BIOGRAPHICAL INFORMATION

Skip Heise
Senior Project Manager
EMA, Inc.

Specific Responsibilities

Skip joined EMA, Inc. in 2000 as a Senior GIS Consultant and is responsible for managing large-scale geospatial technology implementation projects for the utility industry. His responsibilities also include performing business development and marketing-related activities.

Skip Heise graduated from the University of Wisconsin-Madison with a Bachelor of Science degree in Landscape Architecture with a focus on Remote Sensing and Geographic Information Systems (GIS). Skip has worked in the GIS industry for more than 13 years as a technical consultant for both Environmental Systems Research Institute (ESRI) and EMA.

Skip is currently supporting the City of Albuquerque (NM) Water Utility Division with its Enterprise GIS and CMMS implementation program.

Past Experience

Prior to joining EMA, Skip worked as a Technical Applications Consultant for three years and as a Sales Account Representative for three years for ESRI.

Educational Information

B.S. – University of Wisconsin-Madison, 1991

Professional Memberships

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Mobile Asset Notebook (MANO) Empowers HBWS Operations and Maintenance Crews with GIS Capabilities in the Field

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ABSTRACT

The Honolulu Board of Water Supply (HBWS) is providing mapping and spatial analysis capabilities to the field via mobile-based hardware and software technology. Technology to support operations for field crews and the mobile workforce has grown rapidly over the past three years. Today, software vendors are offering products that support development of mobile-based GIS solutions. Providing HBWS's operations and maintenance crews with GIS capabilities in the field has resulted in several major benefits including the ability to: Access the most up-to-date infrastructure information; view maps of existing water system layout; identify feature attributes; query for specific assets; view land parcels, ownership, and easement information; and distinguish facilities by geographical location (e.g., street name, intersection, and address). In addition, advanced mobile GIS software may empower field crews with sophisticated analysis applications to automatically identify valves to isolate during main break events as well as update GIS data through mark-up or redlining capabilities. The mobile GIS application can be updated every night or once a week with new information captured in the central GIS database. This presentation will examine a case study on the implementation of a mobile-based GIS application called MANO (Mobile Asset Notebook) for the HBWS.

HONOLULU BOARD OF WATER SUPPLY

The Honolulu Board of Water Supply (HBWS) is a semi-autonomous agency of the City and County of Honolulu. Its primary function is to provide municipal water supply to meet the domestic needs and fire protection requirements for the Island of Oahu. With 715 employees, the department services a million residents and is among the 10 largest water utilities in the United States. HBWS treats approximately 50 million gallons of water, from 170 water sources and 110 reservoirs, per year; maintains 1,900 miles of pipeline, and 155,000 metered connections. The Board is responsible for providing a safe, reliable water distribution system for residents at the most affordable cost possible.

The Board's GIS was installed in 1979 with the implementation of ESRI software and conversion of the City/County land base and water infrastructure data. Since that time, HBWS has been using GIS primarily for cartographic mapping purposes but very little for analysis. The focus of GIS was primarily on database maintenance and hard-copy map generation and the system was considered underutilized for day-to-day operations. In June 2000, the Board formed a GIS team to develop a strategy that could realize the full potential of GIS to support the organization's business requirements and operational needs.

In November 2000, the Board's GIS consultant, EMA, Inc. (www.ema-inc.com), began working with the GIS team to support the development of a vision for enterprise GIS. EMA provided strategic planning services, and is currently doing web-based GIS application programming, ArcGIS migration, mobile-based GIS solutions, and program management support for HBWS. The illustration below (Figure 1) depicts the timeline of major GIS initiatives and milestones for the utility.

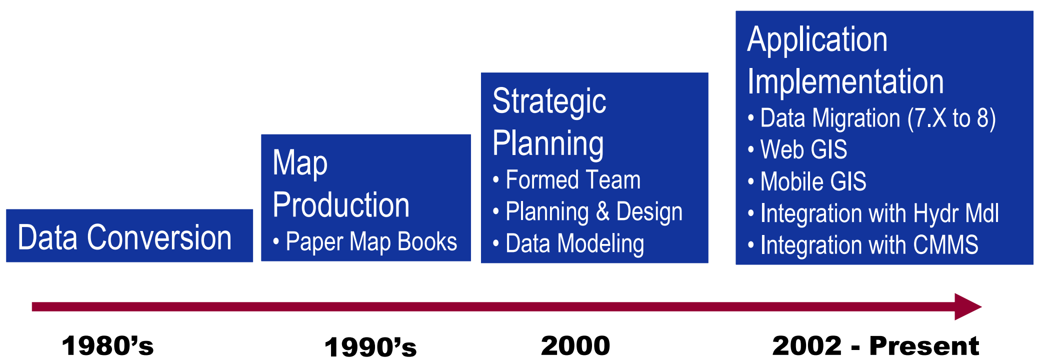

Figure 1: Illustration shows HBWS GIS Timeline

In November 2003, HBWS and EMA launched an initiative to implement a Mobile Asset Notebook (MANO) for the organization's field operations and maintenance staff. This paper presents a case study of the mobile-based GIS project.

BENEFITS OF MANO FOR HBWS

The HBWS GIS has expanded greatly over the past two to three years with the migration from a file-based departmental GIS to an enterprise GIS environment within a corporate database management system. HBWS staff can now access the GIS application and data from any desktop connected to the organization's network via web-based GIS services. Every day, utility staff is realizing the benefits of this capability. They are also keeping the enterprise spatial database up-to-date by inputting as-built information on a daily basis. This is critical to ensure that the end-user applications and web-based services are accessing the most up-to-date information from the HBWS water distribution system infrastructure.

Following the HBWS GIS Strategic Plan, the next major expansion for the system will provide mapping and spatial analysis capabilities to the field via mobile-based hardware and software technology. Technology to support operations for field crews and the mobile workforce has grown rapidly over the past three years and GIS vendors are now offering products that support the development of mobile-based GIS solutions. Enabling HBWS operations and maintenance crews with GIS capabilities in the field provides major benefits, allowing staff to:

- Access the most up-to-date infrastructure information
- View maps of the existing water system layout
- Identify feature attributes and query for specific assets
- View land parcels, ownership, and easement information
- Locate facilities by geography such as street name, intersection, and address
- Automatically identify valves to isolate during main break events
- Update GIS data through mark-up or "redlining" capabilities

Mobile or field-based GIS provides the ability to take digital maps out into the field to support construction, maintenance, and repair operations. Today, crews use paper maps or map books in the field to reference the water system layout. Paper maps quickly become out-dated as information in the GIS changes. A mobile GIS application allows crews to take the latest GIS data and information into the field without the need for paper documents. Applications can be updated nightly or weekly with new information captured in the central GIS database. Bottom line, a mobile GIS application provides the ability to display the water infrastructure and land base information maintained in the GIS database in the field where it is needed most.

BUSINESS-DRIVEN IMPLEMENTATION APPROACH

A business-driven approach was used for the implementation of mobile GIS. Based on the premise that business needs drive decisions regarding application functionality and data, the functional and data requirements for the mobile GIS largely are driven by the need to support specific work- and maintenance-related business processes. The business driven implementation approach includes four project phases:

1. Definition
2. Design
3. Development
4. Deployment

DEFINITION PHASE

The first phase of the project was to define and document business needs and technical requirements for mobile GIS, including defining the business vision and needs, application functional requirements, integration touch points, and data sources required to support implementation. Activities included:

- Defining business needs and functional requirements
- Defining system use cases
- Identifying hardware and software requirements

Defining Business Needs and Functional Requirements

The real value of mobile GIS is delivered through an application environment that has been developed or configured to support specific business needs. The intended users of the mobile GIS application are HBWS Operations, Maintenance, Engineering, and Customer Care staff requiring access to geospatial data and information in the field. These are people that have been trained to perform specific job functions, such as supervising maintenance, taking trouble calls from customers, planning and scheduling work activities for crews to perform, performing maintenance and repairs, and so on. These users may have minimum computer technology experience. Therefore, the application needs to be easy to use while providing only the information required by crews to support their work activities.

To establish the requirements, a core team of seven operations and maintenance staff was assembled to represent end users. The core team represented five HBWS business sections:

- Maintenance-Engineering-Design
- Maintenance-Construction
- Customer Care-Investigation
- Maintenance-Field
- Maintenance-Plant Operations

A series of workshops was facilitated with the core team to identify and validate requirements for mobile GIS. The workshops were business-focused – not technology-centered – to identify the work activities and business processes performed by staff. From these activities, the information required to support the work and functionality needed to deliver the information was defined. It was determined that the following business activities could be supported by mobile GIS.

- Locating water lines, leaks, buried valves, and meters, and verifying other utilities
- Providing construction inspection services of HBWS projects, sub-contracted to private contractors to ensure compliance, keep detailed records of all activities and process progress payments. Also coordinate the contractor's work with other units within HBWS and other affected City agencies/private entities when existing facilities/installations are affected
- Project coordination with external agencies, formulation of water main replacement program, and condition assessment of all HBWS facilities
- Rightsizing large accounts (3-8 meters). HBWS uses electronic monitors to capture flow data and work with customers to identify the source of leakage/use within a property
- Prepare Plans and Specifications. Field Assessment of existing conditions to develop project scope of work
- Identify P&E projects for the RFIP budget, coordinate construction projects with the City and State, and handle project engineering for waterline and facility projects
- Perform water system analysis, hydraulic model calibration, and various field investigations due to water system related complaints

During the workshops, high-level user needs were discussed. A web-based follow-up questionnaire was distributed to survey and rank the needs. The results are illustrated in Figure 3 below.

Priority data/ functional needs by category.	Prioritized Needs
Needs Relating to Displaying Data Layers	• Construction project locations • Locations for foreign utilities (sewer, electric, gas, fiber) • Location of water valves • Location of fiber cables • Association of water mains to laterals and the connected meters • Location of meters including description of location • Easement boundaries • Abandoned water mains • Ortho photos • Elevation contours • Curb lines • Watershed boundaries • Existing bus routes • Locations for temporary meters • AMR antenna coverage area
Needs Relating to Displaying Attribute Information	• Track which valves are closed • Identify water mains that can't be shut down per Plant Operations • Track which valves are throttled • Access and display the depth of water main • ECR, meter number, and MXU number for meters • Static pressure for fire hydrants • Hydrant and valve maintenance and repair information • Average pressure for a meter • Billing and consumption information • Backflow prevention information stored in CAS
Needs Relating to Displaying Documents	• Distribution maps for a specific location • As-built drawings for a specific location • Customer service information for individual meters, including sketches and scanned multi-page TIFF images of service records • Tax Map key maps • Primary contact at other utilities (name, phone, address, cell, etc) • Contact information for large accounts to use during outages • Meter maintenance records in the field (data stored in CAS) • Flow chart information from large meter database
Needs Relating to Valve Isolation	• Perform a system trace function to identify connectivity of the water system and validate in the field • Identify valves to close for pipe section isolation when a main breaks • Identify customers out of service during a main break

	• Identify hydrants to be out of service during a main break
Needs Relating to Navigating the Map	• Zoom to a location by street name, intersection, address • Navigate back to the previous zoom extent multiple times • Select and zoom to a hydrant by entering the hydrant number • Search and locate businesses by name and zoom to map location
Needs Relating to Thematic Mapping	• See water pipes color-coded by water pressure system • Color code pipes by water type (potable, non-potable, R0, R1, desalinated) • Identify closed valves and color code valves by open/closed status • Color code parcels by critical account (schools, hospitals, care facilities, dialysis patients, etc.) • Show pipes color-coded by size • Color code valves by valve type • Color code parcels by pending backflow devices
Needs Relating to Redlining (including map markup)	• Ability for all users to view redline polygons and redline maps • Email redlined maps • Save local redlined maps • Additional redline tools (text, straight line, click & drag box, multi-click and point, polygon, arrow, and ability to format tools) • Recall a redlined drawing • Mark up scanned as-built distribution maps (additional information on pipe layout, schematics, and changes during construction)

Figure 2: Priority data and functional needs

Defining System Use Cases

Once the business needs and functional requirements were identified and validated with the core team, the detailed system requirements could be defined. A use case approach was employed to define system requirements. System use cases describe the desired behavior the application must possess to support the business processes. A system use case was created for each desired behavior of the mobile GIS application. The system use cases were provided to a level of detail to design, develop, and test the application functionality. Specifically, each system use case included the following elements:

- *Brief Description* – Provides the purpose of the use case and desired results
- *Assumptions* – Assumptions about the process of the use case
- *Actors* – People (users) or other systems that interact with this use case
- *Flow of Events* – Step-by-step sequence of actor and system interactions including basic and alternate flow
- *Special Requirements* – Typically a non-functional requirement that is specific to a use case but is not easily or naturally specified in the text of the use case's event flow
- *Pre-Conditions* – State of the system that must be present prior to a use case being performed
- *Post-Conditions* – Possible states the system can be in immediately after finishing a use case
- *Data & Accuracy Requirements* – Specified for the data required to support the system use case

MANO System Use Cases	
• Navigate map • Display data layer • Measure line and radius • Manage book mark • Identify attribute • Map tips • Color code map • Locate area • Locate by GPS • Zoom to HBWS facility	• Copy map to clipboard • Extract and synchronize mobile data • FileNet document extraction • FileNet document display (client) • Redline map • ArcMap redline manager • Map notes • Pipe isolation • Print map • Online help

Figure 3: Major system use cases defined for the Mobile GIS application.

Identifying Hardware and Software Requirements

After a complete understanding of the intended user's work activities, business needs, and functional requirements, hardware and software specifications could be determined. As opposed to traditional desktop applications, emphasis had to be placed on hardware because the applications would be used in the field. Since HBWS crews had no mobile technology, a major study was performed to identify the proper computer hardware to support a mobile GIS application. The team acquired demo machines from leading vendors in three different forms, including Tablet PC's, Slate computers, and traditional laptops. Based on industry research, internal analysis, and field testing, the HBWS team chose to go with rugged equipment – in this case Panasonic Toughbooks in both laptop and tablet forms.

DESIGN PHASE

After the business needs and functional requirements were fully understood, the next step in the software development process was to create a high-level system design to serve the following purposes:

1. Communicate major components of the mobile GIS application architecture to HBWS staff who will ultimately be responsible for maintaining and managing the application
2. Help determine system dependencies, such as necessary hardware and external software packages (ArcIMS, FileNet, etc)
3. Help the development team delineate major software components and assign appropriate team members to develop these components

The mobile GIS application operates primarily as a stand-alone mapping application separate from the HBWS network, not relying on connections to network resources, such as ArcSDE or ArcIMS to function. However, the HBWS map data and supporting documents used by the mobile GIS application are not static. Map data is constantly updated to improve accuracy and reflect real-world infrastructure changes. New documents, such as scanned as-built diagrams, are regularly added to the FileNet document management system. To accommodate the changing nature of HBWS databases the system architecture includes data extraction and synchronization elements. In a typical scenario, the user would connect the mobile computer to the HBWS network at the end of the work day and initiate the data synchronization process. Geographic data, scanned documents, and other data would then be automatically updated on the mobile unit.

The system design (Figure 4) also includes a map *redlining* system that allows users to mark up a map image to point out data inaccuracies. Redline records created in the field are temporarily stored on the mobile unit. When the unit is connected to the HBWS network during the data synchronization process, the redline records are submitted to a server-side redline database.

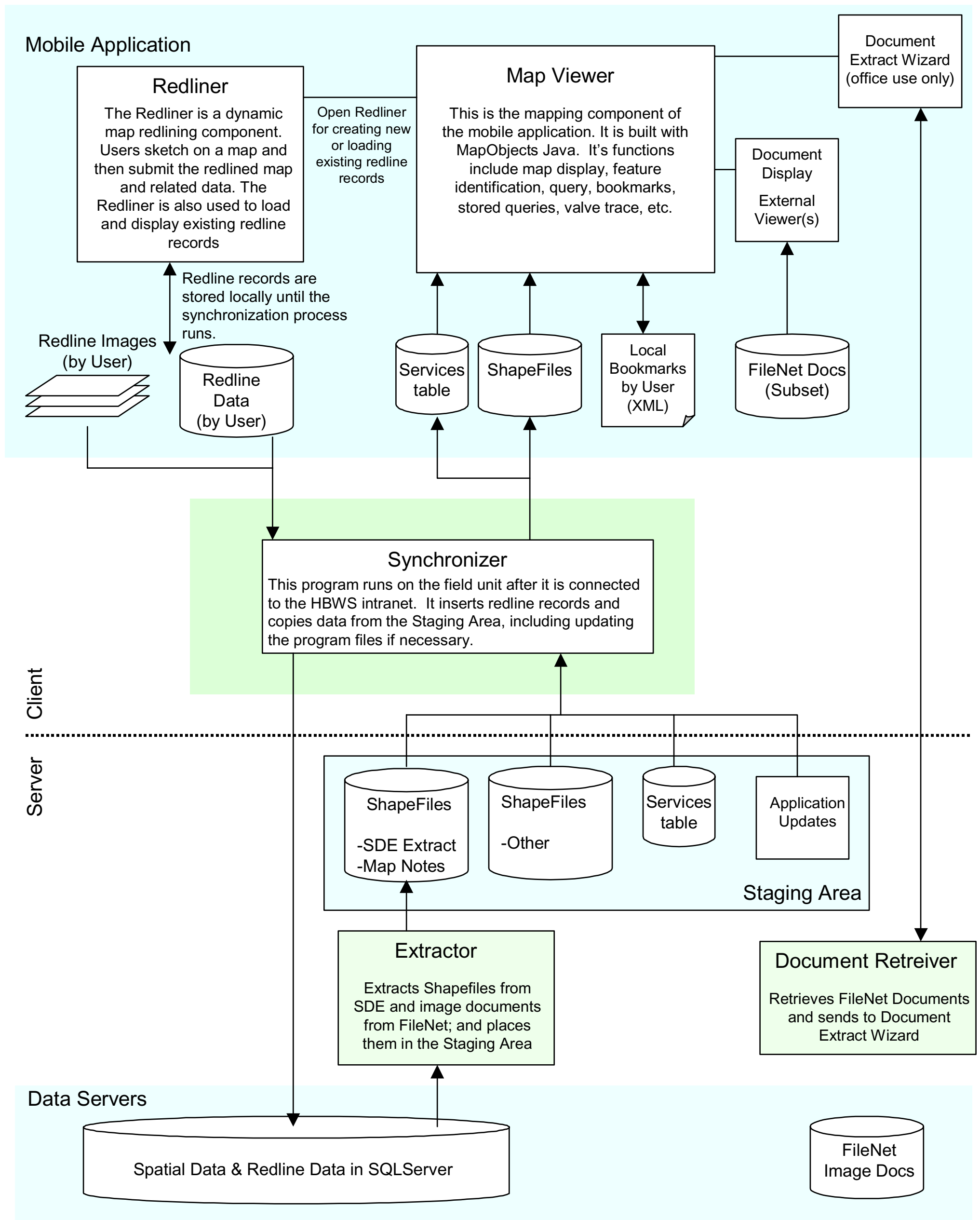

Figure 4: A high-level system design for Mobile GIS.

DEVELOPMENT PHASE

The application was developed using an iterative approach that included running through the steps of 1) development, 2) testing, 3) client feedback, and 4) rework for every application component. By following this process, the user core team was involved in reviewing and testing the application during the development process, providing the development team with comments and feedback from users during development instead of deployment. This also helped the Project Managers impact user expectations and minimize the risk of deploying an application that users rejected.

Test Plan

A test plan was created to develop a strategy and approach to shake down the Mobile GIS application. The plan was intended to be used by HBWS GIS staff and the core team in understanding and carrying out prescribed test activities and managing these activities through successful completion.

The test plan outlined steps to be taken during testing periods to demonstrate that the application met the business needs and functional requirements identified during the requirements phase. The plan included a test case for each major functional component and each test case included a number of scenarios or test scripts. The scripts were based on the system use cases described in the software requirements specification, ensuring that the application is tested according to its intended use. Each test case references the associated functional requirement being tested.

The test cases verified that the system met documented functional requirements. For each test case to pass, every step in the test scripts must have successfully produced expected results. Any system errors or problems encountered during the test were recorded in a Software Change Order (SCO), and the test case was marked as 'failed.' The development team addressed any issues and the test was performed again during the subsequent testing iteration. The application was deemed complete once it passed all test cases.

DEPLOYMENT PHASE

The project deployment phase included the transition from the development to production environment, user training, and support in the field.

Transition from Development to Production

After the development and test phase was complete, the application was installed and configured on production field units and servers. It was initially deployed to a pilot group of 15 users. First, the client applications were installed on the laptop and tablet computers. Then the synchronization and redline components were installed on the HBWS data server. The synchronizer was set up to run nightly so that field units would have the most up-to-date enterprise GIS data each morning.

User Training

Once the mobile GIS application was configured in the HBWS production environment, it was time to educate end users utilizing a "train the trainer" approach. A half-day workshop was facilitated with the HBWS IT and GIS groups, who would be handling the help desk and answering end-user questions regarding the application. This initial training session provided the IT staff with an overview of the application's functionality and focused on technical components and configuration methodology. GIS group members were training at the same time on application functionality using training materials that would be used in the future to provide training to end users. Next, the core team and other designated end-users were trained. Each training session lasted four hours over a one-week period. Each functional area of the application was presented in a lecture format followed by hands-on exercises using the application.

Field Support

After users were fully trained, each person received the final version of the application already loaded on the Toughbook field computers. Call support is provided to all field users by the HBWS IT and GIS teams. Rollout was smooth because the core team had been involved throughout the development cycle. When it came time to move to production, users were familiar with the tools, which they had been using in pilot mode for several months.

SUMMARY

The HBWS is rapidly deploying geospatial information and technology to support enterprise business needs. Following the HBWS strategic GIS plan, the latest initiative is the implementation and deployment of a mobile GIS application called the Mobile Asset Notebook (MANO). This application was intended to support the business processes and work activities of field operations and maintenance staff by providing the ability to:

- Access the latest infrastructure information
- View maps of the existing water system layout
- Identify feature attributes and query for specific assets
- View land parcels, ownership, and easement information
- Locate facilities by geography, such as street name, intersection, and address
- Automatically identify valves to isolate during main break events
- Update GIS data through mark-up or redlining capabilities

The application was deployed in September 2004 and was well-received by users in the pilot group. The business-driven methodology employed by EMA and HBWS to implement the solution proved to be a major factor in the project's success. The approach involved a core team of operations and maintenance staff that was a solid representation of the user community. They were involved throughout the development lifecycle and provided invaluable feedback to the development team. This made deployment virtually painless and ultimately increased user acceptance of the tools.