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Wireless Damage Assessment put to the Test

Wireless handheld computing is evolving as the emergency manager's answer to obtaining real-time intelligence from the field. A recent live demonstration of the latest technologies sheds some light on technology that works and technologies needing more work.



The iTalk™ rapid damage assessment application running on HP Jornada™ and SideArm™ handheld PCs.

We find that most emergency managers we have spoken to agree that too much time is spent manually logging information into databases in the Emergency Operation Center. Affordable and effective wireless handheld technologies and applications allow the incident commander and field personnel to capture and communicate information to EOC's in near real-time. This technology shows great promise in helping to reduce double entry of data and freeing the emergency manager to focus on coordinating response and recovery activities and resources.

Technologies Tested

On March 25, 2002, Natural Resources Canada sponsored a project to test the latest in wireless and mobile technologies to address three important elements of an enhanced disaster management information system:

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1. **Rapid Collection and Real-time Communication of Disaster Information** – using a catastrophic earthquake scenario and a Rapid Damage Assessment application, test use of handheld computing devices to collect and communicate building damage data for ‘near real-time’ display on an emergency management mapping system located in an operations center;
2. **Wireless Communications** – multi-mode wireless data transmission options to keep data flowing between field and EOC personnel, including use of affordable and broadly-used wireless networks such as CDPD (cellular packet), GSM/GPRS (radio packet) and MSAT (satellite);
3. **Spatial Decision Support Applications** – integrate data from multiple GIS (electronic) mapping systems and overlay predicted and actual (field) data in near real-time.

Our objective was to demonstrate sharing of critical data across multiple distributed systems used by multiple emergency organizations in an open systems environment.

The commercial products used in the demonstration were:

1. **iTALK™ - Rapid Damage Assessment (RDA) Application.** This handheld computer application developed by EMIS Technologies Inc. was used to collect and communicate geo-referenced building damage data based on ATC-20. The data was synchronized with a database repository in the EOC and quickly displayed on the emergency management mapping applications. The application is tailored for building damage assessments but is currently being extended to allow assessment of any critical infrastructure and incorporate daily-use application for emergency responders.
2. **ArcView™ 3.2 with the EM-Tools™ Earthquake Hazard Model.** A hazard model developed by Lookfar Solutions Inc. generates predicted damage maps based on Modified Mercalli Index (MMI) and Peak Ground Acceleration (PGA) to help responders prioritize assessment areas and response/recovery activities. As actual building damage information

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begins to come in from the field, color-coded icons representing building placards are overlaid on the predicted damage data to produce an increasingly accurate account of damage. Three types of output can be displayed on maps: building status (placard posting), extent of dollar loss, and indicators of possible number of people at risk.

These damage map 'layers' were also being displayed 'real-time' and in their native formats over the City of Vancouver's existing web-based GIS system (using **AutoDesk MapGuide™**).

3. **Web-based Reporting.** Crystal Reports™, a web-based reporting tool, was used to publish damage summary reports in formats useful to the desktop (EOC) users and the handheld (field) users.



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Other technologies tested in the demonstration were:

1. **Mitsubishi ST111 Mobile Satellite Terminal™.**
2. **Garmin GPS V™** (<http://www.garmin.com/products/gps5/>).
3. **HP Jornada™ 720 Pocket PC** running Windows CE and SQL CE.
4. **Melard SideArm™ Ruggedized Handheld Computer.**
5. **Microsoft SQL 2000™ Server.**

Results and 'Lessons Learned'

The demonstration was used as a learning experience for all of the stakeholders, observers and industry participants. The vast majority of participants surveyed after the demonstration felt the technologies demonstrated were feasible and likely to be adopted by their organizations; however, there were some shortcomings noted and many suggestions for expanding the applications for day-to-day use. This is a synopsis of our findings:

Rapid Damage Assessment using Handheld Devices

1. The 'ergonomics' of most handheld devices need improvements:
 - screen display washes out in bright sunshine;
 - screen displays on the handheld devices were wide enough to accommodate the ATC-20 form layout but other Pocket PC and Palm devices lacked the screen real estate to be considered a viable option for this particular application;
 - 'ruggedized' and 'weather-proof' devices, like the Melard SideArm device tested, will be required for most field applications;
 - many handheld devices lack sufficient integrated components and ports to enable simultaneous operation of multiple input/output devices, such as GPS and multiple communications cards (expansion devices help but add to the 'clutter');
 - the HP Jornada's integrated keyboard was useful for the small amount of data entry required in the ATC-20 forms, whereas many other handheld devices rely on a 'pop-up

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keyboard' that hides 1/3 of the display screen. External keyboards are not likely to be used by an inspector while assessing a building.

2. Several extensions were suggested to allow the data collection application to be used on a daily basis. Daily-use applications must be integrated with, or added to, applications like rapid damage assessment to ensure field workers can use it and the cost of the device is justified;
3. The enterprise database (SQL 2000) must be integrated with existing corporate databases (e.g. building records database) to avoid storing and maintaining data in more than one place.

Wireless Communications

Experience shows that terrestrial communications networks will likely be impacted or not available for several hours or even days following a catastrophic event. Therefore, any field data collection and communication solution must be able to work with multiple, widely available wireless networks. We tested sending building assessment reports from a field device (HP Jornada) to EOC server (running Microsoft SQL 2000 Database) using TCP/IP over a 19.2 KBPS CDPD (cellular digital packet), 56 KBPS GSM/GPRS (packet radio) and 4.6 KBPS MSAT (satellite) networks. Data was captured into a SQL CE database on the handheld device and then synchronized with a SQL 2000 Enterprise server located in the Vancouver EOC.

CDPD is a commonly used cellular network for data communications but coverage is weak in rural areas and the network will likely be damaged or over-loaded immediately after a catastrophic event. This wireless network was tested because it is commonly used to support day-to-day data communications between field personnel and their departmental servers. The CDPD network may also become available after a catastrophic event when rapid damage assessments are being performed, so we tested CDPD as a first-tier wireless network option.

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We used a Sierra Wireless AirCard® with the Jornada. Tests showed that data transmission over CDPD was reliable and efficient. Existing CDPD network speed is rated at a respectable 19.2 KBPS and our new building assessment records were sent (synchronized) with the server database within 37 seconds. Downloading over 1100 building records to the handheld took roughly 4 minutes 30 seconds.

GSM/GPRS is a relatively new, integrated wireless voice and “always-on” high-speed (56 KBPS) packet data service. GPRS is a packet radio based service and was tested as a potential first or second-tier wireless network solution. Coverage for GSM/GPRS service is planned to be equivalent or better than current analog cell phone coverage.

A GSM/GPRS capable cellular phone (Motorola P280) was connected to the handheld device via a serial cable purchased with the phone. This combination offers the field worker multi-tasking voice and data communications capabilities. It would have been preferable to use an integrated GSM/GPRS capable card like Sierra Wireless' AirCard® 750 (the first Tri-band GSM/GPRS wireless network card). However, this card was not generally available in time for our demonstration.

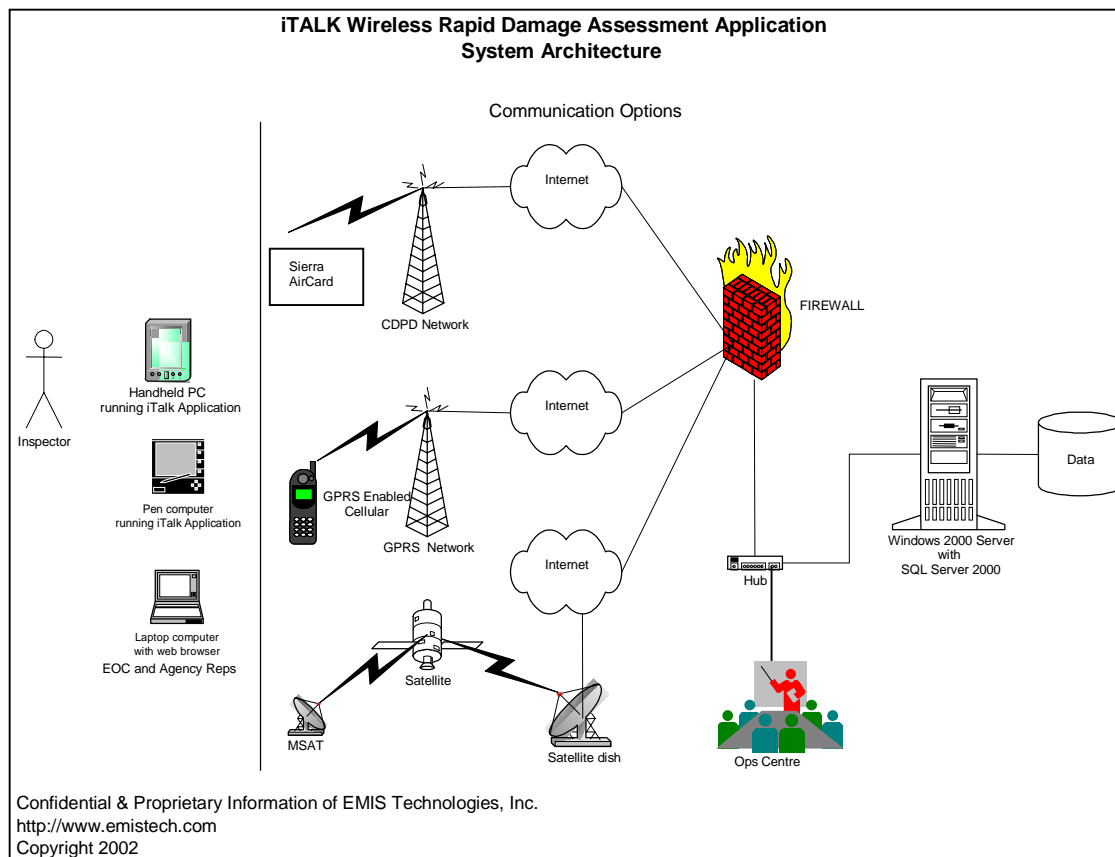
Tests showed a great deal of network latency when synchronizing data from the handheld device and the enterprise server. A new building assessment record took just under 3 minutes to synchronize with the server database; however, displaying the Damage Report web page was much quicker (20-30 seconds). EMIS Technologies has since found a solution to minimize this latency that appears related in part to the way GPRS handles data packets during the database synchronization process.

MSAT is one of several satellite communication options available and was tested as a potential third-tier network solution (in the event that CDPD and GPRS are not available). A serial cable connected the handheld device to a mobile satellite terminal and a dial-up (PPP) TCP/IP connection established through a local application service provider (ASP).

MSAT testing proved challenging. We were surprised to discover that several ASP's did not support a 4800 BPS connection; therefore, we had to set-up a dedicated dial-up server at EMIS' office.

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Even though we were doing a straightforward dial-up connection, we discovered that Windows CE registry settings had to be changed to get the connection working (an undocumented problem). Once connected, we were able to synchronize our damage assessment data with the EOC server within 5 minutes. It is not a surprise that moving data satellite is a slow option right now but during a catastrophic event, there may be no better options and improvements are coming.

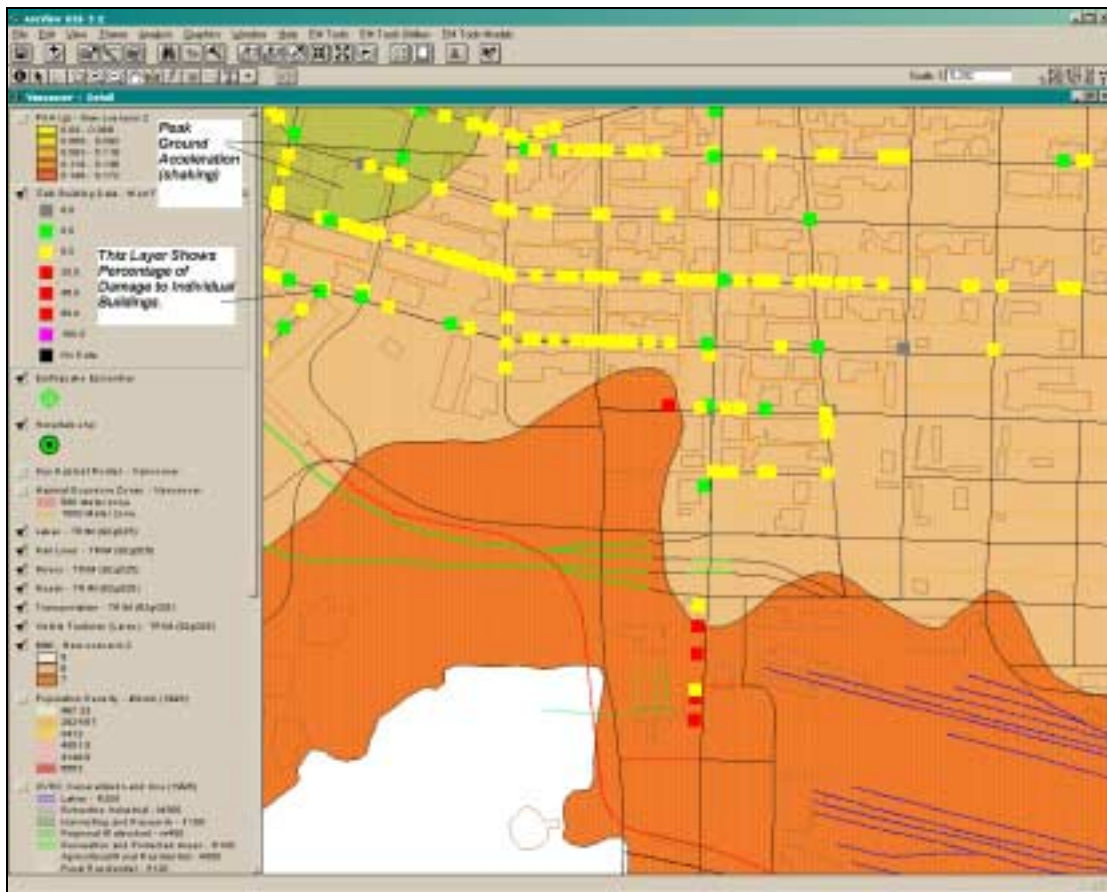


Real-time, Multi-vendor GIS Decision Support Tools

The ArcView GIS mapping applications worked extremely well and performance targets were met. An automatic refresh utility kept the data display current, showing both the predicted and actual building damage. A shared folder was set-up on the enterprise server and an automated export utility implemented to share output from the hazard model (shapefiles) across the network of EM/2000

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emergency management software users. These shared files were also accessible by Vancouver's GIS mapping system that quickly rendered the data as just another layer on a map that was accessible by web browsers. The unique feature of this web-based map server was its ability to read and combine data from multiple competing GIS systems without any complex and time consuming data translation/conversion.



The Future

The objective of this demonstration project was to test the ability of currently available technologies to achieve the goal of sharing critical data across multiple distributed systems used by multiple emergency

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organizations in an open systems environment. The wireless rapid damage assessment and hazard modeling applications demonstrated that this goal can best be met using current industry-standard technology platforms and standard methodologies, such as ATC-20, are adopted across multiple responding agencies. Handheld devices and wireless networks are becoming more capable and affordable every day; however, the old adage still applies: "Use the right tool for the job".

About the author: Mike Morrow is president of EMIS Technologies Inc., an emergency management technology consultant, based in Vancouver, B.C. For the past fourteen years, Mike has helped in the design, development, implementation, training and support of emergency management information systems for EOC's around the world. His most recent achievements were the implementation of a comprehensive emergency management information system for the City of Vancouver and the B.C. Provincial Emergency Program (using EM/2000™) and a special events logging system for the G8 Summit Meeting in Banff, Alberta. To contact Mike, call (604) 688-4499 or visit www.emistech.com.