5A.6 THE NATIONAL WEATHER SERVICE INTER-REGIONAL INTEGRATED SERVICES (IRIS) DATABASE

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ABSTRACT

The Inter-Regional Integrated Services (IRIS) Database is being designed to serve as the foundation for information storage throughout the National Weather Service (NWS). IRIS will be a central collection and distribution point for many types of information used by NWS personnel, including information on contacts, requirements, outreach, weather events and products, verification, and geospatial information. Using existing technologies, it is revolutionary in that it replaces a multitude of programs, databases, and data formats with a single structure and location where this information is stored. This standardization will then easily facilitate sharing of information between programs and offices as well as between offices and regional or national headquarters, improving data flow, especially during service backup situations. Planned functionality will improve situational awareness of forecasters and management by including enhanced mapping capabilities to increase the accuracy of event reports, preliminary verification, simple product generation in multiple formats, and a greatly increased customer service interface from which forecasters can easily determine if forecast weather will have an impact on particular NWS stakeholders.

This project is the result of a synergy of efforts between many different people at different levels and locations within the organization, and will create benefits for the NWS, the weather enterprise, and the general public.

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1. INTRODUCTION

The IRIS project began as a grassroots effort from a group of NWS personnel to better organize a vast array of event, contact, and other data into a single database structure. There was a strong desire to reduce duplication of efforts that regularly occur when using a number of different programs within an office, as well as to make such data and locally developed programs more easily available to other NWS offices. Finally, there is also a strong need to do a better job communicating with, and providing service to, local NWS customers, partners, and stakeholders.

The developers of a number of popular NWS field programs (StormLog, PANDA, Hydromet Database, other local applications) got together with other interested personnel and devised the plan to standardize the database structure used by all of them. Others soon joined the effort to add more applications, and the national scope was enhanced by including customer needs in the database. The development team settled on a PostgreSQL relational

database format with PostGIS extensions to best utilize the geographic nature of this comprehensive dataset.

1.1 *Past Attempts to Centralize Data*

There have been several local or regional projects within the NWS that have been implemented to manage contact information, generate reports of precipitation and other weather phenomena, and perform real-time short-fused warning verification. The Hydromet Database in the NWS Eastern Region and the PANDA real-time verification application in the NWS Central Region are two examples. The Hydromet Database uses a centralized server and web interface to collect and store precipitation and wind reports received from spotters. These reports then can be formatted as standardized text and graphical products for utilization by various customers. PANDA has been used within the NWS Central Region to generate real-time verification of severe weather events

While these and other efforts at individual weather forecast offices (WFO) have been successful within their regional or local scope, they are not able to share data with each other, or allow offices to use more than one program without significant duplication of efforts. Various individuals in the NWS have recognized a need for a centrally managed system that can be implemented nationally. The IRIS database project team in collaboration with the development groups from these and similar projects have joined together to develop an integrated database and applications that will be used throughout the NWS.

1.2 *IRIS is Truly "Inter-Regional"*

One of the most unique aspects of IRIS and the associated applications is inter-regional nature of the project. New programs and systems in the NWS usually develop from a single office, region, or national entity. Rarely does a project of this scope begin as a grassroots effort from field and regional personnel in all parts of the country. The synergy that quickly developed on the development team as the idea began to take shape has been a major driving factor in the advancement of IRIS.

2. PURPOSE

2.1 *Information Management*

With no national solution for managing contact information, each office has designed its contact database around its own needs and around the technical capabilities of the staff on hand. This has resulted in contact databases designed around word processor documents, spreadsheets, databases, and typewritten pages. The unique nature of how each office maintains its data makes it difficult to transfer this data to neighboring offices. Also, updates to the data occur on a frequent basis with new spotters, phone number changes, and people within an organization changing. The database is not a static document than can be printed and transferred to a backup office once. It must be maintained and transferred on a regular basis. The expertise that designed the database in one office using a specific technology may not be present in all neighboring offices.

In addition to maintaining contact information, storing weather reports in IRIS for use in NWS products will allow a forecast office to generate and transmit multiple types of products, in multiple formats, from a common database. Current capability in this regard is cumbersome and at times lacks accuracy in event location reporting. Using a single source to generate multiple products will help ensure the most current and accurate information is being used in NWS products. Examples of products which may be generated using IRIS include precipitation summaries, Local Storm Reports, and snowfall maps. Additionally, pulling the data from a single source will also allow for generation of products in various formats including, XML, KML and GIS enabled formats.

2.2 *Outreach*

The IRIS database provides a centralized location for outreach information, allowing all staff members to enter and view information that previously may have been limited to the Warning Coordination Meteorologist (WCM) or their designee. Not only would this approach allow more staff members to provide information in a short period of time, but it would also allow all staff members to enter contacts that they make with customers, allowing more a more comprehensive database of outreach efforts.

2.3 *Customer Service Improvements*

IRIS will not only include contact information for key NWS customers and partners in our mission, but it will include provisions to store weather and dissemination needs of those entities. Forecast staff will be able to compare established customer needs criteria with those being forecast, in order to more consistently inform them when upcoming weather may impact them. Information on data format, dissemination methods, and other preferences stored in IRIS will help determine requirements for future NWS services.

2.4 *Backup*

NWS offices are set up so that each office has two backup offices (NWS, 2004). Operational software used to generate forecasts in each office is

designed so that backup capabilities can be quickly assumed by an office upon notification that an office cannot perform its duties. A critical aspect of backup operations involves contacting customers during warning situations. The present backup capabilities allow all forecast duties to be performed, but quick access to contact information may be inaccurate or difficult to determine.

3. IRIS DESIGN

3.1 *Centralized Database*

IRIS is designed so that one operating principle is used by all weather offices for contact information. A central database server is the repository for all information. If this centralized solution ends up presenting performance or availability problems, offices also could maintain a subset of the database locally. The local copy will only contain information for their office and all offices for which they provide service backup.

As information is added, deleted, and modified, it is updated in the local database and replicated in all offices that have responsibility for backup for that office. Real-time updating in all offices means that backup operations will always have current contact information rather than waiting for updates to be transferred manually at some future time.

3.2 *Database Description*

There are four main categories of information in the IRIS database: geographic, contact, communication, and product. The information is stored in dozens of tables containing hundreds of fields, allowing for the maximum amount of flexibility in using the data. A great deal of effort was spent creating and revising this database schema to meet the needs of many users while also maintaining proper database design principles such as Third Normal Form. This is not the type of work that needs to be duplicated for every new project that comes along. The designers hope the IRIS database will serve as the foundation for many different applications and are willing to make further additions or modifications to satisfy future needs.

3.2.1 *Geographic Information*

Location details such as FIPS codes, elevation, latitude and longitude, and population will be stored for each entity in the office domain. This information can be ingested in a semi-automated fashion using existing databases and geospatial data sources. Similar information will be included in the county table, which will facilitate use of the database records for geospatial information systems (GIS) in the future.

The geographic information stored in the IRIS database would be static in nature for the most part, with changes occurring on an infrequent basis.

3.2.2 *Contact Information*

The contact tables contain relevant information defining all entities with which the NWS interacts. These contacts include weather spotters, Emergency Management, media, federal/state/local agencies, employees, cooperative observers, or any other entities who use NWS information or provide data to the NWS. These tables will also keep track of specific weather criteria that are important to specific contacts.

3.2.3 *Communications Information*

These tables are records of communications (meetings, outreach events, phone calls) held with any of the contacts. The data will be used to help keep track of, and improve, communications conducted by an office.

3.2.4 *Weather Reports Information*

These tables will store weather event information used to help disseminate accurate reports, and to help calibrate our services by quickly providing verification.

3.2.5 *Product Information*

All NWS warnings will be stored for verification and dissemination purposes. The database also will track Local Storm Reports and Public Information Statements that were issued from within IRIS.

3.3 *Database Software*

IRIS uses the PostgreSQL relational database management system (RDBMS) (http://www.postgresql.org/) for all data storage. To support geospatial data storage, retrieval and analysis, the PostGIS spatial database extension (http://postgis.refractions.net/) to the PostgreSQL RDBMS is also installed. The PostGIS extension spatially enables the PostgreSQL backend and provides similar functionality as the ESRI Advanced Spatial Data Server (ArcSDE) for geospatial applications.

IRIS data is accessed via php enabled web pages (http://www.php.net/) developed using the Symfony web application development framework (http://www.symfony-project.org). Geoserver (http://geoserver.org/) is used to serve spatial data stored in IRIS as a collection of web services

3.4 *Development Platform*

The core applications that perform the various data manipulation operations on the IRIS database

were developed using the symfony application development platform. Symfony is an open source application development framework for developing web applications via PHP. Symfony was designed for enterprise-level web applications and provides a development environment and framework suitable for a team-based development project such as IRIS. Configuration management, architectural structuring, code generation and testing/debugging are all incorporated within the Symfony platform.

4. IRIS APPLICATIONS

The IRIS project contains a multitude of current programs and applications that are being re-written to utilize the IRIS database; as well as new applications designed specifically for IRIS. The following sections describe the applications. Sections 4.1 through 4.4 describe current applications; 4.5 through 4.8 are new programs. Not included as an application is a planned administrative interface, which will facilitate the population and manipulation of base data in the database.

4.1 *StormLog*

Offices across the NWS use many different procedures for logging weather reports from office designed programs to paper logs. In addition to the many different programs and logs, the format of these reports can also vary from person to person. StormLog (Lenning, et al. 2008) is a program that uses Google Maps to display all contacts on a county by county basis and is designed to store all reports received in one centralized electronic database.

There are several advantages to storing the reports in this fashion. All reports are instantly visible, either by a specific county or all on the same list, on any computer inside the office, no matter who enters the report. Also, all reports can be searched by a specific date or a specific observer or station and displayed on the fly. StormLog also ensures that all reports are entered and displayed in the same fashion in order to avoid any confusion from different people entering the information.

StormLog is also an information management tool for contact information. If a spotter changes their phone number, location or address, anyone can access the spotter's information and change the necessary information and it is instantly updated. Other information like the weather equipment a spotter has or the last time they attended spotter training is also stored. StormLog also serves as a one stop shopping for county contacts. Not only does the program display the spotter contacts for each county, it also displays the emergency manager(s), media, law enforcement and EAS station information for each county.

4.2 *SevereClear*

SevereClear (Jones et al., 2008) is another multi-regional NWS project designed to fill an operational gap in situational awareness. Previously, keeping track of warnings and reports during major severe weather events was difficult and time consuming for a WFO staff. SevereClear uses a graphical display of radar, warning polygons, local storm reports, and product tables to keep staff apprised of warning and event status. The program excels by utilizing a selectable table of active, expired, and cancelled watch/warning/advisory products, displayed side-by-side with a fully interactive and searchable geographical weather display. During real time testing, benefits to the operational staff from using SevereClear were significantly lower gaps in data flow and increased situational awareness in times of significant weather events. SevereClear is currently in use as a standalone program in a number of NWS offices; an upcoming version will incorporate the IRIS database structure allowing it to work hand-in-hand with other programs in a NWS office.

4.3 *PANDA*

Although NWS forecasters are trained to base their warning decisions on meteorology and potential impact, it is also important to monitor verification internally, in order to improve performance. Databasing NWS watches and warnings in IRIS in addition to weather reports will allow for real time warning verification. The PANDA program calculates preliminary warning verification statistics for weather events on a real time basis, providing instant feedback to local forecast offices. This verification can help determine where additional verification efforts are needed, as well as maintain a level of situational awareness with respect to office performance during an event.

PANDA was originally designed as a severe weather verification tool. However by utilizing the IRIS database, it will be able to verify all types of warnings, from Tornado and Flash Flood warnings, to Winter Storm, High Wind, and even Red Flag warnings. This will greatly reduce the workload at the local office level in terms of gathering storm reports from different sources, and manually calculating verification statistics. All local verification will also be accessible from a single source.

4.4 *Weather Event Reporting*

NWS offices use a number of local/regional programs to organize, format, and disseminate weather event reports during times of significant weather. These reports can be either severe convective or long duration events such as snowfall, rainfall, or wind, and are sent as Local Storm Reports or Public Information Statements. Programs such as Eastern Region's Hydromet database and Salt Lake

City's Event Database are being rewritten to utilize IRIS data. IRIS will also allow the NWS to transmit other event reports in other formats such as XML in the future.

4.5 *Outreach Reporting*

Currently, NWS WCMs must tabulate and report on all outreach activities that occur at an office, a process that is generally cumbersome to track and difficult to assess. IRIS will organize all outreach activities and provide a quick and accurate means to assess and report on outreach activities; regional and national officials should also be able to generate reports on the fly. The data is also expected to be compatible with another national outreach program, the National Outreach, Event, and Education System (NOEES), expected to allow the public to see upcoming NWS outreach activities in their area.

4.6 *Wildfire Incident Management (IMET) Dispatch Management*

IRIS will be used to track meteorologists sent to Wildland fires as well as providing a platform for incident meteorologists to query fire behavior from past fires.

IMET dispatches can be tracked from the first notification that a meteorologist is needed at an incident to the final IMET leaving the fire. The initial dispatch information containing information such as fire name, location, and who the initial IMET will be is entered by the NWS National Fire Weather Operations Program Leader. Once an IMET is notified that he/she is being sent to a fire, the IMET then enters information into the database about fire behavior, local weather conditions unique to this location. This information is kept as a daily log for viewing at a later time by other IMETs dispatched to this same fire, or a fire nearby where local conditions could be very similar. With this information in a database that is easily queried, an office can quickly find out the location and number of IMETs in their area. This information can be used to notify IMETs of rapidly changing conditions that such as an approaching thunderstorm.

4.7 *Customer Needs Interface*

A major future endeavor for IRIS is a customer needs interface, which will provide NWS staff with quick access to weather criteria that are important to particular NWS stakeholders. This information, separate from formal warning criteria is often informally brought to the attention of NWS offices, but not acted upon in the long term. Knowing what customer needs information is important to particular stakeholders will allow NWS staff to inform them of upcoming events, even if they don't meet specified warning criteria (or greatly exceed them). Examples of such needs might be snowfall thresholds for Highway Departments or school districts; heat index information for health officials, or wind/ice data for power crew safety. Collection, organization, and analysis of this information will also be used to continuously recalibrate NWS warning products and services. This interface will also serve as the office organizer for all customer/stakeholder contact information at all levels, including local, state, and national.

4.8 *GIS and Mapping Capabilities*

Despite the fact that much of the information used by the NWS has a geographic component, the agency lacks an enterprise-wide Geographic Information System (GIS). This absence has several ramifications, including several independent and possibly inconsistent sources of map data within the agency. It also means there are many stand-alone map interfaces throughout the NWS that share few if any underlying pieces. Currently, developers of local software applications must start from scratch if they wish to incorporate a map interface, resulting in a large duplication of effort for every new map-based project, a re-investment in time, training, and data acquisition, and difficulty in collaboration. In the absence if an existing NWS enterprise GIS, the ability of IRIS to store, analyze and distribute all spatial information that is important to the organization may provide the opportunity for IRIS to become the enterprise GIS of the NWS.

Driven by a rich collection of geographic data, a powerful yet user-friendly map interface is an important element of the IRIS design. So far IRIS developers have used PHP and Geoserver fed by PostGIS on the server side, as well as Openlayers (http://www.openlayers.org/), Google Maps (http://code.google.com/apis/maps/) and Geotools (http://geotools.codehaus.org/) on the client side to develop many useful map interfaces to the data.

The IRIS database will also serve as a mapping interface for event reporting and for a real time verification tool for NWS. As of October 2007, short duration warnings such as tornado, severe thunderstorm, and flash flood are verified on a storm-based (polygon) basis. The increased specificity of the warning location requires event reports to also include improved specificity; simply knowing an event occurred within the same county as a warning no longer satisfies verification requirements. The mapping capabilities of IRIS will allow event reports to be more accurately reported and depicted. Previous reporting methods linked a report to an azimuth and range from a location that was often unspecified; it was listed as a city but could represent a city center, city limit, or main post office. IRIS will help more accurately depict the report by incorporating actual radar echoes or more accurate map locations. This should help quickly map events to the exact time and place they occurred, producing more accurate

verification results and helping forecasters provide better warnings as an event unfolds.

Mapping wildfire IMET dispatches will also allow forecasters the ability to quickly see where IMETs are in relation to changing weather. In the past, this capability was cumbersome at best, and in a worst case scenario, forecasters may not have been aware that IMETs were manning a fire that was threatened by changing weather.

By its very nature, weather is a spatially varying phenomenon. The mapping capabilities of IRIS will give forecasters the ability to place weather sensitive events and people on a map interface. This will allow greater situational awareness for potential problems, and a quick interface for contact information to notify customers and stakeholders of potential problems.

5. CONCLUSION

IRIS is envisioned as the database foundation for a multitude of applications that will help improve many internal and external NWS services. IRIS provides a standard structure to collect and organize many types of data commonly used in the NWS, from hydrometeorological data to customer contact and spotter information.

From this platform, the NWS will be able to provide more accurate event reporting and real time verification, better situational awareness, improved assessment of customer needs and outreach, better service backup capabilities in times of emergency, and increased information sharing at all levels. IRIS will standardize data and information collection from many observing platforms, and improve the dissemination of information in both standardized and customer driven formats that will serve multiple user communities. The utilization of open source technologies such as PostgreSQL, PostGIS, PHP and Symfony allow both for rapid development and efficient use of NWS information technology resources.

The initial database structure of IRIS has been completed along with some initial software functionality. Prototyping and field testing will begin in spring 2008 as applications are fully converted to the new database structure. An initial operating capable IRIS deliverable is planned for October 2008.

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