

Reporting on the Use of Handheld Computers and the Display/Capture of Geospatial Data

Appendix C – Survey of User Experiences

This appendix comprises a survey of mobile GIS user experiences. The intent of this survey is to provide the Geography Division with a set of specific references to users who are currently deploying mobile field collection solutions as part of an overall data management strategy. As noted in the main body of the report, the use of mobile technology is exploding. While there are probably thousands of current mobile GIS users, we have attempted to focus on user experiences that have a direct bearing on the GSS Initiative. However, we have also included a couple of examples of applications that are “outside the box” and should be followed over the next year.

Commercial Software Solutions

Any discussion of computer technology ultimately focuses on the combination of hardware and software that are being deployed. Therefore, this appendix is organized around specific commercial off the shelf (COTS) solutions that represent promising options for the GSS Initiative.

1. ArcGIS Mobile - <http://www.esri.com/software/arcgis/arcgismobile/index.html>

As noted in the main body of the report, we believe that ArcGIS Mobile is the system that most closely matches the requirements for the GSS Initiative. During the interview process we learned that it is being deployed by a wide range of users on an extensive array of devices and that it is an affordable solution for existing Esri users. It can be deployed on any Windows based mobile device and can be customized to meet a variety of user needs. It allows for enterprise wide data maintenance with a tight coupling of field and web based technology.

1.1 US Fish and Wildlife Service (USFWS) - Deepwater Horizon (MC252) Oil Spill Response.

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The response of the USFWS to the Deepwater Horizon Oil Spill is the most public and dramatic recent implementation of mobile GIS technology. It involved a coordinated effort from the FWS, Coast Guard, several state agencies and BP Oil. Esri used it as a real time test bed for its newest release of ArcGIS Mobile 10. A number of different field data collection activities were synchronized with a BP server located in Houston, TX. The USFWS effort focused on the collection of birds and other wildlife that were impacted by the oil. ArcGIS mobile was deployed on Trimble Nomad GPS devices. The application was designed to replace a paper based reporting system. GPS coordinates of wildlife pickups were collected along with photos and attributes. When wireless networks were available the data could be immediately transmitted to Houston for almost real time viewing thorough web mapping applications. According to the FWS scientists the conceptual design of the project was excellent. There were some glitches relating to design of the application and connection to wireless networks. Based on user feedback the application was modified to meet requirements and alternative network access was utilized or the data were stored on the device and transmitted later to the server. The final version of the application was judged to be very

easy to use, requiring only about 15 minutes training. Given the nature of the environment, the use of basemaps or imagery was not an important factor in collecting the coordinate points. While there was some initial concern over storing the data on a BP server it never became an issue and a high level of trust was established. The USFWS is interested in National Resource Damage Assessment (NRDA) from the event. They plan to utilize ArcGIS Mobile as part of that long term process. Based on their experience they believe that ArcGIS mobile was a success in streamlining and coordinating the collection of mobile data. Based on their understanding of the GSS Initiative they believe it would be a useful alternative.

1.2 Florida Fish and Wildlife Conservation Commission

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The Commission quickly deployed ArcGIS mobile for the Deepwater Horizon event. They had a number of wildlife specialists collecting field data on rugged tablet computers. The field data were synchronized to their own server (not the BP one) with an Esri SDE Geodatabase. The transmission was usually handled via Wi-Fi connections at airports. They were very pleased with the application and found it far superior to their previous experience with ArcPAD. The application required little training and was very “Google Earth” like. The touch screen on the tablet PCs was very functional. The cached maps were much better than previous versions. They noted some glitches with loading image data and noted that one must carefully synchronize the ArcMap MXD project with the one that is pushed to the mobile device. Any changes must be made at the Mobile Product Center and a new project must be transferred to the device. They are planning to deploy an extensive ArcGIS mobile application, “Smart Cop” on laptop computers for 700 of their law enforcement officers throughout Florida.

1.3 South Carolina Electric & Gas

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SCE& G is the largest utility company in South Carolina (Figure 1). For more than two decades they have utilized GIS to inventory, plan and analyze their networks and other resources. Over that period their applications have evolved through a series of different systems.

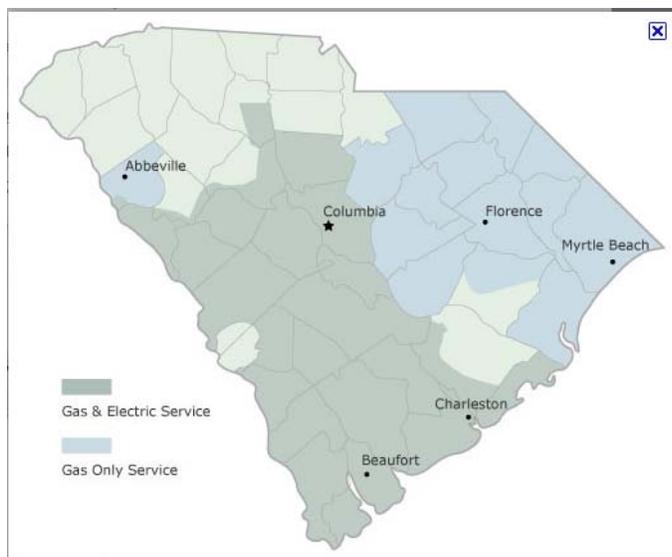


Figure 1 SCE&G service area

According to the GIS manager:

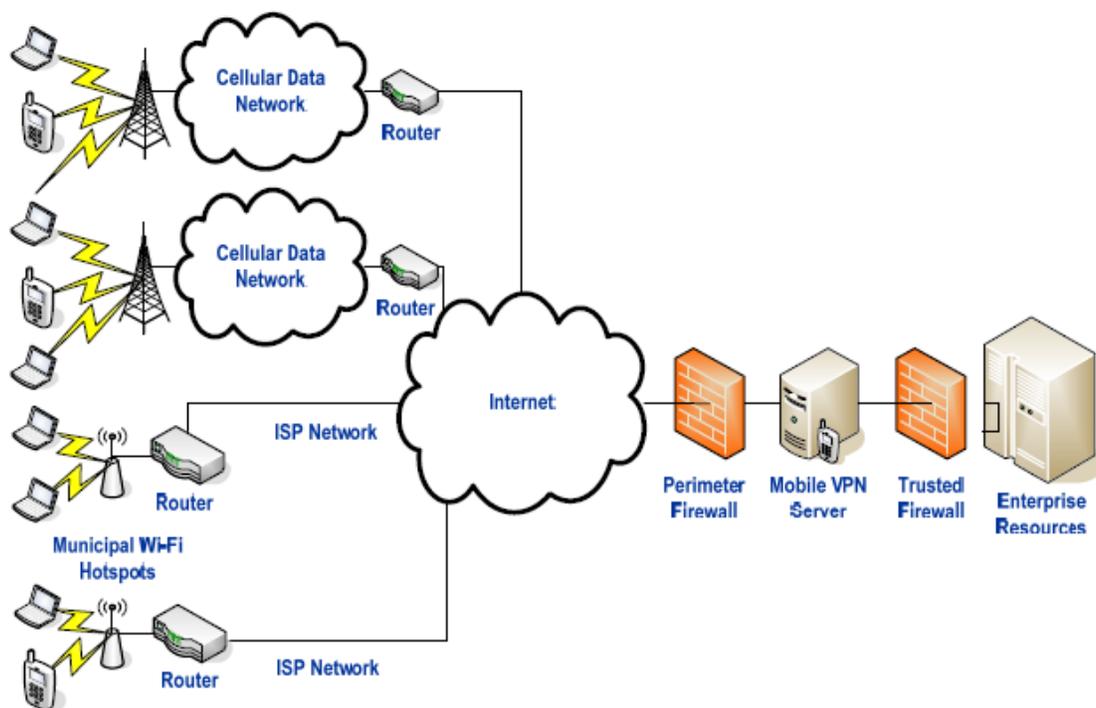
“We are currently messing with ArcGIS 10 Mobile for field data collection. Most of our field updates come in the form of paper “as-built” drawings. Only recently has it become cost effective for us to investigate taking computers into the field – when you have as many trucks and contractors as we do it gets pricey real quick. Many other companies have been doing it for years but it has cost them a ton of money without really adding a whole lot of tangible benefit beyond the wow factor. Replicated database, more accurate maps, GPS and aerial photography are finally providing some bang for the buck to go large scale.”

The deployment of mobile technology by a major gas and electric company at this time provides an excellent comparison with the GSS Initiative. They have a mature GIS data base that is focused on point level information regarding customer services and information. They maintain a topologically structured network of linear features, (their network of service lines for gas and electric). This network topology is critical for outage analysis. They perform spatial searches to determine error checks such as locating duplicate features. They must maintain their data on a continuous manner from a variety of sources. Much of their data is related specifically to an address associated with a structure – or multiple meters for a structure. They assemble address information from a variety of sources (First American / Core Logic) as well as field efforts, maps, and imagery (license access from Bing). Ideally, they would like to have the address points during the construction phase of a new subdivision. They work closely with local governments to acquire digital submissions of planned developments. The level of representation is generally a single point – ideally located near the meter. The association of tabular data to this point is key to the integration of their data. This linkage provides a complete continuous robust source of information about their customers. They know the type and quantify of use of both gas and electric at a point level. Therefore, they know land use, costs, revenue, etc. They have convinced management that spatial data is an asset; therefore, the financing is now a long term investment rather than a onetime expenditure. Their workforce is continuously updating and refining the database. The goal is a perfect point and line feature network. The workforce basically drives trucks, therefore, they can easily handle data collection and edits data on a laptop with a USB mapping grade GPS card (WAAS). They are concerned about administrative boundaries for regulatory compliance, rate determination, taxing, property acquisition, and management. They need to perform reverse 911 to notify customers about gas leaks and other problems. They are making use of web services (ArcGIS Server and Google API) to provide almost

real time information to management. For example, with the customer information system they can estimate the potential revenue from expanding their distribution network into a new area. Management uses a web browser (Google API) to visualize and manage outages. It is also providing a tool for monitoring specific customer issues. For example, when a customer complains about their bill they can easily review the bills of customers in the same neighborhood and determine whether the bills are comparable or whether there was an anomaly at the customer's house. When they identify anomalies they can conduct an energy use review with the customer to identify faulty water heaters, insulation issues, etc. They can also monitor gas usage and check on whether developers have installed the number of gas hookups they committed to during the planning stage.

SCE&G uses NetMotion (<http://www.netmotionwireless.com/>) for secure data transfer from mobile devices. They have found that it provides a very secure and easy to use to transmit data over wireless networks (Figure 2). A brief description:

Mobility XE is a software-only [Mobile Virtual Private Network \(Mobile VPN\)](#) that provides secure, continuous remote access to network resources and applications from mobile devices over any wired or wireless IP-based network.



Mobile devices communicate via multiple cellular data networks or Wi-Fi hotspots in the field, to connect to departmental resources via the public Internet. A mobile VPN secures the connection end-to-end and maintains reliable connections as each device moves between the various networks.

Figure 2 NetMotion Mobile Virtual Private Network (<http://www.netmotionwireless.com/>)

1.4 Norfolk Southern Railroad

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Reference document: Trimble User Profiles “*Trimble Extends ArcGIS Mobile Technology with Advanced GNSS Post processing Support*” (Courtesy of Trimble)

Norfolk Southern Railroad manages 17,000 miles of track in 22 states. They recently created an extremely high resolution and detailed inventory of the entire rail infrastructure (track, signals, crossings, switches, etc.). This inventory was generated from LiDAR and high resolution imagery, as well as, field observation. The current task is to maintain this detailed GIS database (Geodatabase and Oracle) in almost real time – must update every 12 hours. They selected ArcGIS mobile as the solution based on its ability to synchronize the field observations with the server based corporate data base, the ability to customize the data and tools stored on the mobile devices and licensing considerations. As a current Esri customer they also found it to be a cost effective addition. They selected Trimble devices (GeoXH and Junos) because of seamless cross platform deployment. The GeoXH provides sub foot accuracy and the Juno is providing about 2 meter accuracy. They trained about 300 supervisors to conduct a continuous assessment of features and to transmit updates of about 4,500 changes each year. It is critical to keep the data current. Any changes must be synchronized to conform to the U.S. Department of Transportation and Federal Railroad Administration (FRA) Positive Train Control (PTC) system. PCT depends on the GIS infrastructure data to control the operation of trains. It is a detailed three dimensional database that automatically controls the speed of a train and can even stop a train in an emergency. Therefore, the supervisors in the field who are basically in charge of about 100 miles of track must be able to quickly and accurately capture and transmit any additions, deletions, or changes to a set of point and line features. The application had to provide disconnected access to an extremely high resolution image database of the entire the system (22 states) and it had to be simple enough for supervisors to use in the field. The final deployment is only about six buttons. The imagery was cached and stored on SD flash cards that are compatible with the Trimble devices. They plan to include geotagged photos and video. Another ArcGIS mobile application was designed for the real estate division. This application is designed for laptop computers and the data includes imagery and about 500,000 parcels. Norfolk Southern has found the ArcGIS mobile 10 solution to be much improved over previous versions and has deployed it to meet very strict requirements for the PTC system. It has critical requirements in terms of accuracy, completeness, and currency. It also must support simultaneous update from about 300 users spread across 22 states. The Norfolk Southern contact sees similar parallels with the GSS initiative.

1.5 CSX Rail

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CSX is a large Esri and Trimble customer. They have traditionally been ArcPad based, but are now moving towards ArcGIS Server and ArcGIS Mobile. CSX operates in 22 states east of the Mississippi River. They maintain 23,000 miles of track. Their needs are similar to Norfolk Southern. They are capturing and maintaining detailed features of the rail system at a positional accuracy of better than 2.2 meters to support the Positive Train Control system. They have maintained an ArcGIS Geodatabase for

several years and have utilized ArcPad extensively. They found the ArcPAD application to be difficult to support and “too heavy” for many tasks. Over the last couple of years they have switched to ArcGIS Mobile. Now they customize applications using ArcGIS Mobile tools. They have about five different applications that run on a wide range of devices. These include Trimble GeoXH and Junos as well as laptops. They are considering using RTK to support their very high accuracy requirements. Each device has a unique device number and is authenticated to the server via tokens. They currently have about 150 – 200 users but expect this to double very soon. They are deploying applications throughout the company. For example, hundreds of signal construction crews will soon be conducting field data collection. Tank inspectors need the ability to place points on an image of a building. Three hundred customer service employees work with 6,000 customers to review rail service and infrastructure needs. They will soon move to ArcGIS Mobile on laptops. They transmit data via Wi-Fi or wait to upload data from hotels. They maintain two versions of the database – edit and production. They are working to improve the version control of these.

1.6 Virginia Department of Transportation (VDOT) and Timmons Group

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Reference Document *Functional Requirements Document ArcGIS Mobile Application for VDOT Environmental Division* (Courtesy of VDOT)

The VDOT environmental department is in the process of deploying a customized ArcGIS Mobile application that will enable the VDOT field based non GIS workforce to synchronize field data to their enterprise GIS and Oracle databases. It is being developed by the Timmons Group in Richmond. The final application will be in place in spring 2011. The intended users are spread across the state into nine districts. The application which utilizes the Microsoft Server Compact is intended to be used by field personnel to collect data for different program areas such as: Hazmat, Wetlands, Cultural Resources, Water Quality, and Noise. There are multiple data types that users can create within each of these program areas. Users can edit attributes or use GPS to add a new point, line, or polygon features. All the data collection forms are generated dynamically using templates. All the data collection forms are bound to a mobile database and supported by look up tables, word completions, and drop down lists. This mobile database is extracted from an Oracle database using the Microsoft synchronization framework. Once users collect all the data, they can dock their devices and can synchronize the GIS data to the ArcGIS Server. The system is designed to both push and pull data between the mobile devices and the server (Figure 3).

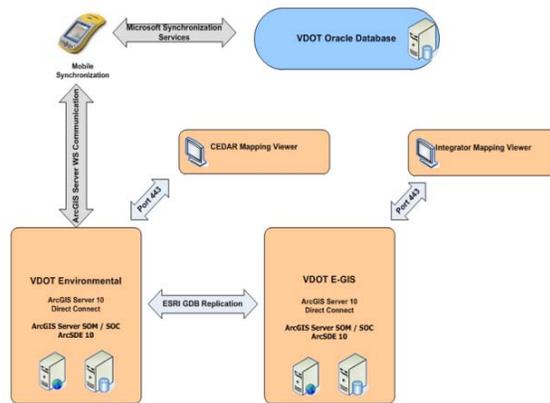


Figure 3 VDOT ArcGIS Mobile flow chart (Courtesy of VDOT)

1.7 Fairfax County Water Authority

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Fairfax County Water Authority is beta testing its ArcGIS Mobile application, developed by Timmons Group to coordinate the field data collection activities of about 40 field workers. This system is designed to integrate field operations with server side storage and web applications. They are bulk loading water mains, hydrants, water meters, valves, fittings, etc. They associate water meters to houses that are represented by address points from the Fairfax County GIS. Each of these features is stored in a SAP database. They maintain test, production, and publication versions of the data. Some field operations will directly update the publication data base; others will stage the data for QC before any changes are made to the production data base. They utilize about 40 Trimble ProXH gps devices that operate in a disconnected environment. They also will support a number of laptop users. Customer address point data and other base layers are supplied by the Fairfax County GIS. This enables Fairfax Water to concentrate on its operational layers. They anticipate closer integration via web services. They believe that there are many similarities with the GSS Initiative and would be happy to share their experiences with the Bureau.

2. CartoPac - <http://www.cartopac.com/>

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During our survey of mobile GIS users it became evident that CartoPac is used by several organizations to handle many of the same communication tasks as ArcGIS mobile (Figure 4). It consists of four modules that have recently been included on the GSA schedule.

The CartoPac Field Server is used to synchronize data via any computer with an internet connection. The web interface also provides direct post processing of GPS data and integration with ArcGIS technology

CartoPac Data Interchange for ArcGIS (CDI) -This is designed for users whose customers whose project requires repeated asset data collection. It provides for GPS post processing to be handled directly from an ArcMap utilizing any ArcGIS-compatible data formats

CartoPac Mobile® - An integrated solution for customized for multiple projects with different objectives. CartoPac's patented, high-speed raster/vector engine can handle tens of gigabytes of imagery and view large data layers on handhelds.

CartoPac Studio –This is an integrated solution configuration environment for defining database settings and connections, designing forms, and configuring mobile devices.

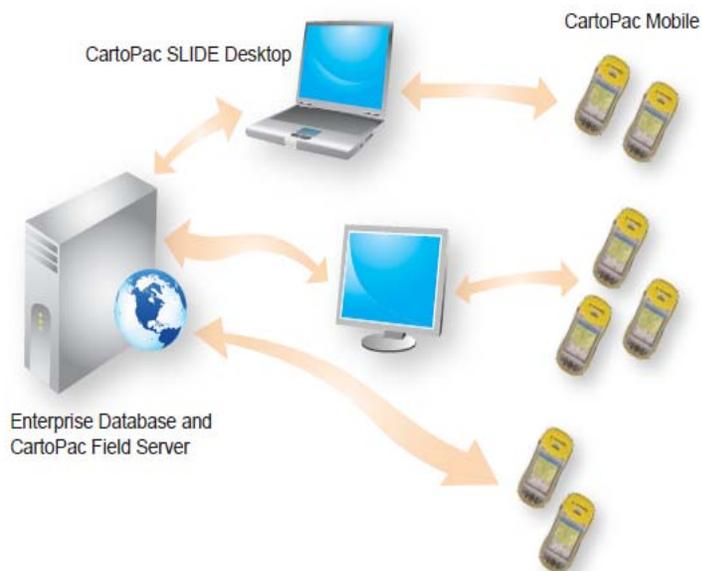


Figure 4 CartoPac Integration Tools (www.cartopac.com)

2.1 BLM / Wyoming

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Reference Document *Mobile Mapping Helps Wyoming BLM Patrol 18 Million Acres*

http://trl.trimble.com/docushare/dsweb/Get/Document-397036/022501-132_Wyoming_%20BLM_Customer_Story_1107_lr.pdf

BLM maintains a state wide inventory of many features relating to the management of federal lands. For example, they have point, line, and polygon features relating to oil and gas wells. In fact, some counties may have 50,000 wells which are recorded as point level features. They also collect roads (linear) and pits (polygons). They need to closely integrate the field data collection with the server side geodatabase. They have selected CartoPac to perform these tasks. Since they cannot rely on access to wireless communications they needed to store a high resolution basemap on the mobile device. They utilized the CartoPac system to compress about 10.5 GB worth of digital maps to create a 2 GB seamless mosaic of the state (1:100,000-scale) that fits on an SD card that maybe inserted into a Trimble device. They have found that the field GPS application can easily navigate to and synchronize with this basemap. It provides a good means of navigation and reference material. BLM does not encourage wireless transmission; therefore, the data from mobile devices are transferred to desktop computers and then added to a “holding geodatabase” before they are entered into the corporate database. They also synchronize the push and pull of data via a web site. They utilize Trimble Juno GPS devices. They report that based on a comparison with hundreds of thousands of survey points that the Juno provides about two meter accuracy that meets their requirements. They plan to start capturing geotagged photographs. They believe there are many parallels with the GSS Initiative in terms of the capture and validation of point and line features in rural areas.

2.2 San Juan County NM

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The San Juan County NM (population ~114,000) rural addressing department is charged with the collection and maintenance of addresses throughout the county to meet emergency response needs. They assign new addresses and are the LUCA contact point. They have maintained an ArcGIS database for several years and have recently deployed a mobile component to capture and validate their data. The data consists of address points (front door), streets, hydrants, gates, low points, etc. They use Trimble GeoXT

units to obtain sub meter accuracy. They also have found the Laser Tech Tru Pulse rangefinder to be an excellent device to calculate coordinates from remote locations. Addresses are based on a mile marker system with a potential address every 52.8 feet (100 addresses per mile). Data are also recorded on the type of residence (mobile home, single family, etc.) but they do not have any zoning. Addresses can be assigned to non structure points such as a utility connection for a billboard. These are noted with a UT suffix. The addresses are linked to a tax ID number rather than the parcel number. They believe that the parcels which are maintained by the assessor are not particularly well georeferenced (don't match the image). The street segments are integrated with the existing road network through topological edits handled only by the coordinator during post processing. Address points are handled by other staff. The streets maintain normal attributes (street names, address ranges) but the most critical information relates to Public Service Assess Points (PSAP). These are the dispatch assignment areas. The county data are transmitted to the state department of revenue that maintains the state wide E-911 data base. They will sell the street centerlines but will not release the address points, which they believe contain sensitive data. They do not store census geography as attributes, but probably will use geoprocessing tools to attach the 2010 census geography. They conducted an extensive search before deciding to purchase CartoPac and are very pleased with the product. They find the synchronization between the server and the mobile device to be very efficient. The coordinator was quite critical of the LUCA software and suggests that the Bureau develop easy procedures to ingest Esri shapefiles. In New Mexico this could be handled from the single state office.

Other CartoPac users (From Jake Opdahl [jake@cartopac.com])

2.3 USAF

F.E. Warren AFB utilizes CartoPac within their Esri environment (SDE) for utilities mapping on the base. Air force Space Command is in the process of implementing CartoPac tools for enterprise support of installations within Space Command.

2.4 National Parks Service (NPS)–Mesa Verde, Great Sand Dunes

CartoPac is used for the following:

- Cultural resource mapping.
- CartoPac Field Server for MEVE which allows for download/upload of data via a web interface.
- They collect one GPS point but may collect multiple related records while at the location as well. The back end database is a SQL Server environment.
- Great Sand Dunes: The initial pilot was for a vegetation mapping application. This particular application is deployed via ArcMap utilizing our ArcGIS extension with a personal geodatabase as the backend data.
- Abandoned Mine Lands (AML). This solution is another web based deployment. The solution allows users to collect AML site information (non-spatial), related features (spatial features) and related monitoring information (non-spatial). Phase two will integrate the solution directly with NPMAP (NPS web portal).
- Fire Mapping: CartoPac will be implementing a web based deployment (either integrated with ArcGIS Server/geocortex or within the NPMAP environment) for field data collection.

2.5 Colorado State Forest Service

The CartoPac technology is used to handle multiple relational databases, using custom forms on the mobile device to accommodate the multiple workflows, and data transfer from desktop to field devices.

An online interface is used to check out the personal geodatabase and provide data interchange for ArcGIS. Using CartoPac Enterprise, custom forms are deployed on the mobile device. Users are also able to interface with the Web data model components, such as subtypes, domains, and relationship classes, to maintain the data integrity.

2.6 Washington County UT

Reference Document: *Handheld computers with GPS help county record conditions and locations of its public assets* (http://americacityandcounty.com/technology/gis_gps/handheld-gps-computers-track-assets-200904/)

In order comply with Governmental Accounting Standards Board (GASB) requirements, the county needed to complete a comprehensive inventory of infrastructure assets (signs, roads, culverts, bridges, and manholes). They purchased five handheld computers from Trimble with cameras. Starting last fall, two teams of two employees began traveling through the county twice a week, using the devices to record asset types, locations and conditions of road signs and culverts, as well as to take photos of each asset. In the office, the field data are transferred into ArcGIS environment. CartoPac Field Solutions helped customize a software solution with customized forms and helped streamline the workflow for the field crews. "In just four months, four field workers have been able to collect information for about 1,500 culverts and 1,100 road signs," Hansen says. "We're now well on our way to having an up-to-date inventory of county assets." The Washington County Mosquito Abatement District started using the same software to collect information about mosquito species, locations, and larvae throughout the county.

3. TerraGo <http://www.terragotech.com>

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As noted in the main body of the report, the TerraGo GeoPDF format has been adopted by several federal agencies (USGS, USACE, etc.). TerraGo provides a set of tools to export standard GIS themes (raster and vector) as GeoPDFs. It also provides a free Adobe Acrobat toolbar that enables a user to navigate and toggle layers. It also supports GPS integration. As with other Adobe PDF formats the GeoPDF files are highly portable and versatile without the need for specialized application software. In this environment users can transfer the files to desktop or windows mobile devices. As a standalone product the GeoPDF provides a great deal of functionality for the users in many domains. For example, real estate agents find them useful for bundling a series of thematic data, base maps and imagery.

The TerraGo Mobile product extends the viewing environment to support mobile data collection. In this environment users are employing the GeoPDF format to actually collect and edit data in the field that can be synchronized with a geodatabase. These field based operations can be performed on Windows based laptops and mobile devices manufactured by Trimble and Topcon and others. Even without GPS connectivity a user can quite accurately determine the coordinates of features based on any of the reference materials. With GPS connectivity and TerraGo Mobile applications one can use the GeoPDF as a field map book to collect point, line or polygon features. They can also complete forms to acquire attributes and also attach photos, videos or voice messages (Figures 5 and 6). These can be transmitted to a server, opened through hotlinks with ArcGIS desktop web services.

Geospatial Collaboration: Roundtrip ArcGIS to Mobile and Back Again



Figure 5 - TerraGo mobile on Trimble Juno (www.terragotech.com)

Geospatial Collaboration: Roundtrip ArcGIS to Mobile and Back Again



Figure 6 TerraGo menu for media www.terragotech.com

3.1 US Department of Agriculture (USDA)

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The USDA has developed several major programs for providing technical assistance to farmers for protecting water quality. Part of the solution for managing these problems is communicating the location and extent of the spread of nutrients resulting from the generation and use of animal wastes in farming. The State of Wisconsin, has addressed this problem by providing maps in GeoPDF format to the public using a unique, web-based GeoPDF mapbook (Figure 7). Using a standard web browser, users can select a region and download a GeoPDF map of the area. The maps are created with TerraGo's Publisher for ArcGIS and the mapbook with TerraGo Composer. Consumers then use the TerraGo Toolbar to measure areas and distances, locate coordinates, place markups and comments and export these for further use. The value of this solution is demonstrated by the growth in downloads, which is nearing 7,000 per month. A practical objective for exploiting this system is to provide methods of capturing users comments and markups for integration with internal USDA data bases. A model for such a system exists with the BLM's ePlanning initiative, which uses TerraGo solutions to capture public comments on BLM projects. Moreover, USDA has begun an enterprise-level initiative to create national public awareness of USDA contributions to water resources management. The NRCS service now in production provides a proof for deploying simple geo-enabled data submission and validation as well as exercises crowd sourcing principles.

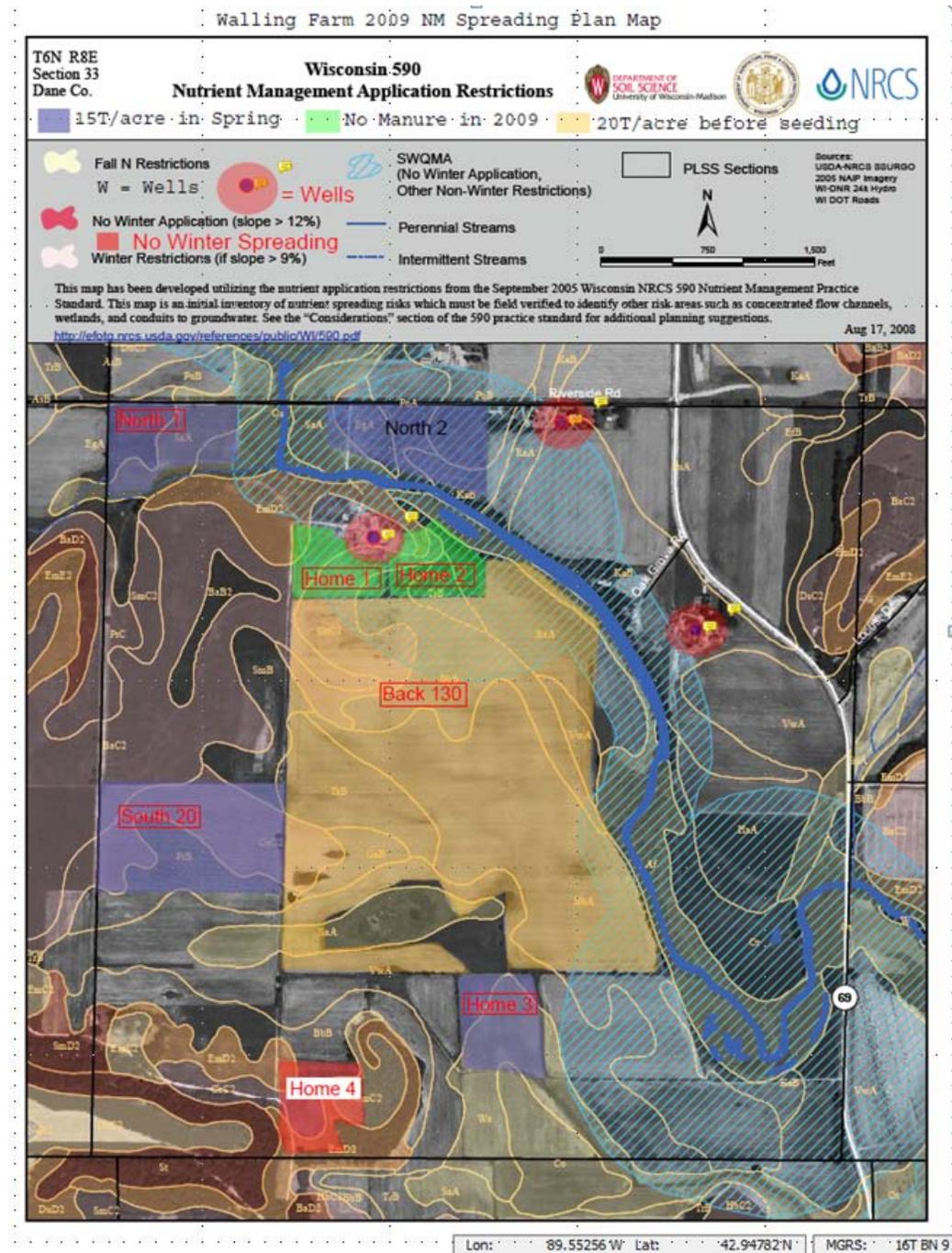


Figure 7 WisconsinTerraGo sample map <http://mmas-mapping.soils.wisc.edu/>

4. GIS Roam – iPhone/ iPad (www.cogent3d.com)

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The main body of the report included a brief description of the GISRoam application for the Apple iPhone and iPad. This application from Cogent3D allows a user to collect Esri shapefiles (points, lines, or polygons) with attributes, store them, transmit them to a server and download them to an ArcGIS environment. It is possible to visualize these features in relationship to a number of different base maps. It is even possible to transmit the data to a server in the “cloud”. Then, through a web interface, the shapefiles can be downloaded and used with any GIS software capable of reading them. In the process of our research it became apparent that this \$22 application (including data storage and web access) was beginning to gain some serious attention.

4.1 USGS Denver CO

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N.B. The following is not an endorsement by the U.S. Government

Several geologists at the USGS office in Denver are actively using GIS Roam on Apple iPads. They report that the combination of hardware and software forms an excellent field data collection environment. They are impressed with the battery life and durability of the iPad in a variety of conditions. According to Jonathan Caine:

“I’m using GISRoam on an iPad and there are a number of us who may use this as our primary digital mapping platform and application. I had been using a Trimble Nomad and ArcPAD but there are screen size issues with the Nomad and non-intuitive use issues with Arc that make the iPad and Roam far superior. Roam has many of the capabilities that ArcPAD has and the Beta version I am using has the ability to import georegistered images and basemaps as well as digitizing on these images. I suspect Roam will continue to improve and attain the greatest potential for Earth science mapping of any App I have worked with.” Email 10/13/2010

Caine also reported that new releases of GIS Roam will incorporate GeoPDF formats and other base maps.

5. Freeance / Blackberry (<http://www.freeance.com/>)

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Freeance is a commercial map viewer and GPS collection application for RIM's Blackberry proprietary operating system. According to the Freeance web site (<http://www.freeance.com/customers.php>) close to 30 organizations are using its application to gather information and photographs about events and condition of features. Since these data are saved as Esri shapefiles, the application is proving to be a viable way to create a spatially based inventory. Freeance has the advantage of being widely supported on several smartphones and covered under several service plans. Therefore, it can be quickly deployed. Its limited field based editing functions eliminate it from consideration as a primary device for data capture. However, it could serve as a practical approach to validate existing data. The Freeance website includes brief descriptions of user applications. Some of these are:

US National Weather Service

The National Weather Service Southern Region uses BlackBerry smartphones equipped with GPS to survey damage resulting from severe weather. Freeance Mobile software is used to push Esri map services out to BlackBerry smartphones and to build forms used to log locations and details of storm damage.

Nova Scotia Power

Field asset mapping for an electric utility. Freeance Mobile software was deployed to collect the customer connectivity data associated with NSP's 25,000 km distribution facility.

State of Florida, Division of Emergency Management

Used to survey damage from storms and other related weather events that require map viewing and GPS map point logging with digital photos. Inventory details and location of damage and display on browser based maps.

City of Bryan, OH

City Engineer Brian Wieland has his field crews mapping new GPS points with digital photos and custom forms directly to the existing Esri ArcGIS Server.

South Windsor, CN

Used to track the locations of public works crews and vehicles in real time

"The interface on the BlackBerry itself contains customizable forms allowing each user to enter information to be filed along with the GPS data -- and on the back end, the Freeance software connects to [BlackBerry Enterprise Server](#) as well as a [PostgreSQL](#) database and the ArcGIS platform for mapping.

http://marketing.freeance.com/mobile/BlackBerry_CS%20Digital%20Communities%20South%20Windsor%20CT.pdf

Linn County, IO

A foreman can record a lat/long location, take a picture of the problem, record a series of notes and upload the information to a database where the office manager can then assign each of the subsequent tasks to the proper employees.

Chicago Illinois Police Department

Police applications for mobile commanders and crime event map viewing. Special event patrol tracking and AVL on BlackBerry smartphones. Use web and mobile based GIS mapping for law enforcement applications. Developed “Where’s My Team” for Chicago PD that tracks 400 officers.

Mobile AL, Area Water Sanitary and Sewer,

Used for system locates, work orders and database records in the field by a large water utility.

South San Francisco, CA

GIS access for public works employees who reference both utility maps and database records, and do not have laptops in the field.

Vaughan, Ontario

The application lets users see aerial photos with overlying property boundaries and icons identifying which properties have open service cases, color-coded by priority. Councilors and city staff can click on a property, see the case details, and give an immediate answer to a citizen, viewing the information right on their BlackBerry Smartphone.

Murfreesboro, TN

Used to inventory tornado damages and the reconstruction and demolition permitting progresses. The ability to capture GPS coordinates, pictures, and data into a single database.

Frederick County, MD

First responders at the site of a natural disaster can now quickly find maps of the area, showing the location of power lines, emergency healthcare centers, police stations, municipal boundaries and even new map data such as path of tornado for evacuation routes for hurricanes. First responders also use the BlackBerry to map building damage assessment reports with digital photos, quickly communicating back to emergency operations center where damage is located and where resources are needed. Freeance Mobile now allows real-time communication and data exchange with first responders. Before deployment of Freeance Mobile, critical field information and damage assessment was only available to emergency headquarters when field workers came in at the end of the day.

Westmoreland County, PA

Crime location GIS maps are displayed on BlackBerry smartphones allowing investigators to lookup property owners, aerial photography, political boundaries and other geographic layers.

El Paso (TX) Electric Company

Field service uses in an electric distribution utility.

6. Mapzen <http://cloudmade.com/>

Contact:

CloudMade

1370 Willow Road, 2nd Floor

Menlo Park, CA 94025

650-321-7700

Mapzen is an iPhone application designed to support the creation of points of interest for Open Street Map. It is a free application available at the iTunes Store. It is closely coupled to OSM and one must have an OSM account (free) to use it. While it is difficult to assess the user experience with Mapzen, it provides an extremely appealing user interface to collect points of interest by direct GPS coordinates or by dragging (Figure 8)

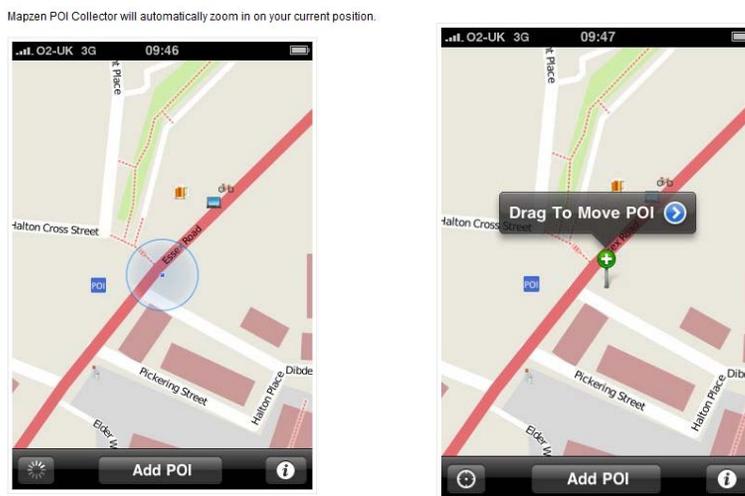


Figure 8 Mapzen iPhone application to add and move POI

<http://cloudmade.com/products/mapzen-poi-collector/tutorials/1>

The following instructions describe how the process operates:

Hit the "Add POI" button to add a new place of interest to the map. The POI will be placed on your current location. Most places of interest that you add will be buildings that contain shops, businesses and amenities. To make the maps as accurate as possible, try to position the POI over the centre of the business. To re-position the POI, tap and hold the white cross at the top of the pin. As you move your finger around the screen of the iPhone, the pin will move. Try and get the bottom of the pin in the centre point of the shop, business or amenity you are adding. When you have the pin in place, click on the arrow in the blue circle to add more information.

7. Radius Mobile www.1spatial.com

Contact:

Tennyson House
Cambridge Business Park
Cambridge
Cambridgeshire
CB4 0WZ
UNITED KINGDOM
Tel: +44 (0)1223 420414
Fax: +44 (0)1223 420044

The 1Spatial Web Page (www.1spatial.com) describes Radius Mobile that runs on Microsoft Windows platforms and is based on 1Spatial's own GIS component library. Among the listed features are:

- GPS and EDM/Total station support
- Update the map directly on the latest version of the data
- Perform survey construction and calculations on-line and feed them directly into Radius Mobile
- Fully integrate map maintenance with the surveying process, including support for Total Stations and GPS devices
- Verify data on-site through immediate revisions
- Achieve direct quality assurance on geometry and attributes
- Maintain data consistency without intermediate format translations
- Wide range of Survey functions including
 - Simple surveying from base line (line and offset)
 - Distance and bearing
 - Polar base line surveying
 - Distance from two known points (bilateration)
 - Distance from three known points (trilateration)
 - Intersection
 - Projection
 - Prolongation
- Full Oracle Spatial support
- Full integration with FME Suite from Safe Software
- Full topological support

Users – The Web site includes a brochure dated 2007 (http://www.1spatial.com/pdf/rm_broch.pdf). It lists the following users:

OS Ireland
National Mapping Agency Malaysia

7. LaFIS software GeoRover www.gaf.de

Contact:

GAF AG

Arnulfstr. 197

D-80634 Munich, Germany

The German company, GAF, describes a mobile product GeoRover that works with windows and ArcGIS Engine 9.3. The web site describes the product as a “mobile software tool especially tailored for geologists and borne from real mapping practice”. It is designed to speed up the fieldwork and map creation significantly and enhance the geological mapping process considerably due to combination of traditional geological mapping practice with spatial data management, GIS, and GPS technology. For the collection of field data in remote areas a PDA version of GeoRover is available. The PDA version permits data transfer to basis GeoRover station and features digital field book capabilities, core GIS functionalities including raster data management. The list of features includes:

- Pre-field-preparation menu to establish consistent mapping standards and to consider different individual mapping methods
- Rapid access to digital maps, imagery and data files with 1 - 4 window mode linked to each other
- Permanent online GPS tracking for display on map to allow an exact geolocation, orientation and navigation in the field
- Integrated field book with pre defined pick-list of expected observation categories
- Geographically linked onscreen visualization of all entries
- Standard USGS and user defined geological feature- and symbols settings
- Robust and reliable backup routines suitable for field use
- Standardized printing forms for documentation purposes

We did not contact any users.

8. Cartègraph <http://www.cartègraph.com/products.html>

Contact:

Cartègraph

3600 Digital Drive

Dubuque, Iowa 52003

P: 563.556.8120

F: 563.556.8149

According to its web site Cartègraph Mobile (Figure 9):

“provides mobile maps created via ESRI’s ArcCatalog or ArcServer Advanced, giving you the ability to interact with a mapped view of assets and work orders, complete with record details and location data. With its Live Location function, Cartègraph Mobile provides a mapped reference to your current position; allowing you to gauge your proximity to work locations and helping you plan the most efficient routes to reach them. Cartègraph Mobile is fully compatible with today’s camera-equipped devices, allowing you to take pictures and instantly attach the images to individual inspection and work records, providing a visual reference that can be used for future comparison. To ensure that data is transferred as quickly as possible, Cartègraph Mobile features real-time syncing, a function that allows you to store and forward updated information directly to your database from the field, eliminating the need to sync your device each time you return to the

office. Cartegraph provides Esri mobile base maps, allowing mobile users to see assets and current location on a map for quick reference and planning.”



Figure 9 - Example of Cartegraph Mobile application (www.cartegraph.com)

8.1 Golden Co

The City paired the functionality of the mobile SIGNview application with the portability of Trimble wireless data collection devices, providing their field crews the tools to get the record, fill it out, and close it all in one session, and all in the field.

9. Erdas www.erdas.com

Contact:

ERDAS Inc.

5051 Peachtree Corners Circle

Norcross, GA 30092-2500 USA

Phone: +1 770 776 3400

E-mail: info@erdas.com

The ERDAS web site describes a product ERDAS ADE Mobile

(<http://www.erdas.com/Products/ERDASProductInformation/tabid/84/currentid/1131/objectid/1131/default.aspx>). The product is described as:

“Management of Oracle Spatial and Attribute Data in a Hand-held Mobile Device providing connected and disconnected users with a common software platform, ERDAS ADE offers versatility and flexibility for data collection and validation requirements. ERDAS ADE Mobile is a powerful spatial editor for any Windows Mobile GPS or hand-held device. ERDAS ADE Mobile allows users to take their database with them into the field to access and interactively update location information or work offline. “

Its functions include:

- Real-Time Editing
- Supports Desktop GIS Editing Functions
- Support for Targeted Updates
- Built upon Oracle Spatial, ERDAS ADE is Wi-Fi-enabled

The Web site lists only two clients: US Bureau of the Census and F-DOT Florida Turnpike Enterprise