FIPS PUB 10-4

This publication directs the data element and representation codes for the interchange of information among Federal departments and independent agencies identifying countries, dependencies, areas of special sovereignty, and their principal administrative divisions. This standard is intended for applications involving the interchange of international data associated with the mission of the Department of State and national defense programs.

2.4.2 USIGS Data Model

The United States Imagery & Geospatial Information Data Model (USIGS/DM) defines support data for use throughout the USIGS Community. In addition, the Imagery View describes a conceptual framework that links imagery and geospatial information within the context of the DoD Data Model (DDM). As such, it is a significant step in meeting NIMA's overall mission to seamlessly integrate imagery and mapping information for DoD. The modeling effort is a continual process. The latest status and project information can be found on the NIMA website (URL: <http://www.nima.mil/org/se/seid/usigs.html>).

2.4.3 Emerging Standard for Data Modeling - Unified Modeling Language

The Unified Modeling Language (UML) is an emerging standard that can be used for data modeling. UML is a language for specifying, constructing, visualizing, and documenting the artifacts of a software-intensive system.

The Unified Modeling Language fuses the concepts of Booch's object-oriented design method, Rumbaugh's Object Modeling Technique (OMT), and Jacobson's Object-Oriented Software Engineering (OOSE). The result is a single, common, and widely usable modeling language for users of these and other methods. In particular, the UML contains elements that address the modeling of concurrent, distributed systems. UML focuses on a standard modeling language, not a standard process.

UML has been adopted by OMG, and is rapidly gaining acceptance by the CASE tool vendor community.

2.5 Human-Computer Interfaces

USIGS developers will refer to the JTA for this service area. See [JTA97] Section 2.5. The following paragraph profiles MIL-STD-2525A for USIGS.

2.5.1 Common Warfighting Symbology - MIL-STD-2525A

Common Warfighting Symbology, MIL-STD-2525A, specifies a common set of warfighting symbols, with the intent to enhance DoD's joint warfighting interoperability. The standard was previously cited as a graphics data interchange standard. The symbols must be compliant with the National Imagery Transmission Format Standards (NITFS) Computer Graphic Metafile (CGM) implementation.

2.6 Information Systems Security Standards

There is no change to JTA mandated standards.

Part 3. Electrical Standards

This part has no specific content in the current draft of the JTA. NIMA representatives on the appropriate JTA development groups intend to incorporate the necessary standards minimizing or negating the need for any additions or exceptions.

Part 4. Mechanical Standards

This part has no specific content in the current draft of the JTA. NIMA representatives on the appropriate JTA development groups intend to incorporate the necessary standards minimizing or negating the need for any additions or exceptions.

Appendix D: Acronyms

ACINT	Acoustic Intelligence
AFRTS	Armed Forces Radio and Television Service
AIG	Architecture Integration Group
AOI	area of interest
API	Application Program Interface
ARIDPCM	Adaptive Recursive Interpolated Differential Pulse Code Modulation
ARU	USIGS Architecture Division
ASD	Assistant Secretary of Defense
BGN	Board on Geographic Names
BIIF	Basic Image Interchange Format
BIMA	Basic Imagery and Mapping Annotations
BRI	Basic Rate Interface
C3I	Command, Control, Communications, and Intelligence
C4I	Command, Control, Communications, Computers, and Intelligence
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CCITT	International Telegraph and Telephone Consultative Committee (now ITU)
CFS	Center for Standards (DISA)
CGM	Computer Graphics Metafile
CIA	Central Intelligence Agency
CIL	Command Image Library
CINC	Commander in Chief

CISA	C4I Integration Support Activity
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
COE	Common Operating Environment
COMINT	Communications Intelligence
CONUS	Continental United States
CORBA	Common Object Request Broker Architecture
CSA	Common Support Application
CTE	Certification Test and Evaluation
DCE	Distributed Computing Environment
DCT	discrete cosine transform
DDDS	Defense Data Dictionary System
DDM	DoD Data Model
DIA	Defense Intelligence Agency
DII	Defense Information Infrastructure
DIS	Draft International Standard
DISA	Defense Information Systems Agency
DMA	Defense Mapping Agency (now part of NIMA)
DNS	Domain Name Service
DOC	Distributed Object Computing
DoD	Department of Defense
DOI	Department of the Interior
DOT	Department of Transportation
DPCM	Differential Pulse Code Modulation
DSSSL	Document Style Semantics and Specification Language

EGM	Earth Gravitational Model
ELINT	Electronic Intelligence
EPA	Environmental Protection Agency
FAS	Feature Annotation Service
FCS	Feature Compression Service
FEMA	Federal Emergency Management Agency
FGDC	Federal Geographic Data Committee
FGS	Feature Generalization Services
FIPS	Federal Information Processing Standard
GCTS	Geospatial Coordinate Transformation Services
GDAS	Geospatial Domain Access Services
GDS	Geospatial Dissemination Services
GIAS	Geospatial Information Access Services; Geospatial and Imagery Access Services
GIES	Geospatial Information Extraction Services
GIF	Graphics Interchange Format
GIRS	Geospatial Information Retrieval Services
GIS	Geographic Information System
GPIS	Geospatial Product Information Service
GPS	Global Positioning System
GSMC	Geospatial Standards Management Committee
GSMS	Geospatial Symbol Management Services
HCI	Human Computer Interface
I&RTS	Integration and Runtime Specification
IAS	Image Annotation Service

ICS	Image Compression Service
IDL	Interface Definition Language
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IES	Image Exploitation Services
IETF	Internet Engineering Task Force
IGC	Imagery and Geospatial Community
IGMS	Image Geometry Model Services
IMGS	Image Map Generation Services
IMS	Image Manipulation Services
IPL	Image Product Library
IR	Infra-Red
ISB	Intelligence Systems Board
ISMC	Imagery Standards Management Committee
ISO	International Organization for Standardization
ISP	International Standardized Profile
ISR	Intelligence, Surveillance, and Reconnaissance
ISS	Image Synthesis Services
IT	Information Technology
ITF	Integrated Task Force
ITSG	Information Technology Standards Guidance
ITU	International Telecommunications Union (formerly called CCITT)
IUS	Image Understanding Services
JCS	Joint Chiefs of Staff

JDK	Java Development Kit
JFIF	JPEG File Interchange Format
JIEO	Joint Interoperability & Engineering Organization
JITC	Joint Interoperability Test Command
JPEG	Joint Photographic Expert Group
JPL	Jet Propulsion Lab
JTA	Joint Technical Architecture
JTADG	JTA Development Group
JTC1	Joint Technical Committee 1 (ISO/IEC)
JTFs	Joint Task Forces
LE	Linear Error
LZW	Lempel-Ziv-Welch
MC&G	Mapping, Charting, & Geodesy
MPEG	Motion Pictures Expert Group
MSA	Mission Specific Application
NASA	National Aeronautics and Space Administration
NCCB	NIMA Configuration Control Board
NIL	National Image Library
NIMA	National Imagery and Mapping Agency
NIST	National Institute of Standards and Technology
NITF	National Imagery Transmission Format
NITFS	National Imagery Transmission Format Standard
NNPP	NIMA NITFS Program Plan
NNSS	Navy Navigation Satellite System

NRO	National Reconnaissance Office
NSA	National Security Agency
OA&D	Object Analysis and Design
ODP	Open Distributed Processing
OGC	Open GIS Consortium
OGE	Open Geospatial Exchange
OLTP	On-Line Transaction Processing
OMA	Object Management Architecture
OMG	Object Management Group
OMT	Object Modeling Technique
OOSE	Object-Oriented Software Engineering
OSD	Office of the Secretary of Defense
OSE	Open System Environment
PAS	Publicly Available Specification
PEO	Program Executive Office
PHIGS	Programmer's Hierarchical Interactive Graphics System
PNG	Portable Network Graphics
POSIX	Portable Operating Systems Interface
PREMO	Presentation Environment for Multimedia Objects
PRI	Primary Rate Interface
RFP	Request for Proposals
RM	Reference Model
RPC	Remote Procedure Call
RPF	Raster Product Format

SAR	Synthetic Aperture Radar
SCC	Standards Coordinating Committee
SDTS	Spatial Data Transfer Standard
SGML	Standard Generalized Markup Language
SHADE	Shared Data Environment
SPID	Standards Profile for Imagery Distribution
SQL3	Structured Query Language 3
TADIL	Tactical Digital Information Link
TAFIG	Technical Architecture Framework and Implementation Guidance
TAFIM	Technical Architecture Framework for Information Management
TBD	To Be Determined
TBR	To Be Resolved
TFRD	Tape Format Requirements Document
TRM	Technical Reference Model
UIP	USIGS Interoperability Profile
UML	Unified Modeling Language
URL	Uniform Resource Locator
USD(A&T)	Undersecretary of Defense (Acquisition and Technology)
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USIGS	United States Imagery and Geospatial information System
USIS	United States Imagery System
UTA	USIGS Technical Architecture
UTM	Universal Transverse Mercator

UTRM	USIGS Technical Reference Model
VPF	Vector Product Format
VQ	Vector Quantization
VRML	Virtual Reality Markup Language
VSP	Video Standards Profile
VWG	Video Working Group
WG1	Working Group 1
WGS	World Geodetic System

For a more complete set of USIGS acronyms, see the USIGS Glossary [Ugloss97].

Appendix E: References

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