Serving and Collecting GIS Data In The Field – Real Time!

Contra Costa County Public Works Department (CCCPWD) uses PDA based cell phones in the field to serve and collect geographically based information. This includes maps and associated attributes, documents, and photographs. We have integrated a sub-meter GPS with the phones, all of which fits on a small clipboard. Information collected is immediately posted on our servers and made available. If a crew is collecting data in one part of the County and someone wants to see it at the opposite side of the County, the turnaround is immediate. CCCPWD utilizes ArcIMS, SDE/ORACLE, and our own programs to accomplish this seamlessly. The practicality of this system was demonstrated last fall when a landslide took out a portion of Morgan Territory Road along with a pickup truck. Data and photographs were immediately transmitted to the main office. Precautions were taken immediately to close the road and a press release was issued.

Mehmet "DJ" Kutsal, Director, Computer Services
Contra Costa County Public Works Department

Background:

In 2003 APWA (American Public Works Association) identified putting practical and affordable data communications in the field as the technical challenge. This was due to the recognition of the fact that in today's world, a Public Works Department can't afford the multiple trips to the same location in the field in order to identify, verify, remedy, and confirm the work they need to get done with multiple trips to the location. Crews are constantly faced with trying to answer questions such as "What is it?" "Where is it?" "Is it supposed to be there?" "Who does it belong to?" "Where is the documentation?" So they need timely, accurate, and up-to-date answers on the spot.

Introduction:

In early 2004, as a part of the effort to update its Strategic Plan, the Contra Costa County Public Works Department (CCCPWD) decided to incorporate the APWA challenge into it. Being the first County out of 58 in California to be accredited by the APWA and to keep our effectiveness and efficiency at its peak was a primary incentive in making such a decision.

During the remainder of 2004 and 2005, CCCPWD began undertaking a master plan which would allow it to upgrade its Information Technology environment to meet these strategic goals. Some of the primary steps involved were:

1. To upgrade the operating systems to the current versions. CCCPWD utilizes 3 Unix servers and 17 MS Windows servers. The 250 workstations also run MS Windows. So the servers were upgraded to Windows 2003 Server and the workstations to Windows XP.
2. The physical network was rebuilt to run at Gigabit and the server and switching backbone was entirely moved to fiber.

3. The data storage was changed from SAN to NAS and storage was increased to 8 Terabytes.
4. CCCPWD moved from ArcGIS 8.3 to 9.1 and began offering internal training sessions for power users. Training was also offered for general users on Arc Explorer.
5. ArcSDE and ArcIMS were implemented and data migration to ArcSDE ORACLE began.
6. An Intranet was implemented to provide an easily manageable and user friendly platform for the GIS and other business critical applications such as the Document Management System.
7. A Web server independent of the centralized and contracted web service and specifically for CCCPWD was proposed to County Department of Information Technology and approved for implementation. Following that, the server was deployed and development of applications began.
8. Parallel to all of this, CCCPWD began a "proof of concept" project using the Treo 650 cellphone/PDAs and cellular mode cards with Sprint and Cingular. This project was designed to fully test the ability to send and receive numerical, text, and image data to and from our enterprise systems.

During the proof of concept stage, there were some questions as to the actual viability and usefulness of the capability. However, all of this was dispelled when the practicality of such a system was demonstrated in the fall of 2005 when a landslide took out a portion of Morgan Territory Road along with a pickup truck. Data and photographs were immediately transmitted to the main office. Precautions were taken immediately to close the road and a press release was issued. This event was instrumental in convincing the senior management that this technology was practical and effective.

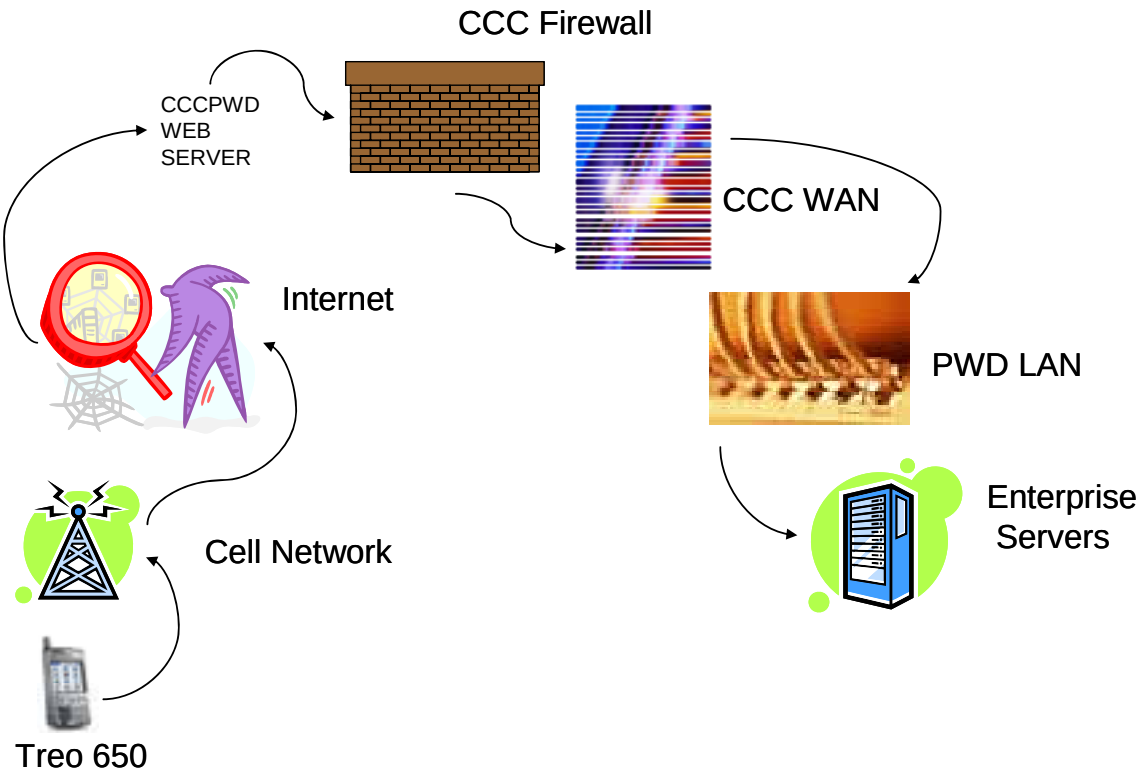
As a result of all of these steps, by the end of 2005, CCCPWD was ready to move into the actual deployment of the capability to its field staff. Sprint and Cingular were invited to compete to be the service provider for CCCPWD. Cingular was selected as the successful provider and deployment began in early 2006.

The project:

CCCPWD obtained 22 Cingular Treo 650s and 9 cellular modem cards to begin the first stage of the implementation. A majority of the programming developed during the proof of concept was designed to be reusable during the actual implementation. This made the implementation quite a bit easier than it would have been otherwise.

The basic operation of the system is as follows: The Treo 650 or cellular modem talks to our external web server over the internet to make requests and get data using http. The web server in turn tunnels through our firewall and talks to ArcIMS and other enterprise applications on our enterprise servers via HTTP and ArcXML.

The diagram blow depicts this process.



Once the Treo 650 or the cellular modem has reached the CCCPWD web server, the following events take place for GIS service:

1. The incoming device requests a list of services available on web server.
2. The web server gets a list of services available on the enterprise server for IMS and returns that list to the incoming device.
3. The incoming device lists the services and the user selects one as their first step.
4. The incoming device gets the extents (properties) for the service from the web server.
5. Based on the extents, the incoming device then requests an image scaled to it's screen showing the entire map.
6. The web server responds with the actual dimensions and the temporary file name generated by ArcIMS.
7. The incoming device sets it's internal dimensions based on the response and then requests the actual image from the web server.
8. The web server in turn loads it from the enterprise server for IMS.
9. For the basic functions such as zooming, panning, modifying layers, the incoming device performs various calculations and then repeats steps 6 through 8.

The project yield observed so far includes:

1. Everything is real time and on the enterprise servers and immediately available. This point is more significant for incoming data. Since the data is written directly to our enterprise servers, we are not risking the loss of data by carrying it around in the field the whole day. In addition, any data collected by field staff is available right away for a supervisor or another staff member in the field to see real time.
2. It works anywhere there is cell coverage.
   In the case of Contra Costa County, this is pretty much everywhere with Cingular. So the maintenance crews, inspectors, and supervisors are connected to the office even in the field.
3. DSL level service.
   The service we have from Cingular is consistently at DLS levels as opposed to other carriers which affords for quick turn around times.
4. Multiple functions.
   The field staff not only access GIS data in the field with the Treo 650s and the cellular modems but they also access the Maintenance Management/Work Order System, their email, the Document Management System to mention a few. The Treo 650s also give them voice access to the offices since they are also cell phones.

Current Status and Plans:

Although the implementation is slightly behind schedule as of the writing of this paper due to procedural delays in the procurement process over which CCCPWD has no control, we are expecting to catch up quickly.

Currently we are able to:

1. serve maps out to the field staff which will replace paper map books in the vehicles.
2. provide them access to other mission critical systems which they didn't have before.

We are in the initial stages of an implementation which involves the catch basin and culvert cleanout application on this system which will put in use and final testing of the ability to collect data in the field. This application will allow the field staff to easily locate the facility they need to service and record data corresponding to the work they performed. This information will not only e used to plan efficiency into the future cleaning schedules but it will also provide better data in a more efficient manner into the NPDES program. There are numerous other projects in a queue to follow this lead project.

We have been working with CFI wireless's Bluetooth capable sub-meter GPS units available from Seres and Geneq Inc. We have completed an exhaustive evaluation of these units against out network of survey monuments and have determined that they deliver as advertised or better. So we have short term plans to move our field data collection crews to these systems by the end of the year.

Conclusions:

Although similar capability is also commercially available, the choice of implementing our own system has yielded certain benefits the least of which is the immediate availability of the data collected in the field. In addition, most of the funds we would have normally ended up spending in obtaining and customizing an off the shelf system has actually gone towards infrastructure upgrades which benefit CCCPWD at multiple levels.

The implementation of a capability such as this is not by any means an easy undertaking. In addition to having to have key staff with specific talent and skill sets in strategic positions, an effort like this takes management commitment, sound project management, funding, and early and beneficial results.

We feel that this capability has pushed CCCPWD to the forefront of all similar agencies California if not the nation. However, the most important aspect for us is being able to meet the needs of our field staff and reduce the effort they need to put up to access information in order to get their job done.

References:

MS Windows 2003 Server and Windows NT are products of Microsoft Inc.
ArcIMS, ArcSDE, ArcGIS, and ArcExplorer are product of ESRI Inc.