Geographic Information Systems Enterprise Architecture in the National Weather Service

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and

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ABSTRACT

The National Weather Service (NWS) ingests large quantities of data from various sources, including geospatial data. It also disseminates many products and large amounts of data, some of it in geospatial formats. In order for the organization to best serve collaborating NWS offices as well as external partners and customers, an enterprise approach to Geographic Information Systems (GIS) is necessary. Many of the offices within the NWS use similar data and techniques, an enterprise approach to organizing people, data, technology, and standards would foster sharing of information and GIS skills. Furthermore, the enterprise approach allows the development laboratories, national centers, and operational forecast offices to better serve one another and work together to accomplish the NWS mission of saving lives and property. We will discuss the organization of this approach and practical examples of how collaboration is fostered within the NWS as well as with partners and customers.

1. INTRODUCTION

The National Weather Service (NWS) ingests large quantities of data from various sources, including geospatial data. It also disseminates many products and large amounts of data, some of it in geospatial formats (NWS 2008). In order for the organization to best serve collaborating NWS offices as well as external partners and customers, an enterprise approach to Geographic Information Systems (GIS) is necessary. Due to the use of similar data and techniques within many NWS offices, an enterprise approach to organizing people, data, technology, and standards would foster the sharing of information and GIS skills. Furthermore, the enterprise approach allows the development laboratories, national centers, and operational forecast offices to better serve one another and work together to accomplish the NWS mission of saving lives and property (NWS 2004).

As required for operational implementation in the NWS, the NWS Operations and Services Improvement Process (OSIP) is overseeing this enterprise architecture project, OSIP 06-003, as it defines, documents, and establishes the enterprise framework for GIS (NWS 2007). The OSIP statement of need states that the enterprise framework is necessary in order for the NWS to organize existing GIS activities and align the NWS with other Federal agencies

utilizing GIS. The statement of need further specifies the framework as an architecture which will establish processes and requirements for issuing NWS products and services in GIS-compatible formats, providing NWS offices with software and hardware for use in preparing and analyzing weather related GIS data, implementing a training plan for GIS related topics, equipping offices with base map data for use in operations, installing current technologies for serving and interactively viewing NWS geospatial data over the Internet, and instituting a dedicated staff to work GIS issues for the NWS.

2. CURRENT ACTIVITIES

NWS employees are embracing GIS technologies by developing GIS-compatible data and applications for internal uses as well as to meet customer needs. These efforts are largely grass root efforts that employ a wide range of geospatial software applications and have loose connections to one another (Figure 1). The geospatial projects relying on collaboration between offices are the result of staff sharing geospatial data and ideas by way of common geospatial software packages (Stellman et al. 2009).

NOAA's establishment of an enterprise license agreement with Google™ for Google™ Earth Pro, Enterprise Google™ Earth clients, and Google™ Maps API led to the implementation of point and click forecasts on all of the NWS Weather Forecast Office (WFO) web sites using Google™ Maps. This agreement has also allowed weather forecast offices to increase their use of virtual globes for situational awareness. Some examples of the use of virtual globes are to display radar data packaged with warning polygon, flash flood forecasts combined with impact analysis, and fire weather data (Foster et al. 2009). Individuals from offices at the local, regional, and national levels also collaborated to establish the NWS GIS web site which links GIS weather data seekers to NWS data available for download in GIS compatible formats (NWS 2008). Another project resulting from the collaboration of offices is for experimental web services providing radar, digital forecasts, watch/warning polygons, and hurricane tracks using the Environmental Systems Research Institute's, Inc. (ESRI) ArcServer and ArcIMS technologies. The offices were able to share the cost of the technology and combine their expertise to provide a complete web service (Figure 2). Finally, the regions in the conterminous United States have combined their ArcGIS desktop licenses on one server, so all local forecast offices and regional offices have access to desktop software and extensions for data analysis and manipulation. This provided offices without budget resources for GIS the ability to employ the technology, another venue for collaborating with other offices and laboratories, and increased the available licenses for offices dealing with high impact events (i.e. storm reports, changing flood maps, etc.).

GIS adept staff have also organized themselves in order to share knowledge with one another. The staff maintain an email list serve which allows

for the exchange of basic software questions as well as more technical topics specific to NWS data. The list serve acts as a help desk of sorts for internal NWS staff, but is limited to noaa.gov emails, so a help desk or single point of contact does not exist for external NWS GIS data users. The central and southern region also started compiling their efforts using Google™ Earth into a periodic internal newsletter, which is also shared with other NOAA offices (Figure 3). Finally regional GIS program directors and focal points connect with each other once a month via a conference call. This forum led to the establishment of the previously discussed desktop software license pool as well as the formation of the team which stood up the GIS data web page.

3. VISION AND MISSION

The GIS enterprise architecture framework is an implementation of the NWS vision and mission. In order to articulate this relationship, the OSIP integrated work team defines the vision and mission of the framework as the following:

> *The vision for establishing an **enterprise framework** for GIS in the NWS is to further establish the NWS as a high quality primary provider of weather data to other Federal agencies and partners by providing an organizational structure for NWS geospatial initiatives which includes training, technology guidelines, and mechanisms to insure the NWS adheres to Federal GIS standards (i.e., data in OGC formats).*
>
> *The mission of an enterprise GIS architecture within the NWS is to provide efficient, useful, and accessible data, products, and services through the infusion of GIS technology into NWS operations. This enterprise system will support a robust infrastructure with resources, policy, and standards to further the NWS mission and goals to protect life and property while enhancing the national economy. Dedicating staff hours to geospatial initiatives will serve as the anchor for this robust infrastructure. Utilizing GIS will enhance the NWS's ability to perform its mission of providing NWS data and products in the form of a national information database, an approach which will advance the NWS goal to be a high-quality primary supplier of weather data for governmental agencies, the private sector, the public, and the global community.*

4. ENTERPRISE ARCHITECTURE DESIGN

The NWS GIS enterprise architecture encompasses all aspects of NWS resources needed to efficiently manage and disseminate geospatial weather, water, and climate products. Therefore, the GIS enterprise architecture

framework is composed of four key components: people, data, technology, and policy & procedures (Figure 4). Though technology (software & hardware) and data are often the first things that come to mind when GIS is mentioned, people are actually the most important and costly portion of the GIS enterprise architecture framework. The data and technology components will not advance without dedicated people developing new techniques and managing the integration of these new techniques and subsequent data and services with existing products and services. GIS is an ever-evolving field, so staff will be tasked with staying abreast of new industry standards and moving the agency to comply with the evolving standards. Data is the second most important part of the framework. Many industries have a need for weather, water, and climate data. The NWS strives to be a high-quality primary supplier of weather data and GIS formats are among the most frequently requested data types. Therefore data and metadata, in GIS industry standards, is of critical importance to the agency accomplishing its mission and goals. Currently GIS data can be difficult to discover if the office providing the data has not been linked to the GIS data web page (NWS 2008). The enterprise framework will make this data more easily discoverable by means of a spatially enabled GIS data portal complete with various search options (i.e. geographic, keyword, multi-parameter, etc.).

The efficiency of the people and the data in the enterprise are dependent on the technology and the policy and procedures associated with them. GIS software is often computationally intensive and requires specific hardware capabilities. Running GIS processes on inadequate systems results in long processing times at a minimum, but often leads to software crashes and frozen hardware systems. Therefore the framework also includes the necessary hardware and its administration in order to provide a complete GIS solution for the NWS. Finally, a program without oversight and standards leads to duplicated efforts and inconsistent products from office to office. Policy and procedures setting guidelines for applications and data within a geospatial program will minimize these duplicated efforts and set standards for data and implementing new techniques.

5. THE ROAD TO IMPLEMENTATION

The OSIP integrated work team is working to establish a plan for implementing the GIS enterprise architecture framework into the NWS organizational structure. The projects mentioned above are being used as prototypes for justifying the need for the enterprise. The team has also stepped back to think about the enterprise framework from different perspectives with the NWS. This re-analysis lead to the requirement for the inclusion of a formal help desk tasked to provide assistance to both NWS staff and external customers and partners as they work with NWS data and GIS. The means for accessing NWS GIS data within this framework are detailed in figure 5. At the time of the publication of these proceedings, the team is working on documenting the development plan, business case, training plan, and technical requirements for

implementing the enterprise framework. The major hurdles for this large scale project are corporate buy-in and identifying all of the affected systems so that requirements are written comprehensively.

6. ACKNOWLEDGEMENTS

The authors thank all of the members of the OSIP 06-003 integrated work team as their work is what has led to the content of this paper. The authors' reference to projects using ESRI and Google™ software does not imply endorsement of these products by the NWS.

7. REFERENCES

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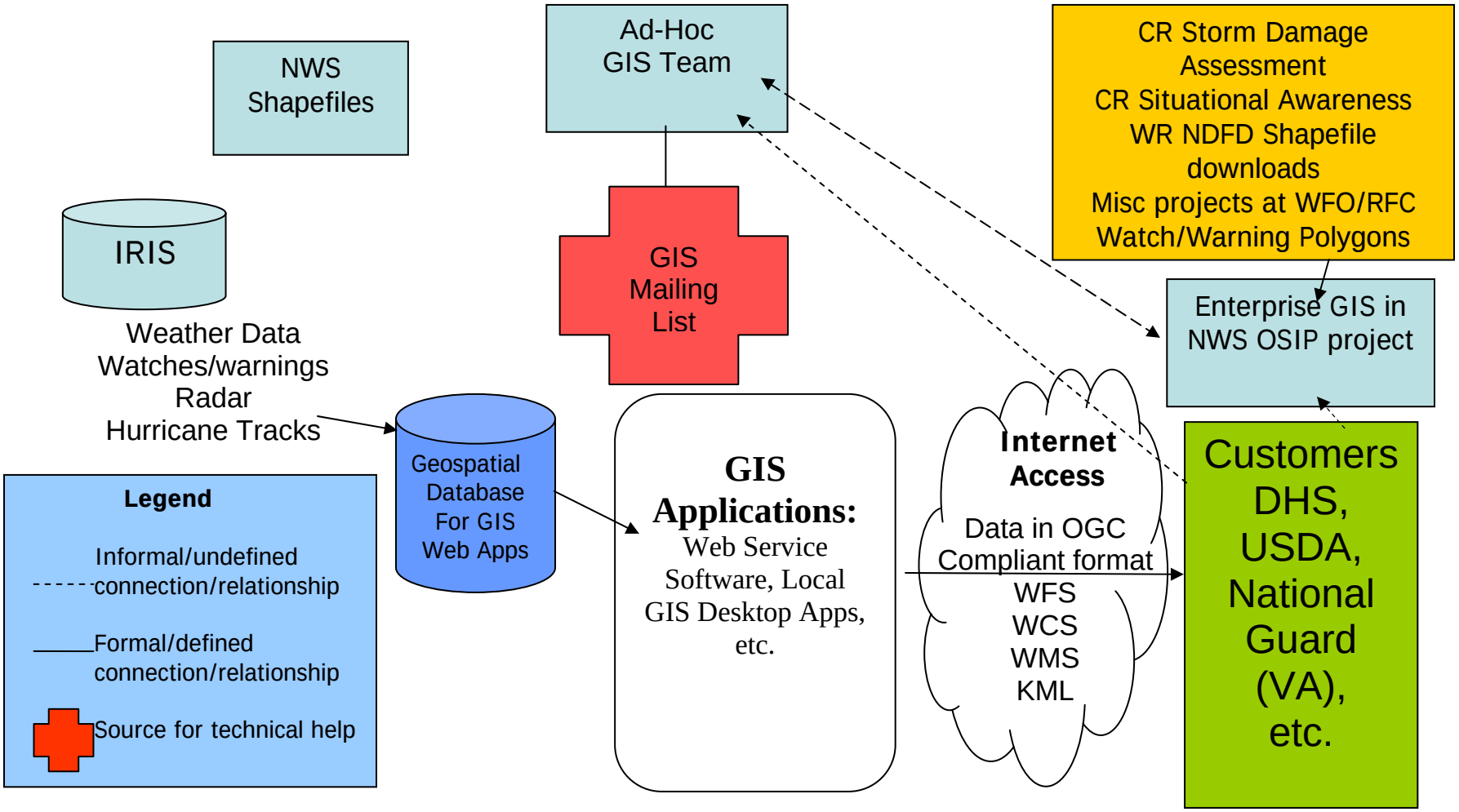


Figure 1 – Current GIS activities in the National Weather Service are largely ad-hoc, grassroots efforts in local and regional offices. In the absence of a national group tasked to coordinate these efforts, there is little interaction between the existing projects. These loose connections are demonstrated by the dashed lines or the complete absence of lines between projects.

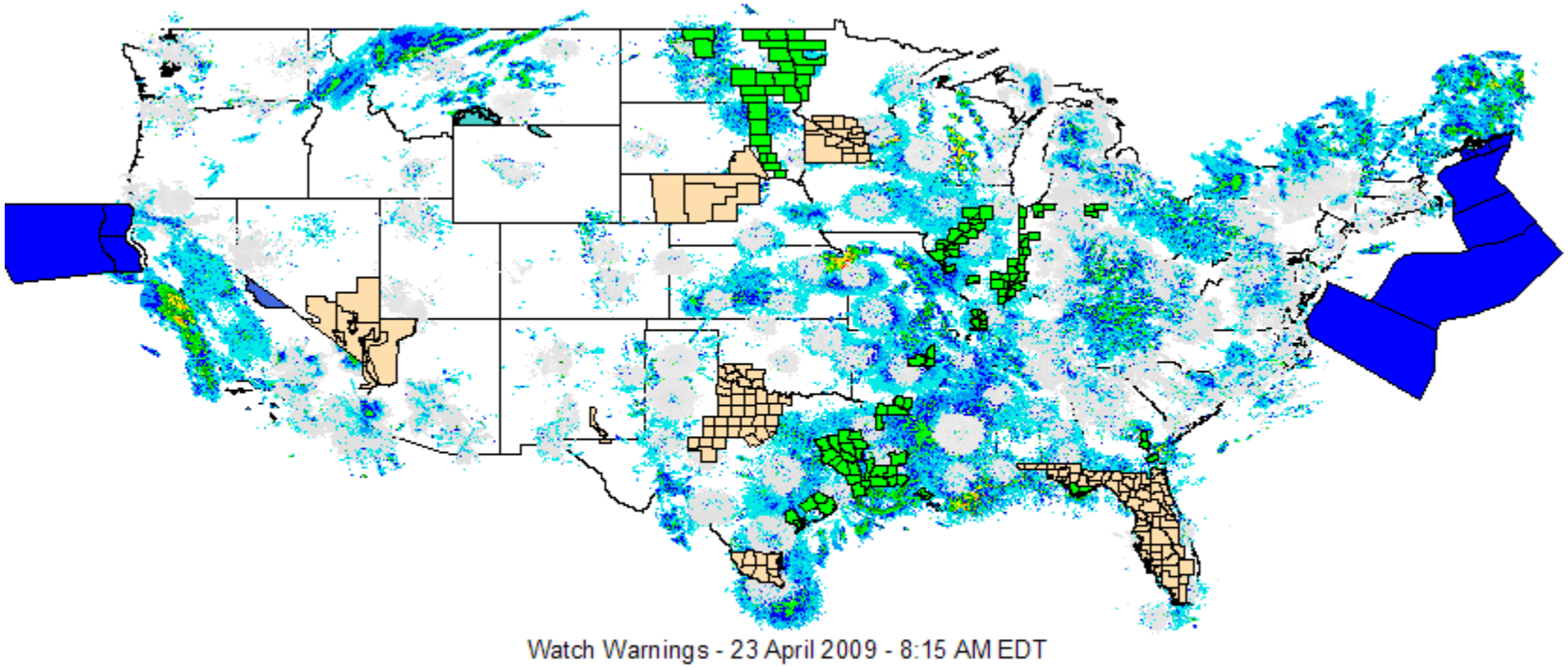
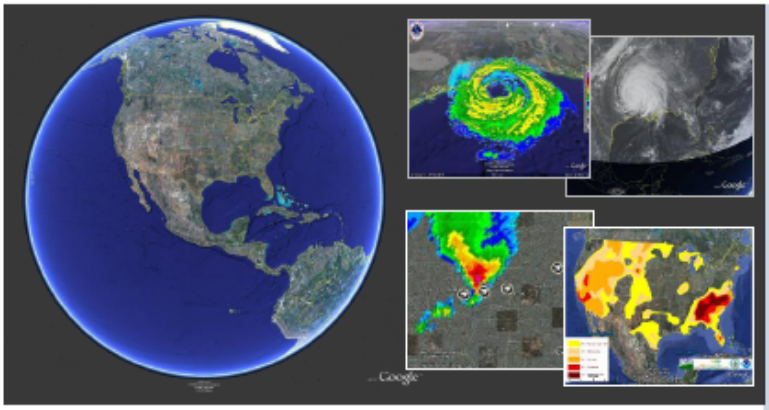


Figure 2 – GIS weather data being served by the National Weather Service.

NWS Google News

Spring 2009 Issue

Your source for sharing Google news, projects, and activities in the National Weather Service



Topics in this issue:

What's New?

What's New in Google Earth 5.0?

By: Tim Brice - WFO El Paso, TX

In early February of this year Google released the latest version of Google Earth (GE). With the release of GE5 there are some interesting improvements. There are six big changes that will affect all users, from developers to the casual viewer. For casual viewers, the first two big changes won't seem like a big deal, but to developers they are a big step forward. For many years developers have been asking Google to allow web pages to be opened inside the pop up balloons.

Historic Imagery: Atlanta 1993

Historic Imagery: Atlanta 2008

Before, the best you could do was provide a link that would open in an external web browser. But now with GE5 you can have web pages open up inside those pop up balloons. In addition to the web pages, developers now have the option to imbed and execute JavaScript inside those pop up balloons. This will allow developers to use forms and scripting to better tailor the gathering and displaying of data within those pop up balloons.

Another exciting change, especially for coastal offices is the new Google oceans. Now, users can not only see what the bottom of the ocean looks like, but they can actually dive below the ocean surface. Users can fly to a location and dive under the water to view things like faults or undersea mountains. The Google Earth user community has begun to populate the undersea world with shipwreck locations or other underwater "must see" information. Google (with NOAA's) help has also added bathymetry data for the Great Lakes so you can now dive below the largest fresh water lake system in the world!

The next development Google has added to GE5 will be of great use for those of you wanting to see how your CWA has changed over time. With the new 5.0 release Google has now made available historical imagery of the earth's surface. Your mileage will vary as some locations have imagery back 50 years while other locations only have a few years of data. To access the data, zoom into a location you are interested in and then click on the clock face on the tool bar. A time slider will appear that will have tick marks on it that will show you what historical imagery is available. It is interesting to see how a certain location has changed over time and how that might affect water runoff in hydrologically sensitive areas.

Google Earth has long been used as a way to show people around a location

Figure 3 – NWS employees share their successes with Google mapping technologies in the form of an internal newsletter.

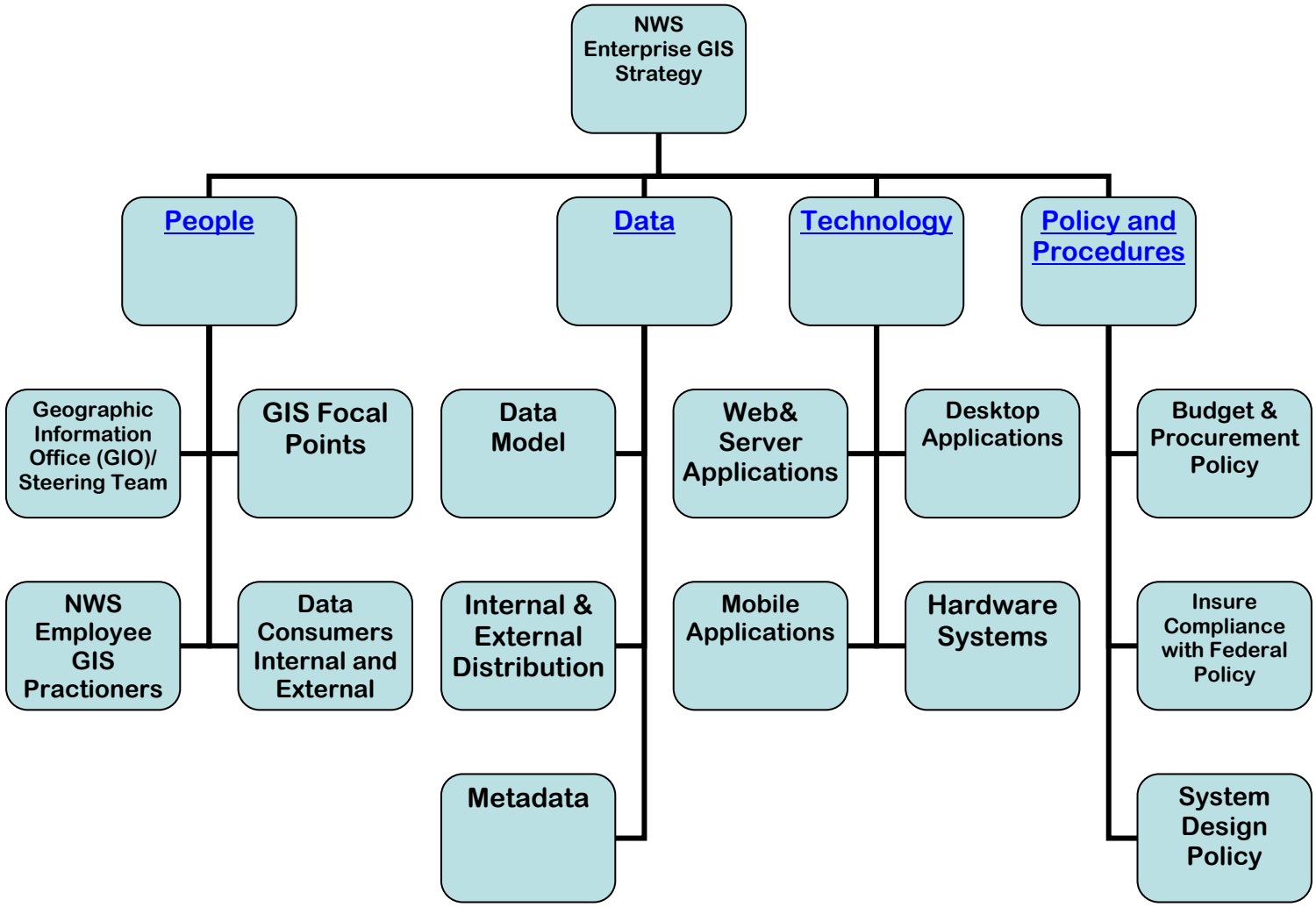


Figure 4 – An organizational overview of the NWS GIS Enterprise Architecture framework. The subdivisions of the 4 key components of the enterprise framework are also indicated in the diagram.

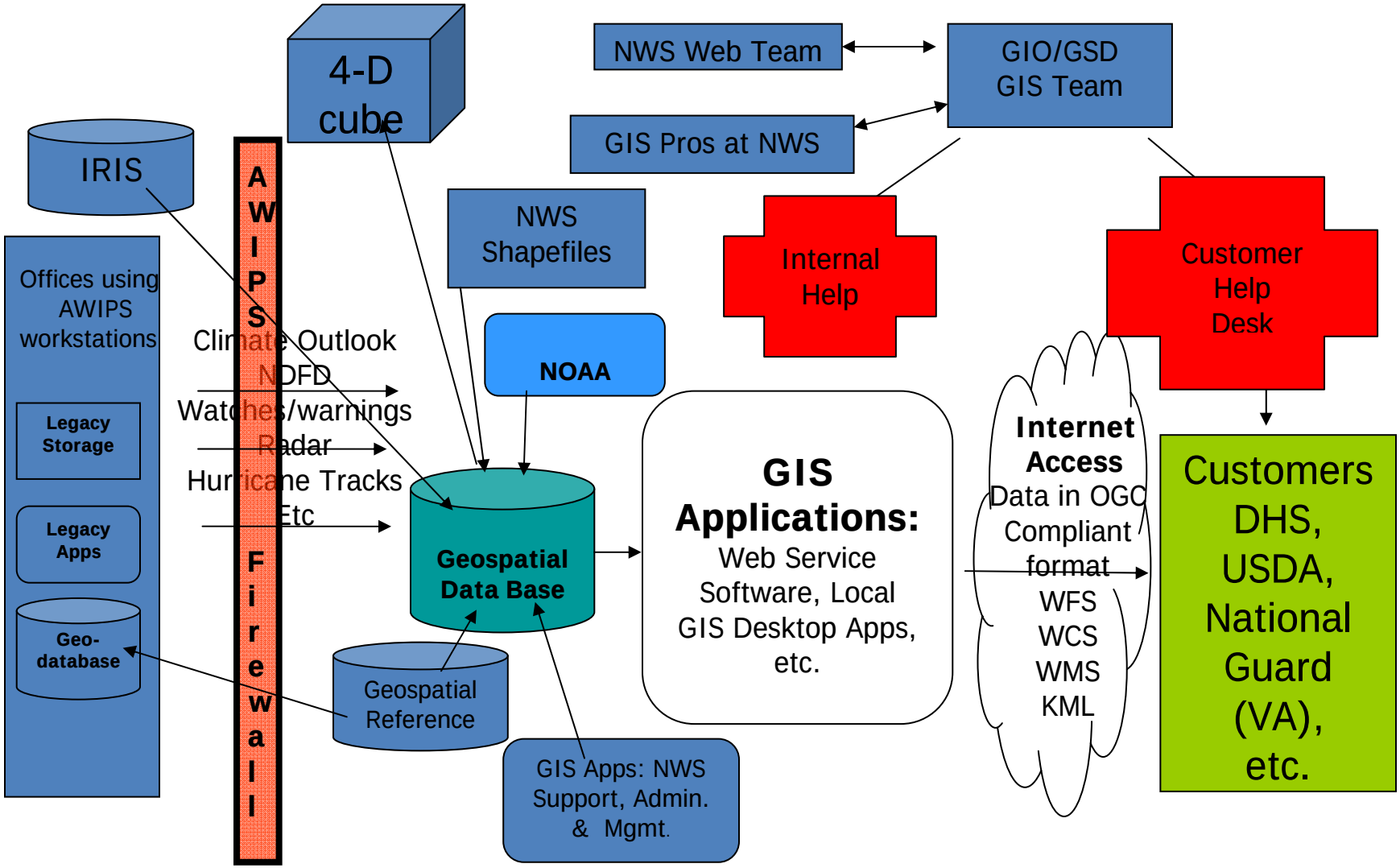


Figure 5 – Data flow within the GIS Enterprise Architecture Framework