

MU CI Plan – Geospatial Sciences (DRAFT)

Context:

Geospatial data and capabilities are integral to virtually all federal, state, local, and government activities. As such, the research topics and associated funding are more frequently requesting integration and interdisciplinary work to investigate the spatial context and representation of research questions. The purpose of this document is to provide guidance to the University of Missouri to help to identify and describe the geospatial data, capabilities, and needs within their research architecture. These capabilities and needs can then be more easily reflected and planned for within MU's Information Technology infrastructure and enhance the business processes that are essential to meet these stated geospatial goals. This document also supports the development and use of common and shared geospatial resources, enhancing as well as leveraging existing capabilities within and across the University of Missouri.

The value of geospatial information is obvious to many people when it is in the form of a map or satellite image. However, the presence and value of geospatial data is not as obvious when it is embedded within text, statistics, charts, records or other information in a database. The tools, standards, and architectural designs that are required to enable the viewing and analysis of that data in a spatial context are also not as readily apparent.

The geospatial element serves as a strong integrating force in many human and natural environmental processes. Time and space, or when and where things happen (geospatial), are often a common factor in business processes which are seemingly disconnected. They often help organizations and the public understand complex relationships that might be overlooked using traditional analytical methods. Use of geospatial information transcends agency mission and business activities with the common view which can be provided through location. Geospatial information, technologies and services are still an underutilized resource for managing a multi-functional, distributed, and organizationally disconnected enterprise such as the federal government.

Background:

The following is a bulleted list of elements that in one sense defines the current state of the geospatial information infrastructure here at the University of Missouri. It must be pointed out that the geospatial field is further along than many in addressing the issues related to data collection, sharing, and dissemination.

- 1) They have established Metadata standards, and determined ways to gather and use metadata records. The State of Missouri's NSDI Clearinghouse has been housed at the University of Missouri since 1996.

Missouri Spatial Data Information Service (MSDIS) – spatial data clearing house for data related to Missouri. Consists of tens of thousands of files. Larger datasets (in the Terabytes) include the Digital Elevation Models (DEM) and images/aerial photos, etc. MSDIS has a mandate – Missouri's geospatial data is an asset that belongs to the people and is disseminated free of charge MSDIS data collection include information on all the structures

in the state of MO – residential, commercial etc. Currently gathering metadata (at least) and hopefully much of the data housed in various cities and counties across the state.

The Missouri Spatial Data Information Service or MSDIS already participates in **Data.gov** and is compliant with ISO standards and conventions to include the incorporation of the new ISO keywords in all metadata elements.

- 2) Geospatial information and analysis is permeating all the disciplines across campus. The U.S. Department of Labor data on GIS demand within the workforce shows a huge gap looming. Currently the University has several programs and initiatives in place or being planned to address this need. These include, but are not limited to:
 - Undergraduate GIS Certificate program
 - Graduate GIS Certificate program
 - Undergraduate Geospatial Intelligence Certificate
 - Graduate Geospatial Intelligence Certificate
 - Geoinformatics emphasis area being developed in Informatics PhD program
- 3) The University of Missouri has had a site license for geospatial information system software since 1989 (*still checking?*)
- 4) The University of Missouri has several centers across campus focusing on geospatial data and services in their grant and contract activities. These include:
 - **Geographic Resources Center (GRC)** since 1980
 - **Center for Applied Research & Environmental Systems (CARES)** since 1992
 - **Missouri Resource Assessment Partnership (MoRAP)** since 1996
 - **Center for Geospatial Intelligence (CGI)** since 2007
- 5) These University centers also actively participate at state, regional, and national levels in their respective areas of expertise. These include:
 - Missouri's Geographic Information Systems Advisory Council (**MGISAC**);
 - Mid-America GIS Consortium (**MAGIC**) a 9-state regional collaboration;
 - National States Geographic Information Council (**NSGIC**) which serves to promote statewide geospatial coordination activities in all states and to be an effective advocate for states in national geospatial policy and initiatives, thereby enabling the NSDI.
- 6) Site license for ArcGIS since... (**get date**) as well as a site license for K-12 educational groups brokered through the State of Missouri and the University of Missouri.

Progress since CI Council was established (Jan, 2013)

The Geospatial Component of the CI Council has only recently been identified. This plan represents a first step at recognition and planning for geospatial aspects for both research and teaching on the University of Missouri. At this point we have identified no added CI investments by the Division of IT or MU campus.

The MSDIS has been able to secure some grant and contract funding to consolidate its computing environment on campus as well as create an off-site backup located at UMS&T. Any increased human capacity and resources are based on soft dollar support from other grants and contracts. It is our understanding that no applied geospatial research center receives any funding from the University of Missouri.

The only funding that is targeted for geospatial comes from the MSDIS allocation that was based on a Governor's line item placed in the University of Missouri's budget back in 1996. That line item has not been increased by the state but has been able to grow to reflect inflation as managed by the College of Arts and Science. The MSDIS data is currently stored on Division of IT hardware and for disaster readiness the data is replicated at an additional site on the MU campus and offsite at Rolla MO. Again, funding provided by MU Geographic Resources Center through a contract enables this update and upgrade to happen. *Base funding for MSDIS through MU is (\$265,000).*

With focus on geo-enabling most if not all data, the advent of mobile devices and their use in mapping, the growing nature of location-based services, and the incorporation of context and place into many research agendas, the MSDIS has seen a dramatic growth in the volume of data (*to be pulled from Center reports*) to be logged and registered. MSDIS' current holdings include 507 Gb of vector data for download (56,723 files in 1,319 folders) as well as 19.9 Tb of raster data (imagery and LiDAR) for download (318,668 files in 5,598 folders). These additional data sets/types that are growing and may possibly need to be added to the collection include higher resolution imagery, more terrain data (LiDAR), volunteered geographic information (Twitter, GPS, photographs, etc.), not to mention the growth of digital geospatial data compilation ranging from University-based research to local government levels all the way to federal levels.

Critical Issues:

1. **Coordination**: Each center on campus has geospatial staff and titling (GIS Specialists; Sr. GIS Specialists; etc.) but no one is tasked to provide coordination across centers nor is there a single point of contact for tying these resources together and helping faculty navigate to and exploit available resources – data, support, or services for effectively using the data. Other universities have identified and filled this need – including Washington University in St Louis and Iowa State University by creating a GIS Coordinator position for their campus.
2. **IT Infrastructure Costs**: Costs associated with the growing digital holdings of on the University's campus (MSDIS and CARES) continue to grow. For example, MSDIS just completed a \$96,000 upgrade to its systems through a contract. MSDIS is slated to expend \$15,000 in software costs as well as \$35,000 in hardware and system management / maintenance costs over this next year. Maintenance of the SW and HW environments continues to take more staff time and resources. MSDIS' original design for a single data warehouse solution was not able to be achieved in practice as it was complicated by the off-site S&T element. Current considerations include a second try at a single data warehouse or possibly moving the data to a cloud-based service.
3. **Geospatial Archive**: Library of Congress – digital preservation – North Carolina Geospatial Data Archiving Project (2004-2010) - Continued on by GeoMAPP (Geospatial Multistate Archive and Preservation Partnership) but project concluded Dec 31, 2011. (cite: <http://www.lib.ncsu.edu/ncgdap/>)(<http://www.geomapp.net/>). This activity addressed the core basis of a critical issue within the geospatial world which revolves around archival of geospatial data. The MSDIS is the 'default' archive but with data volumes growing and no additional funds a point is coming in the future where old-

data may be removed to make room for the newest versions. The **GeoMAPP** project created several White Papers that would provide insight into this issue. These include:

- [Geoarchiving Business Planning Toolkit](#)
 - [Best Practices for Geospatial Data Transfer for Digital Preservation](#)
 - [Best Practices for Archival Processing for Geospatial Datasets](#)
 - [Archival Metadata Elements for the Preservation of Geospatial Datasets](#)
 - [GeoMAPP Storage Primer](#)
 - [National Inventory of Geospatial Records](#)
 - [Emerging Trends in Content Packaging for Geospatial Data](#)
 - [Archival Challenges Associated with the Esri Personal Geodatabase and File Geodatabase Formats](#)
4. **Research Computing Geospatial Architecture Funding:** A very early opportunity (NSF 04-521: CFDA: 47.070: Digital Government (DigitalGov)) outlined a project/program to integrate geospatial information technology within and across enterprise architecture frameworks. The basis was to support decision-making but could be re-framed to support interdisciplinary research. If there are no funds available at the campus level we must find opportunities elsewhere and build the collaboration among researchers to make the proposal successful.
 5. **Inventory and Marketing:** MU researchers are generally unaware of the available resources and how to use them to expand or enhance their research. We need a programmatic plan to first inventory and catalog both geospatial and human resource holdings, then create a marketing plan to faculty and researchers on campus to expose them to these resources. Finally, a pro-active program that links researchers and geospatial domain experts to collaboratively address RFPs, contracts, or other grant opportunities.

One Year Objectives:

1. Host meeting of geospatial educators across the state (public and private higher ed. and K-12). Increase awareness, strengthen relationships and gather momentum.
2. Gather data on MU's geospatial units – information about the labs, their data, services available and other relevant resources.
3. Disseminate that information across campus. Offer some fashion of a referral service – perhaps begin with a web site and blog.
4. Organize training for NSF program officer (or others) to come to campus and provide guidance on how to build geospatial work into a project budget
5. Begin gathering data that represents MU's Geospatial Report Card

Three Year Objectives:

1. Establish a coordinator position to help MU researchers identify and use geospatial analyses.
2. Increase the number of faculty and students using GIS data

3. Increase the volume of GIS data.
4. Collaborate with regional and/or national data repositories.
5. Measure progress on Geospatial Report Card.

Marketing:

Suggestions for increasing MU researchers' awareness of geospatial data and how it can be used to enhance one's research outcomes.

- Celebrate international GIS Day - share information on what is available and how to tap into it. **Nov 18, 2015**
- Offer a scholarship for student to attend GIS users conference and then share what they learned.
- The **University of Missouri** has credits to online learning resources that could be more widely shared.
- Emphasize geospatial at an upcoming CI Day
- Organize an event to highlight the geospatial skills and capabilities across the state – K12, higher education, government and industry.
- Organize workshops for undergraduate, graduate and K-12 students and teachers.
- Help facilitate internships as a way to learn of the discipline and increase skills across the state.

Geospatial Plan Construct:

This document provides some background and guidance, as well as highlights the geospatial perspective to the University through each of five (5) reference models as defined by the Federal Enterprise Architecture's Geospatial Profile (<https://www.fgdc.gov/fgdc-news/geoprofile20050131>)) By doing so, it instructs MU on best practices in illuminating the geospatial aspects of their research processes, thereby facilitating the building of interoperable geospatial data and tools. By application, organizations have the opportunity to improve information exchange across – and beyond – academic disciplines in terms of viewing problems and analyzing information based on the location of entities (or events) of interest. By embracing the multi-disciplinary and pervasive nature of geospatial capabilities, this plan is intended to promote broad use of common geospatial information and services among researchers across all disciplines.

The National Spatial Data Infrastructure (NSDI) is defined, in OMB Circular A-16, as the technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data. From a business viewpoint, this use of common NSDI business practices enables communities to use geospatial resources wisely, and to enhance the NSDI through the integration across all levels of government.

Spatial data based business practices:

- 1) Prepare, maintain, publish, and implement a strategy for advancing geographic information and related spatial data activities appropriate to their mission lines of business.
- 2) Collect, maintain, disseminate, and preserve spatial information such that the resulting data, information, or products can be readily shared with other users, and promote data integration between all sources. This includes ensuring that data information products and other records created during spatial data activities are included within management schedules.
- 3) Promote data standards, such as the FGDC/ISO Standards for Digital Geospatial Metadata, and other appropriate standards, documenting spatial data with the relevant metadata, and making metadata available online through the Geospatial One-Stop Portal network of registered NSDI-compatible Clearinghouse nodes of which MSDIS is one.
- 4) Coordinate and work in partnership with federal, state, tribal and local government agencies, academia and the private sector, to efficiently and cost-effectively collect, integrate, maintain, disseminate, and preserve spatial data. This includes using building upon local data wherever possible.
- 5) Use spatial information to enhance digital research-based initiatives, to make spatial information and services more useful to researchers and teachers, to enhance business operations, to support context-based decision-making, and to enhance reporting and publishing.
- 6) Protect personal privacy and maintain security of data and systems.
- 7) Allocate resources for effective spatial data search, acquisition, maintenance, and dissemination.

Following these business practices will enable the University of Missouri the greatest:

- access to data and services;
- knowledge of data lineage and quality and appropriate data security;
- standards and specifications for interoperability;
- delivery systems with multiple means of delivery; and

The plan consists of a set of interrelated “reference models” designed to facilitate cross-disciplinary analysis and the identification of duplicative investments, gaps and opportunities for collaboration within and across the University of Missouri. Collectively, the reference models comprise a framework for describing important elements of the geospatial plan in a common and consistent way. Through the use of this common framework and vocabulary, the University’s IT portfolio can be better managed and leveraged across the research enterprise.

Performance Reference Model — the discussion focuses on providing managers with metrics that can be used to measure their geospatial maturity. In order for this planning effort to be effective in transforming research, it must start with the ability to define and measure the performance aspects of such a transformation. The performance methodology for this Geospatial Plan begins with an initial elaboration of performance groupings and measurement indicators that relate directly to performance. It continues by providing some suggestions regarding the integration of these indicators/metrics into ongoing assessment and monitoring. The performance discussion concludes with a proposed ‘maturity model’ that is intended to help the University measure the status of this transformation of their geospatial programs and research activities.

Geospatial information and technologies interact and impact at multiple levels within each reference model. As well, each College or research group is currently in a different phase of integrating geospatial technologies, services, and data into their research operations. This initial draft of a *Geospatial Integration Maturity Model* (GIMM) is to serve as a broad, outcomes-based assessment tool. The GIMM report card helps groups measure their overall level of geospatial integration and provides the ability to assess improvements based on the maturity model for architecting these technologies and services to achieve their objectives and measure their contribution to overall performance.

The performance categories for the GIMM arise from the broad geospatial community of practice as it has evolved to try to monitor these same areas.

The categories of interest include:

- *Coordination* —The level of facilitation, coordination, and collaboration in place regarding geospatial leadership for an organization.
- *Governance, Management, & Planning* — The existence and evolution of plans and strategies for developing or leveraging the geospatial components of their research data.
- *Data Acquisition, Documentation, & Maintenance* —The stage of implementation regarding geospatial data lifecycle processes such as development, documentation, and maintenance.
- *Standards & Best Practices* —The level of adoption and compliance with geospatial technology and process standards related to their data architecture.

- *Data Access & Distribution* —The existence and continuing development of geospatial data holdings, their discoverability, searchability, and accessibility.
- *Policies & Compliance* —The development and use of compliance –based processes for assessing consistency of integration, adoption, and service implementation for geospatial technologies, data, and services.
- *Enterprise Integration* —The degree to which the geospatial aspects of the research data collected by the University of Missouri’s research base are planned for, integrated, leveraged, and used to guide a researcher’s investments and future initiatives.
- *Training and Skills Development* —The level at which the organization as a whole is aware, understands, and communicates the potential utility and application of geospatial technologies to achieve their research activities.

**Performance measures should reflect a sense of prioritized achievement and should reflect both outcomes and outputs. For each GIMM category the range of possible geospatial indicators has been identified and categorized along a continuum expressed as levels 0 through 5, with fives equating to levels of high achievement for that category.

Business Reference Model — This element focuses on processes and methodologies to help identify and describe the geospatial nature of their research activities. The value of place or location-based analysis is often overlooked. The coupling of geospatial data, services and technology with conventional data and technologies are often one of the most significant enablers of improved decision making within research. It enables key research requirements across all disciplines. This section will help managers and researchers gain a better understanding of if they are doing geospatial research and the resources available to them, and if not, how they can incorporate geospatial data, services and technology into their research.

The following list of questions is provided to help the researcher and managers assess whether their operations could benefit from location based approaches, as well as determine where and how to incorporate these approaches into their current or planned research activity.

- 1) Is the activity associated with a place or a location?
- 2) Would the addition of a “where” component of the research activity enhance the project?
- 3) Does the research abstract contain any of the following key words?
Address (physical), address (postal), area, bearing, bearings, city, community, compass, country, direction, distance, district, domicile, event, facility, geography, house, household, incident, latitude, locale, locality, locate, location, longitude, neighborhood, pinpoint, place, point, port, position, post, property, region, reservation, residence, river reach, route, scene, site, situation, space, spot, station, street, suburb, terrain, territory, topography, town, tract, venue, vicinity, village, watershed, where, whereabouts, zip code, zone
- 4) Does the place/position/location/address have (or could have) an impact on the way that the research is conducted? In other words, do the variables being investigated vary by place/position/location/address or do the characteristics of a place/position/location/address impact the research?
- 5) Does the research require the use of (or could it benefit from having) a map/aerial photograph/satellite image? Would a map/aerial photograph/satellite image be helpful in the conduct of the research or increase the effectiveness of individuals or groups conducting the research?

- 6) Does the research require the use of a Global Positioning System (GPS) or other location determination technology? Would the use of GPS or other location determination technology be helpful in the conduct of the research or increase the effectiveness of individuals or groups conducting the research?
- 7) Does the research require knowing the location of any of the actors in the activity? Is the location of the actor(s) changing and is ongoing knowledge of the location(s) useful to the research? Does an individual or group conducting the research need to know their own location? Is it useful to know the address of the individuals or organizations being served by or affected by the research?

Data Reference Model — The data model addresses all the components, interfaces and processes for implementing and managing an integrated, cohesive geospatial data policy. These components include a data documentation, development and adoption of data sharing standards and protocols, as well as the conceptual and logical design and modeling of the geospatial aspects of research data. This section provides guidance to researchers regarding how to describe geospatial data and metadata, as well as explanations of how existing geospatial data can be integrated and shared within and across the broader research community.

The data plan is intended to promote the common discovery, identification, use, and appropriate sharing of data/information across the research community through its standardized characterization of data, keywords, and information resources. In keeping with the data plan, the following three areas must be addressed and described:

Data Context — A standard approach to representing the geospatial taxonomies that a research group uses to categorize its data. The geospatial data context should reference locational and thematic taxonomies developed by the geospatial research community.

Data Sharing — A standard approach to describing the characteristics and requirements of data exchanges, including data sources. This defines a standard message structure known as an Information Exchange Package. Standard geospatial data exchange models such as Framework Data (developed by FGDC and standardized through ANSI), the Open Geospatial Consortium (OGC) specifications, the National Information Exchange Model (NIEM) community-based model, and standard encoding methods of locational information will be reviewed and reconciled.

The effective benefits of sharing data in this manner include:

- Improving the ability to fuse disparate data types and providing a more comprehensive and holistic view of a particular problem set.
- Improving the ability to make connections and relationships based strictly on “where it is” and “what else is in the area.”
- Enabling interoperability.
- Increasing communication and collaboration.
- Increasing productivity, saving time and money.
- Improving access to research data resources.

Data Description — A standard approach to describing any geospatial data resource. This is achieved through the application of the geospatial metadata standard, the Content Standard for Digital Geospatial Metadata (CSDGM, 1998) to describe data sets and collections. The definition of standardized geospatial data elements and constructs is also required for interoperability.

The expected benefits of developing geospatial data element definitions include:

- Enabling effective sharing of information between collaborating partners - improving communication that, in turn, improves collections.
- Reducing the amount of manual intervention in information processing and integration, which increases productivity and can reduce costs.
- Providing a means for publishing the geospatial data element standards for the benefit of information exchange partners.
- Streamlining access to geospatial information to improve knowledge-worker workflow.
- Improving the quality, consistency, and interoperability of enterprise geospatial data assets and information.
- Supporting the ongoing adoption of the use of standard geospatial data elements in coordination with any kind of application or system modernization.
- Promoting the migration to location-based services architecture, that will simplify the process for improving and extending production systems.

Service Reference Model — The service model creates a baseline for categorizing and aligning geospatial applications into common, reusable service components, which are categorized into appropriate service domains and service types. In line with this goal, the University research community can build upon and extend the plan by defining, classifying, categorizing and recommending common, reusable geospatial “building blocks” – Geospatial Service Components – for reuse in research and teaching computing environments.

Technical Reference Model — The geospatial technical model establishes the basic guidance necessary to help ensure that proposed IT solutions which support, have, or desire a geospatial location component are in compliance with industry standards, and therefore are likely to integrate efficiently into a multi-disciplinary information sharing and research environment. Specifically, the technical model is intended to describe elements of proposed solutions using a standard vocabulary and categorization scheme. This allows for comparison of those elements, facilitating the identification of overlaps and gaps, and opportunities for sharing technical solutions and standards.