GIS Brick and Pattern Working Group D. West
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NIH Geographic Information System (GIS) Standards V1.0

Status of this Memo

This memo proposes a standard for the NIH architecture community. Distribution of this memo is unlimited.

Table of Contents

1 Introduction

The intent of this NIHRFC is to recommend a set of standards and technologies, including patterns and bricks, for implementing Geographic Information Systems (GIS) at the National Institutes of Health (NIH). Although this NIHRFC proposes a set of standards for NIH, it is expected that NIH's expanding efforts in this area may result in the adoption of additional standards within the next couple of years.

This NIHRFC is issued for the benefit of community members. The information contained in this document is accurate as of the date of publication, but is subject to change. Subsequent NIHRFCs will reflect such changes.

2 GIS Technology

A Geographic Information System (GIS) integrates people, processes, hardware, software, and data for capturing, creating, managing, analyzing and displaying all forms of geographically linked information. It can serve as a robust tool used to import, export, layer, or merge existing data to allow for extensive data analysis.

A GIS supports a wide array of functions ranging from geo-computation to cartography/visualization and may require an operational staff with diverse expertise. Staff may be experienced in systems analysis, database systems administration, GIS or Web programming. Most GIS experts also have backgrounds in geography or earth sciences as well as master's degrees in various information technologies. A more detailed breakdown of GIS functions and recommended GIS staff expertise are displayed in the table below:

Table 1: GIS Functions and Staff Expertise

GIS Functions	Expertise Recommended for GIS Staff	GIS Task Examples
Geospatial Data Gathering	Geography, Urban Planning, Civil Engineering, Surveying	GPS, Geo-referencing, Datum, Land Surveying, Field Data Collection
Geo-processing (data computation, modeling, analysis)	Geography, Urban Planning, Civil Engineering, Statistics, Geo-matics, Mathematics & Geometry, Data Mining & Modeling	Simulation Modeling, Uncertainty Modeling, Fuzzy Sets, Geometric Measures, Spatial Statistics, Basic Analysis, Network Analysis, Vector and Object Models, 2.5 and 3D Modeling
Geospatial Data Design & Management	Geo-database Administration	RDBMS, Resource Planning, Geo-data Design & Implementation
Cartography and Visualization	Geography, Urban Planning, Cartography, Drafting, Web Design	Map Design, Graphic Representation, Map Production, Map Use and Evaluation

Currently, Geographical Information Systems are used in a variety of ways by NIH Institutes and Centers (ICs). For example, the National Cancer Institute (NCI) uses GIS to display data from the Surveillance, Epidemiology and End Results (SEER) Program, a premier source for cancer statistics in the United States. The National Library of Medicine (NLM) has developed a GIS application called NOMC to demonstrate advanced mapping and reporting options for the National Network of Libraries of Medicine. GIS is also being used by the NIH Office of Research Facilities (ORF) to display NIH building locations and to report on building maintenance status. Along with IC's, other NIH stakeholders may include the Office of the Director, Office of Communications and Office of Science Policy. Typical GIS users at NIH may range from program analysts and program officials to science policy analysts and public affairs

specialists. Access to GIS provides these users with the ability to analyze complex relationships between projects, scientific infrastructure and outcomes not apparent through text searches or standard Information for Management, Planning, Analysis, and Coordination (IMPAC) II queries. Moreover, a GIS (if publically available) increases public and scientific community access to information on Institute, Center, and NIH funded research.

Expansion of search engine and geospatial capabilities at an enterprise level is beneficial to NIH, our business intelligence programs, and its partners by enhancing access to information on resources, collaboration and partnering possibilities, and adding a new dimension to communications about NIH programs.

2.1 GIS Pattern

Description

The diagram below describes a potential implementation plan for a NIH IC GIS pattern and presents multiple options for publishing and consuming NIH geospatial data. Data can be displayed via a GIS desktop software application (see GIS Desktop Brick) or a Virtual Globe software application (see GIS Virtual Globe Brick). Both applications allow the user to create, display, analyze, query and publish geospatial data. However, the Virtual Globe application allows the user to navigate around a 3D representation of the earth and supports the creation and display of features on the 3D model.

Geospatial data can also be accessed and displayed through a standard Web browser and Web server. The data may be served either by an in-house (see GIS Internet Mapping Server (IMS) Brick) or third party (see GIS Web Service Brick) through reference layer(s) accessed via an internet browser. A web-based GIS display may include a querying component that accesses data directly from the NIH data repositories (IMPAC II, IRDB and Data Mart) through database connectors.

NIH electronic Research Administration (eRA) is currently developing a batch process (on a weekly basis) to call a third party geo-coding web service to generate the geographic data including latitude, longitude and precision for the external organizational ID mailing addresses currently active in the IMPAC II database. The geo-coding pilot was included in the January 2010 IMPAC II enterprise release (Contact eRA Team 5 lead: Patti Gaines, pgaines@mail.nih.gov). NIH eRA will also be responsible for geo-coded data quality control and geo-coded data updates.

Care must be taken to ensure compliance with licenses for software, data, and services. For example, if Google Web Service is used to obtain geo-code location data from street addresses, one may only use that data with Google Maps. This limitation would preclude loading the data into a shared NIH database as this limitation could not be enforced. Similarly, if an application uses a service that restricts use of the data to internal users, that data would not be able to be made available to the public for download.

For GIS security considerations, see section 5 in this document.

Diagram

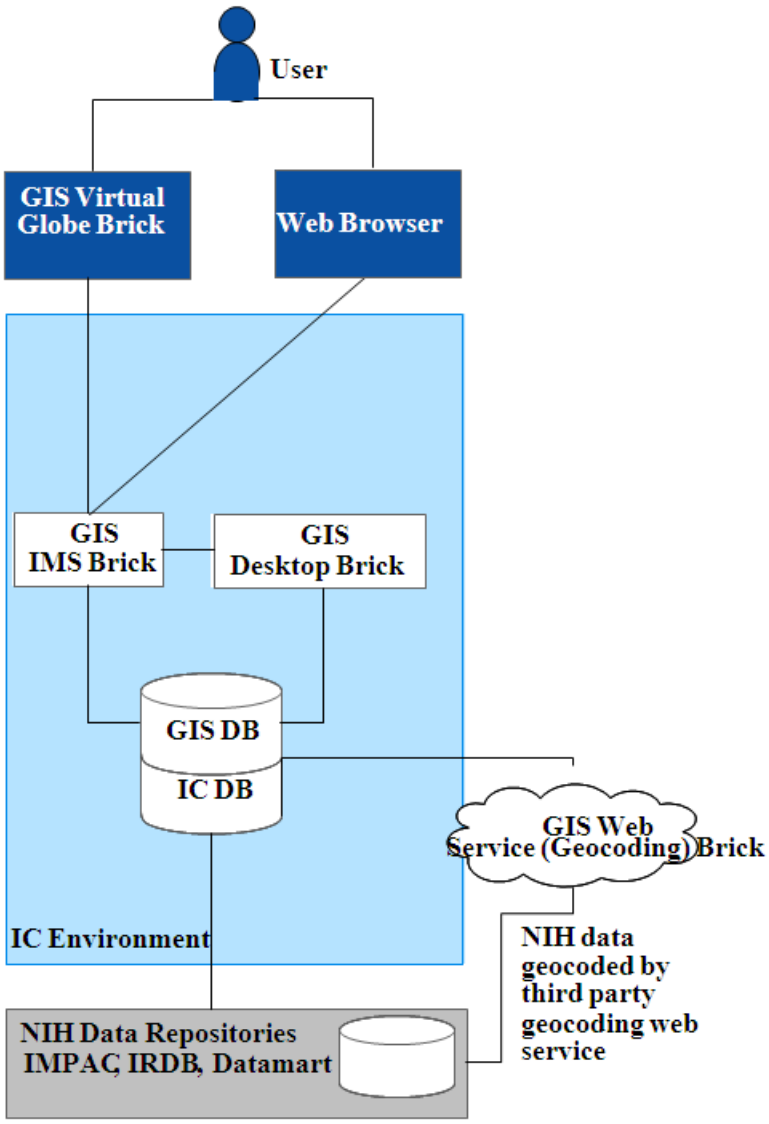

Figure 1: The diagram above describes a potential implementation plan for a NIH IC GIS pattern

Benefits

- Geo-codes stored in the eRA data repository (IMPAC II) will improve the geo-code quality and accuracy across NIH ICs.

Limitations

- See licensing discussion in Section 2.1 description

2.2 GIS Desktop Brick

Description

GIS Desktop applications allow a user to create, display, analyze, query and publish geographic data via desktop. Normal use-case scenario of this brick occurs at the desktop by trained professionals. Typical uses include geo-processing.

Brick

Tactical (0-2 years)	**Strategic** (2-5 years)
▪ ESRI ArcGIS* ▪ Autodesk MapGuide OpenSource ▪ Intergraph GeoMedia WebMap Professional ▪ Pitney Bowes MapInfo ▪ Quantum GIS	▪ ESRI ArcGIS* ▪ Autodesk MapGuide OpenSource ▪ Intergraph GeoMedia WebMap Professional ▪ Pitney Bowes MapInfo ▪ Quantum GIS
Retirement (To be eliminated)	**Containment** (No new development)
	▪ Manifold GIS ▪ Archibus GIS
Baseline (Today)	**Emerging** (To track)
▪ ESRI ArcGIS* ▪ Autodesk MapGuide OpenSource ▪ Intergraph GeoMedia WebMap Professional ▪ Pitney Bowes MapInfo ▪ Quantum GIS ▪ Manifold GIS ▪ Archibus GIS	▪ Global Positioning System (GPS)

Comments

- GIS Products were selected based upon findings of the Gartner Market Report [Requires NIH Login] and the NLM Market Survey [Requires NIH Login]
- NIH/ Office of Research Services (ORS) currently has enterprise site license for ESRI ArcGIS
- Other products may be considered if they adhere to these standards and provide other capabilities or cost benefits.
- For tactical deployment product must:
  - Support Federal Geographic Data Committee (FGDC) Standards
  - Support Open Geospatial Consortium (OGC) Standards
  - Support integration and interoperability with existing and planned infrastructure
  - Support custom cartography
  - Support basic spatial analysis
  - Maintain, when usage includes heavy editing, topological integrity
  - Connect, when usage includes large storage, with spatial RDBMS
  - Support, when usage includes remote sensing, raster
  - Support, at a minimum, data export to one of the following:
    - Open Geospatial Consortium (OGC) Keyhole Markup Language (KML)
    - ESRI Shapefile

        - CAD (Computer Aided Design)
    - Support section 508 compliance
    - Support at a minimum at least one NIH Standard Web Browser per OS environment
- Tactical and Strategic products were selected to leverage NIH's investment in products that are a proven fit for NIH's known future needs. Leveraging baseline products in the future will minimize the operations, maintenance, support and training costs of new products.
- Some baseline products have been designated Retirement and Containment. These products are either not as widely or successfully deployed at NIH, or they do not provide as much functionality, value, or Total Cost of Ownership as the selected Tactical and Strategic products.
- *Note Google, Microsoft, ESRI etc frequently update their geo-data licensing (which they may themselves lease from other providers like Tele Atlas, NAVTEQ etc). For more detail on licensing limitations see licensing discussion in Section 2.1 description.

2.3 GIS Virtual Globe Brick

Description

GIS Virtual Globe applications allow the user to navigate around a 3D representation of the earth, and supports creation and display of features on its 3D model. Normal use-case scenario of this brick occurs at the desktop by end-users. Typical uses include cartography and visualization.

Brick

Tactical (0-2 years)	**Strategic** (2-5 years)
▪ ESRI ArcGIS Explorer* ▪ Google Earth* ▪ Microsoft Bing Maps for Enterprise (web only)* ▪ NASA World Wind	▪ ESRI ArcGIS Explorer* ▪ Google Earth* ▪ Microsoft Bing Maps for Enterprise (web only)* ▪ NASA World Wind
Retirement (To be eliminated)	**Containment** (No new development)
Baseline (Today)	**Emerging** (To track)
▪ ESRI ArcGIS Explorer* ▪ Google Earth* ▪ Microsoft Bing Maps for Enterprise (web only)* ▪ NASA World Wind	▪ Global Positioning System (GPS) ▪ Location Based Service (LBS) ▪ Social Networking

Comments

- GIS Products were selected based upon findings of the Gartner Market Report [Requires NIH Login] and the NLM Market Survey [Requires NIH Login]
- For tactical deployment product must:
    - Support Federal Geographic Data Committee (FGDC) Standards

  - Support Open Geospatial Consortium (OGC) Standards
  - Support integration and interoperability with existing and planned infrastructure
  - Support custom cartography
  - Support, at a minimum, one 3D modeling software
  - Support section 508 compliance
  - Support at a minimum at least one NIH Standard Web Browser per OS environment
- Tactical and Strategic products were selected to leverage NIH's investment in products that are a proven fit for NIH's known future needs. Leveraging baseline products in the future will minimize the operations, maintenance, support and training costs of new products.
- Some baseline products have been designated Retirement and Containment. These products are either not as widely or successfully deployed at NIH, or they do not provide as much functionality, value, or Total Cost of Ownership as the selected Tactical and Strategic products.
- * Note Google, Microsoft, ESRI etc frequently update their geo-data licensing (which they may themselves lease from other providers like Tele Atlas, NAVTEQ etc). For more detail on licensing limitations see licensing discussion in Section 2.1 description.

2.4 GIS Internet Mapping Server (IMS) Brick

Description

GIS Internet Mapping Server allows a user to serve geographic data and in-house reference layer(s) via the internet. Normal use-case scenario of this brick occurs at the server by trained professionals. Typical uses include publishing private domain data and in-house reference layer(s).

Brick

Tactical (0-2 years)	**Strategic** (2-5 years)
▪ ESRI ArcGIS Server and ArcIMS* ▪ Autodesk MapGuide Opensource ▪ MapServer Opensource ▪ Intergraph Geomedia WebMap Professional	▪ ESRI ArcGIS Server and ArcIMS* ▪ Autodesk MapGuide Opensource ▪ MapServer Opensource ▪ Intergraph Geomedia WebMap Professional
Retirement (To be eliminated)	**Containment** (No new development)
	▪ Pitney Bowes MapXtreme
Baseline (Today)	**Emerging** (To track)
▪ ESRI ArcGIS Server and ArcIMS* ▪ Autodesk MapGuide Opensource ▪ MapServer Opensource ▪ Intergraph Geomedia WebMap Professional ▪ Pitney Bowes MapXtreme	▪ Global Positioning System (GPS) ▪ Location Based Service (LBS) ▪ Software as a Service (SaaS)

Comments

- GIS Products were selected based upon findings of the Gartner Market Report [Requires NIH Login] and the NLM Market Survey [Requires NIH Login]
- For tactical deployment product must:
  - Support Federal Geographic Data Committee (FGDC) Standards
  - Support Open Geospatial Consortium (OGC) Standards
  - Support integration and interoperability with existing and planned infrastructure
  - Support custom cartography
  - Support section 508 compliance
  - Support at a minimum at least one NIH Standard Web Browser per OS environment
- Tactical and Strategic products were selected to leverage NIH's investment in products that are a proven fit for NIH's known future needs. Leveraging baseline products in the future will minimize the operations, maintenance, support and training costs of new products.
- Some baseline products have been designated Retirement and Containment. These products are either not as widely or successfully deployed at NIH, or they do not provide as much functionality, value, or Total Cost of Ownership as the selected Tactical and Strategic products.
- * Note Google, Microsoft, ESRI etc frequently update their geo-data licensing (which they may themselves lease from other providers like Tele Atlas, NAVTEQ etc). For more detail on licensing limitations see licensing discussion in Section 2.1 description.

2.5 GIS Web Service Brick

Description

GIS Web Service allows a user to display geographic data over third-party reference layer(s) accessed via the internet. Normal use-case scenario of this brick occurs at the server by Administrators. Typical uses include consuming public domain data and third-party reference layer(s) services.

Brick

Tactical (0-2 years)	**Strategic** (2-5 years)
▪ ESRI ArcWeb Service* ▪ Google Maps* ▪ Microsoft Bing Maps for Enterprise* ▪ OpenLayers & OpenStreetMap ▪ USC GIS Research Laboratory – US Addresses ▪ GeoNames.org – International Addresses	▪ ESRI ArcWeb Service* ▪ Google Maps* ▪ Microsoft Bing Maps for Enterprise* ▪ OpenLayers & OpenStreetMap
Retirement (To be eliminated)	**Containment** (No new development)

Baseline (Today)	Emerging (To track)
▪ ESRI ArcWeb Service* ▪ Google Maps* ▪ Microsoft Bing Maps for Enterprise* ▪ OpenLayers & OpenStreetMap ▪ USC GIS Research Laboratory – US Addresses ▪ GeoNames.org – Intl Addresses	▪ Cloud Computing ▪ Social Networking

Comments

- GIS Products were selected based upon findings of the Gartner Market Report [Requires NIH Login] and the NLM Market Survey [Requires NIH Login]
- For tactical deployment product must:
  - Support Federal Geographic Data Committee (FGDC) Standards
  - Support Open Geospatial Consortium (OGC) Standards
  - Support integration and interoperability with existing and planned infrastructure
  - Support custom cartography
  - Support section 508 compliance
  - Support at a minimum at least one NIH Standard Web Browser per OS environment
- Tactical and Strategic products were selected to leverage NIH's investment in products that are a proven fit for NIH's known future needs. Leveraging baseline products in the future will minimize the operations, maintenance, support and training costs of new products.
- Some baseline products have been designated Retirement and Containment. These products are either not as widely or successfully deployed at NIH, or they do not provide as much functionality, value, or Total Cost of Ownership as the selected Tactical and Strategic products.
- * Note Google, Microsoft, ESRI etc frequently update their geo-data licensing (which they may themselves lease from other providers like Tele Atlas, NAVTEQ etc). For more detail on licensing limitations see licensing discussion in Section 2.1 description.

2.6 GIS Brick Summary Matrix

The matrix below summarizes if a GIS vendor listed under tactical/strategic has developed a product for a brick.

GIS Vendor Name	GIS Desktop Brick	GIS Virtual Globe Brick	GIS IMS Brick	GIS Web Service Brick
ESRI	Yes	Yes	Yes	Yes
Opensource	Yes	Yes	Yes	Yes
Autodesk	Yes	No	Yes	No
Intergraph	Yes	No	Yes	No
Google	No	Yes	No	Yes
Microsoft	No	Yes	No	Yes
Pitney Bowes	Yes	No	No	No

3 References

- Federal Geographic Data Committee (FGDC Standards) http://www.fgdc.gov/standards
- Open Geospatial Consortium (OGC Standards) http://www.opengeospatial.org/standards is an umbrella-term and includes KML (Keyhole Markup Language), WMS (Web Mapping Service) (eg: http://columbo.nrlssc.navy.mil/ogcwms/), WFS (Web FeatureService) etc
- NLM's Market Study of Internet Mapping Server (IMS) - Summary Matrix
- Open Geospatial Consortium (OGC) Mashup: http://www.whitehouse.gov/change/
- http://www.cio.gov/documents/FEA_Geospatial_Profile_v1%201%20_2_again.pdf
- http://www.hhs.gov/web/508/
- http://publicaccess.nih.gov/

4 Contact

To contact the NIHRFC Editor, send an email message to EnterpriseArchitecture@mail.nih.gov.

5 Security Considerations

Security considerations may depend on how the geo-coded data are aggregated and displayed in map visualization. Most GIS systems are non-editable and display data to the public that is read-only, thus decreasing security risk.

Additional security considerations will be based on the type of data within the geospatial system and the security controls embedded within the sources of the geospatial data.

6 Changes

Version	Date	Change	Authority	Author of Change
0.1	10/28/2009	Brick and Pattern Revisions.	Dorothy West	Dorothy West
0.2	11/2/2009	Minor content edits.	Dorothy West	Steve Thornton
0.3	11/2/2009	Minor Intro and Brick Edits	Dorothy West	Dorothy West
0.4	11/12/2009	Brick Revisions	Dorothy West	Harsh Prakash
0.5	11/16/2009	Minor Pattern Revisions	Dorothy West	Dorothy West
0.6	11/20/2009	Minor edits, assignment of NIHRFC number	NIHRFC 0001	Anja Holovac – NIH OCITA
0.7	12/22/2009	Inclusion of comments by eRA team	NIHRFC 0001	Dorothy West
0.8	1/12/2010	Minor formatting changes	NIHRFC 0001	Kiley Ohlson – NIH OCITA
0.9	2/19/2010	Inclusion of comments by ITMC Enterprise Architecture Subcommittee	NIHRFC 0001	Dorothy West
0.10	2/22/2010	Inclusion of additional comments by ITMC Enterprise Architecture Subcommittee	NIHRFC 0001	Dorothy West

Version	Date	Change	Authority	Author of Change
1.0	2/23/2010	Approved by the ARB	ARB	Kiley Ohlson

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Appendix A

Below are the consolidated comments from eRA team.

Section	Comment	Action Taken
Section 2 (Suggested Edit)	Change "Grants" to "Projects" to make it broader so customers have flexibility to use other data sources such as R&D Contracts and/or Intramural Projects.	Edit incorporated into version 0.7 on 12/22/09
Section 2.5 (Suggested Edit)	Add eRA Geo-coding API's to GIS Web Service Brick: - USC GIS Research laboratory – US Addresses - http://www.geonames.org/ - International Addresses	Edit incorporated into version 0.7 on 12/22/09
Section 2.1 (Suggested Edit)	Change the "NIH Geo-coded Data" label in figure 1 to read "NIH Data Geo-coded by Third Party Geo-coding Webservice"	Edit incorporated into version 0.7 on 12/22/09
Section 2.1 (Suggested Edit)	NIH electronic Research Administration (eRA) is currently developing a batch process (on a weekly basis) to call a third party geo-coding webservice to generate the geographic data including latitude, longitude and precision for the external organizational ID mailing	Edit incorporated into version 0.7 on 12/22/09

	addresses currently active in the IMPAC II database. This geo-coding pilot is set to be included in the January 2010 IMPAC II enterprise release (Contact eRA Team 5 lead: Patti Gaines, pgaines@mail.nih.gov). NIH eRA will also be responsible for geo-coded data quality control and geo-coded data updates.	
Section 2.1 (Suggested Edit)	Care must be taken to ensure compliance with licenses for software, data, and services. For example, if you use the Google Web Service to obtain geo-code location data from street addresses, you may only use that data with Google Maps. This limitation would preclude loading the data into a shared NIH database as this limitation could not be enforced. Similarly, if an application uses a service that restricts use of the data to internal users, that data would not be able to be made available to the public for download.	Edit incorporated into version 0.7 on 12/22/09
Section 2.1 (Suggested Edit)	Under Limitations and in Sections 2.2, 2.3, and 2.4 bricks in comments add: See licensing discussion in Section 2.1 Description.	Edit incorporated into version 0.7 on 12/22/09

Below are the consolidated comments from the ITMC Enterprise Architecture Subcommittee.

Section	Comment	Action Taken
Section 2.2 (Suggested Edit)	Normal use-case scenario of GIS Desktop brick occurs at the desktop by trained professionals. Typical uses include geo-processing.	Edit incorporated into version 0.9 on 2/19/10
Section 2.3 (Suggested Edit)	Normal use-case scenario of GIS virtual globe brick occurs at the desktop by end-users. Typical uses include cartography and visualization.	Edit incorporated into version 0.9 on 2/19/10
Section 2.4 (Suggested Edit)	Normal use-case scenario of GIS IMS brick occurs at the server by trained professionals. Typical uses include publishing private domain data and in-house reference layer(s).	Edit incorporated into version 0.9 on 2/19/10

Section 2.5 (Suggested Edit)	Normal use-case scenario of this GIS web service brick occurs at the server by Administrators. Typical uses include consuming public domain data and third-party reference layer(s) services.	Edit incorporated into version 0.9 on 2/19/10
Section 2.6 (Suggested Edit)	Provide a summary matrix of tactical and strategic vendors and their appearances in each brick	Edit incorporated into version 0.9 on 2/19/10
Section 2.2 – 2.5 Comments Section (Suggested Edit)	Provide references to Gartner Market Report and NLM Market Survey for product selection criteria	Edit incorporated into version 0.9 on 2/19/10
Section 2.2 – 2.5 Comments Section (Suggested Edit)	Note Google, Microsoft, ESRI etc frequently update their geo-data licensing (which they may themselves lease from other providers like Tele Atlas, NAVTEQ etc).	Edit incorporated into version 0.9 on 2/19/10
Section 2.2 – 2.5 Comments Section (Suggested Edit)	Support at a minimum at least one NIH Standard Web Browser per OS environment	Edit incorporated into version 0.9 on 2/19/10
Section 2.0 (Suggested Edit)	Along with IC's, other NIH stakeholders may include the Office of the Director, Office of Communications, Office of Science Policy. Typical GIS users at NIH may range from program analysts and program officials to science policy analysts and public affairs specialists.	Edit incorporated into version .10 on 2/22/10
Section 2.1 (Suggested Edit)	The diagram below describes a potential implementation plan for a NIH IC Geographic Information System pattern and presents multiple options for publishing and consuming NIH geospatial data.	Edit incorporated into version .10 on 2/22/10
Section 2.1 – Figure 1	Arrows were removed and pattern was revised to lessen complexity	Edit incorporated into version .10 on 2/22/10