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ITP5127

# Implementing an Enterprise-Wide Geographic Information System Using an IRM-Centric Approach: A Case Study of the US Air Force Geobase Program

Mario L. Oliver
HQ 8 AF, Det 1/DOR, 245 Davis, Suite 345, Barksdale AFB LA 7110, USA, mario.oliver@barksdale.af.mil

Ellen C. England and Summer E. Bartczak
Dept of Systems & Engineering Mgt, Air Force Institute of Technology, 2950 Hobson Way, Bldg., 641,
Wright Patterson AFB OH 45433, USA, T: 937-255-3636, {ellen.england, summer.bartczak@afit.edu}

*The views expressed in this article are those of the author and do not necessarily reflect the official policy of or position of the Air Force, Department of Defense, or US Government.*

## ABSTRACT

This paper presents the findings of a case-study analysis of the applicability and application of IRM principles to the implementation of an Air Force enterprise-wide geographic information system called GeoBase. The research first distills an improved IRM definition by building on key IS academic literature and by adding reference to key Federal documents that outline/mandate IRM in the US government. The refined IRM definition is then compared to the key governing implementation tenants of GeoBase (which are delineated through a model called the GeoBase Sustainment Model) to determine the program's "IRM health." The results of the analysis showed that the current GeoBase implementation program is addressing most of the IRM principles indicated as critical by the academic, business and Federal literature. As such, the research indicates that the implementation approach/model used for GeoBase provides an excellent guide for any government enterprise-wide information system insertion efforts that must be based on sound IRM principles.

## INTRODUCTION

US companies spent more than $250 billion each year in the 1990s on information system and technology (IS&T) projects (The Standish Group, 1994). Furthermore, the US government expends approximately $25 billion annually on IS&T (Cook, 1996). However, the overall success rate of IT projects is below 20 percent (Crescenzi, 1988; The Standish Group, 1994). Increasing the success rate of IS&T projects equates to billions of dollars in savings.

The 1990s also experienced a diffusion of geographic information systems (GIS). Specifically, many military installations adopted GIS technology (Foresman, 1998). Rapid technological developments created a gap between potential benefits of GIS and the frustrations realized due to an inability to assimilate GIS into business processes (Cullis, 1995). The lack of a coherent service-wide insertion process led to the failure of all DoD-sponsored GIS (Cullis 2000).

GeoBase represents the most recent attempt to exploit GIS across the Air Force. Having begun GeoBase implementation without a precise roadmap, GeoBase leadership developed what became known as the GeoBase Sustainment Model (GSM) to reflect what they believed would be the key planning, design, and implementation issues. In doing so, they made every attempt to address classic IS implementation issues as well address the IRM mandates directed upon them as a Federal/DoD IS program. The motivation for this research was to investigate whether the GSM adequately captured the spectrum of key IRM principles (which would also be determined by this research).

## RESEARCH QUESTIONS

In order to qualitatively assess the adequacy of the GeoBase Sustainment Model with respect to key IRM principles, the following research questions were investigated:

1. What are the key dimensions/principles of the IRM construct as it applies to this research?
2. How does the GeoBase Program, as represented by the GeoBase Sustainment Model, address key dimensions of IRM as specified by the academia and the Federal Government?
3. What changes, if any, are required to update the current GeoBase Sustainment Model to ensure better "IRM health"?

## LITERATURE REVIEW

A single definition of IRM has not been universally accepted by either the business or academic arenas. Furthermore, the current Federal definition lacks the specificity required to have great value. As such, for this research, a new operational definition of IRM had to be determined. The following section describes the development of IRM definitions in the academic, Federal Government, and the AF GeoBase program Literature.

### IRM in Literature

The literature abounds with many IRM definitions. As Lewis, Snyder, and Rainer (1995) point out, several of these definitions attempt to expound upon the constituent parts of IRM (information, resources, and management). Lytle (1988) and O'Brien and Morgan (1991), among others, provide their analysis of the IRM literature by presenting IRM as comprised of distinct fields. For example, O'Brien and Morgan relate a model comprised of resource, technology, functional, strategic, and distributed management aspects, which all interact. Such definitions lack the specificity and completeness required to evaluate the research questions.

Following their review of IRM literature in 1995, Lewis, Snyder, and Rainer synthesized the following inclusive definition:

*IRM is a comprehensive approach to planning, organizing, budgeting, directing, monitoring and controlling the people, funding, technologies and activities associated with acquiring, storing, processing and distributing data to meet a business need for the benefit of the entire enterprise (1995, p. 204).*

They went on to operationalize and test the IRM construct. Developing an instrument and using exploratory factor analysis, Lewis et al. identified eight dimensions underlying IRM. This formed the foundation for the researcher's IRM definition, but did not necessarily address the unique aspects of IRM within the Federal Government.

**IRM and the CIO**

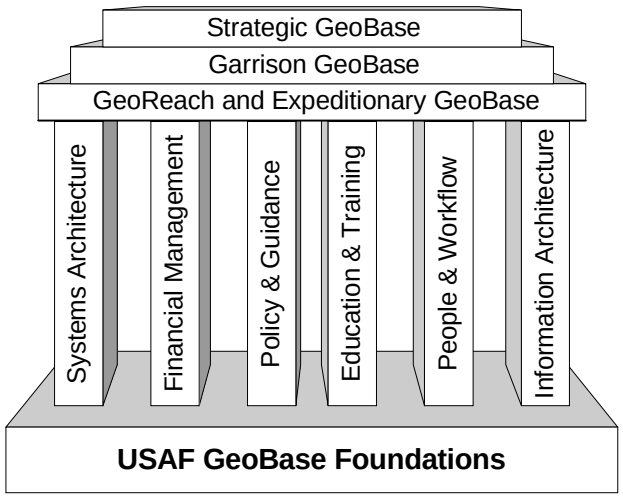
Each Federal agency relies on the following official IRM definition. According to the Office of Management and Budget (OMB) Circular A-130 (1996), IRM means "the process of managing information resources to accomplish agency missions. The term encompasses both information itself and the related resources which can be those such as personnel, equipment, funds, and technology. Further Federal regulations charge each agency to establish a CIO responsible for executing IRM. Therefore, an understanding of the duties of a CIO provide another resource for the creation of an operational IRM definition.

Synnott and Gruber coined the term "chief information officer" in 1981. Since then, the CIO function has been the subject of many academic studies and business articles. However, the term still maintains a similar meaning. CIOs are "responsible for all of their organization's information assets and associated technologies" (Smith, 2002, p. 71). The Federal Government defines the CIO role similarly.

The Clinger-Cohen Act (CCA) of 1996 established the position of the CIO within the Federal Government and focuses on IT and the acquisition process. In fact, the CCA refers to same OMB definition of IRM given above. This definition leaves CIOs without clear, specific direction concerning their role as an IRMer. Therefore, Federal CIOs turn to other resources.

The National Defense University (NDU) instructs students in a program "directly related to the CIO competencies identified by the Federal CIO Council", expanding the CIO concept beyond that found in current legislation (NDU: IRM College). Likewise, the office of the USAF CIO (AF-CIO) mirrors the NDU's IRM dimensions, indicating architecture, process improvement, capital planning and investment, acquisition, performance measures, and strategic planning among its nine focus areas (2000). IRM is also listed as its own AF-CIO focus area separate from all others.

*Figure 1. GeoBase Sustainment Model (adapted from Cullis, 2003)*




**IRM Principles Represented in the Anecdotal GSM**

The GeoBase program provides USAF commanders a geospatially-accurate, integrated view of all base maps (communication and power lines, roads, buildings, etc) using a GIS. The GSM contains six pillars resting on the "USAF GeoBase Foundations" and supporting the three slightly varied applications of the GeoBase program (generically considered one program for the purposes of this paper) used to provide all commanders at all locations and levels an integrated map (Figure 1). Strategic, Garrison, and Expeditionary GeoBase and GeoReach will be. Each of the pillars captures challenges in planning, designing, or implementing the program, as well as IRM. The research focuses on the pillars, because they represent the IRM tenets of the model.

## METHODOLOGY

Two primary methods were employed in conducting this research; a content analysis (Weber, 1990) of the literature to determine an operational definition of IRM, and a multiple-case study analysis (Yin, 1993) to determine application/applicability of the concept to a real-world GIS implementation. The case studies included three major GeoBase implementation sites where an extensive pool of data relating to the actual IRM implementation of GeoBase and the GSM was gained via multiple interviews. Content analysis provided the tool used to synthesize the disparate IRM literature and also to match the operational definition of IRM to the tenets of the anecdotal model (GSM ).

**Results**

Following the order of the research questions, this section presents an analysis of the research findings. The operational definition of IRM is discussed first followed by a comparison to the GSM.

**Key Dimensions of IRM**

The key dimensions of IRM had to be established to overcome the lack of a singularly-accepted, comprehensive IRM definition. Additionally, the research attempted to expand existing IRM definitions to encompass Federal government tenets. The content analysis presented extended the work of Lewis, Snyder, and Rainer (1995), setting a solid foundation to investigate the GSM representation of IRM (Oliver, 2004).

The content analysis confirmed the 1995 work of Lewis, Snyder, and Rainer and justified its use with respect to this research. To begin, the content analysis revealed all of the major categories specified by Lewis et al. are represented. Figure 2 presents the results of the content analysis with respect to the major categories. In the same figure, the major dimensions of IRM are listed as are the analyzed content's sources. A checkmark indicates the respective dimension was referenced in the source document.

Analysis of the GSM required a more thorough content analysis of IRM dimensions to overcome the disparate lexicon of the GIS-based program. The task-level categories for IRM dimensions presented by Lewis, Snyder, and Rainer (1995) provided a more exacting basis for a comparison of the components of the GSM. However, the IRM content analysis did give cause to drop three dimensions from the set proposed by Lewis et al. Additionally, none of the Federal documentation examined referenced these three dimensions.

The categories for IRM dimensions presented by Lewis, Snyder, and Rainer (1995) did not capture all the tenets of IRM found in the broad range of literature. After a thorough examination, two additional major categories were considered: knowledge management (KM) and education and training. These concepts were referenced by a majority of the literature articles and Federal documents. Given the number of references to the education and training of IRM personnel and leadership education, Lewis et al did not fully specify training in their set of IRM dimensions. Education and training was added as a major IRM dimension with the subcategories of user training, education and training of IRM personnel, and leadership education to fully represent the spectrum of ideas found in the IRM literature. Although the researcher recognizes

*Figure 2. IRM Content Analysis Results*

| IRM Dimensional Categories | IRM Literature from Academia | | | | | | | | CIO Literature and Federal Documents | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lewis et al (1995) | Davies (1987) | Lytle (1988) | Owen (1989) | Trauth (1989) | O'Brien and Morgan (1991) | Feeny and Willcocks (1998) | Guimaraes (1988) | Clinger-Cohen Act (1996) | 44 USC 3506 | OMB A-130 No. 4 (2000) | AF-CIO Focus Areas | AFFIRM Survey (2001) | AF Information Strategy (2002) | Benjamin et al (1985) | Stephens et al (1992) |
| Chief Information Officer | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Planning | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Security | ✓ | ✓ | | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Technology Integration | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | ✓ |
| Advisory Committees | ✓ | | | ✓ | | ✓ | | | | | | ✓ | | ✓ | | |
| Enterprise Model | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Information Integration | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | | ✓ | ✓ | | ✓ |
| Data Administration | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |

that KM and IRM are related, the concept was not included as a part of this research due to the fact that KM is a concept that is struggling for definition as well.

**General Comparison of IRM and the GSM**

The first-order analysis of the GSM with respect to the major IRM dimensions indicated the model more than adequately represents the key dimensions. As indicated in Table 1, all the major IRM dimensional categories, except the use of advisory committees, map to a concept presented as a major component/emphasis area of the GSM. Although a robust model, the GSM is underspecified with respect to the key dimensions of IRM (as determined by the literature review). The following discussion will expand upon this assertion.

**Detailed Comparison of IRM and the GSM**

A more exhaustive comparison of the GSM to the entire set of key IRM dimensions further verified the model addresses IRM exceptionally well. Using the content analysis results for the key IRM dimensions and GSM concept categories, matching pairs from each set were identified. Twenty-seven of the 46 GSM concepts mapped to 30 of the 47 IRM dimensions. As such, the GSM represented the key dimensions of IRM more completely than half of the IRM literature included in this study.(the preceding sentence must be clarified…what are you really trying to say—it is unclear to me.) However, the model remains underspecified. The following paragraphs describe strengths and weaknesses of the model (Oliver, 2004).

*Table 1. General Comparison of IRM and GSM*

| Major Categories of Key IRM Dimensions | Matching GSM Tenets |
|---|---|
| Chief Information Officer: Roles and Responsibilities | People and Workflow (GeoBase Information Officer)<br>System Architecture (Federal Mandates) |
| Planning | Foundation |
| Security | Information and System Architecture |
| Technology Integration | System Architecture |
| Advisory Committees | N/A |
| Enterprise Model | Policy and Guidance |
| Information Integration | Policy and Guidance |
| Data Administration | Information Architecture |
| Education and Training | Education and Training |

The GSM represents all major IRM dimensions except the use of advisory committees as previously stated. Furthermore, all dimensions in the content analysis found in the majority of material reviewed, except the CIO's participation in corporate business planning, were matched. Worth noting, the GSM does include multiple references to acquisition and includes IT portfolio management as a concept. The inclusion of acquisition and IT portfolio management gains significance due to the strong emphasis on these concepts in the CCA (the principle, governing Federal mandate).

Although fifteen minor IRM dimensions remained unmatched when comparing to the GSM, only three were identified to be significance omissions as uncovered in the research (use of advisory committees; formal methodology for system development; and planning, designing, and implementing IS). The first-order analysis previously identified the major deficiency of the GSM as not representing the use of advisory committees. While not represented in the GSM, case-study respondents reported the use of advisory committees in the form of working groups and control boards. Use of a formal methodology for systems development and CIO involvement in corporate business planning did not present in the program model or implementation. Neither of these first two deficiencies should rightly be attributed to the GeoBase program. As the GeoBase program falls under the purview of the AF-CIO, developmental methodology and corporate business planning remain the AF-CIO's responsibility. Planning, designing, and implementing of IS or IRM-based programs should still consider these two dimensions primary and perhaps include them in its own model. As such, the GSM, while a robust model, failed to capture all the key dimensions required for "IRM health."

**Comparison of GSM and Federal IRM**

Programs within the Federal Government must abide by legislation that does not dictate the actions of the private sector. Therefore, a detailed examination of the GSM with respect to only Federal IRM documentation assumes greater importance in the USAF environment. Content analysis of only the Federal documentation revealed four dimensions not represented (see Table 2). The content analysis focused on Federal IRM documents revealed Global acquisition control as more relevant in the Federal IRM arena, and it was added to the set of key Federal IRM dimensions. Table 2 summarizes changes to the set of key IRM dimensions for the Federal analysis.

Analysis f the GSM to the Federal set of IRM dimensions led to improved results. The GSM represents the added dimension of acquisition control

*Table 2. Changes to Key IRM Dimensions for Federal-Perspective Analysis of GSM*

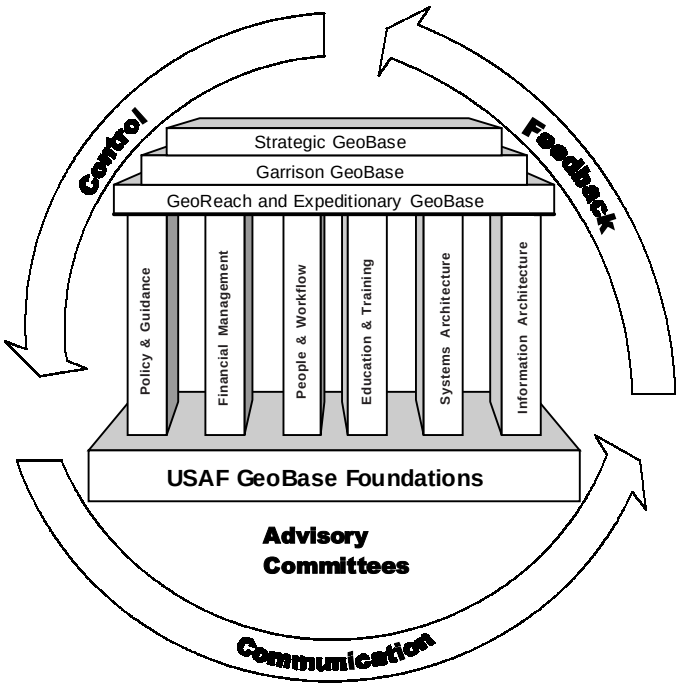
| Change to Definition | IRM Dimension |
|---|---|
| Delete: | IS/T Plan Incorporates Central, Distributed and Desktop Domains |
| Delete: | Planning Process for IS&T Incorporates End Users |
| Delete: | Formal Support for End-user Computing |
| Delete: | Office Automation Capabilities |
| Add: | Global Acquisition Control |

in both the Systems Architecture and Financial Management pillars. Additionally, dimension removed were not previously matched, improving the results. The GSM captures many tenets contained in the cornerstones of Federal and USAF IRM policy. However, changes to the model may further increase its effectiveness in representing key IRM dimensions. Suggested changes will be discussed next.

**Changes Indicated for the GSM**

The analyses of the GSM presented above qualitatively validate the proposition that the model adequately represent key IRM dimensions. However, the analyses also indicate several changes to the GSM to improve its representation of the implementation issues and IRM. Figure 3 depicts the proposed revisions to the current GSM. In the new model, GeoBase Foundations, Policy & Guidance, and Systems Architecture incorporate involvement in higher-level planning and formal methodology for systems development. Communication, feedback, and control, as indicated by literature and respondents, remain critical aspect of advisory committees and have been added to the model.

*Figure 3. Proposed Revision to the GSM*




## CONCLUSION

Public and private-sector organizations spend billions of dollars on implementing IS&T projects. Often, organizations do not know whether or not they are in fact implementing IRM while doing so. This research expands the operational definition of IRM generated by Lewis, Snyder, and Rainer (1995) to include aspects particular to the Federal government. Using this new Federally-enhanced IRM definition, public-sector organizations have a another tool with which to assess "IRM health" with respect to IS&T implementations. Specifically, the GSM was found to represent the key dimensions of IRM more comprehensively than 50 percent of the IRM literature and primary Federal IRM documents included in this study. All in all, the current GSM, and the GeoBase implementation programs by association, effectively addresses IRM as identified in business and academic literature, service documentation, and, most importantly, mandated by the Federal government. Given the success of the program, the GSM, with minor modifications, may serve as a Federal government-wide implementation model for information-based, technology-enabled programs and other IS&T initiatives. Future research to address the unique nature of geographic information system implementation and the IRM compliance/health of this and other IS&T insertion programs could provide useful insight to this research.

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