BIOGRAPHICAL INFORMATION

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Specific Responsibilities

Brady rejoined Idea Integration as the Solution Director for the Geospatial Practice. Brady is responsible for managing Idea's geospatial clients and staff in the Western Region. Managing a staff of experts in the geospatial arena, Brady and the Idea geospatial team have worked on projects ranging from county and city land management, utilities, flood plain, defense, telecom, commercial store location. Over 400 successful projects have been completed in Brady's time at Idea Integration.

Past Experience

Owned and operated his own business in the aviation industry
Worked with Enghouse Systems, Ltd. on the CableCad product
Over 15 years in software development, Over 9 years in GIS systems development.

Education Information

B.S. Management of Information System – GMI Engineering and Management Institute (Kettering University)

Professional Memberships

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Computer Enabled Routing for Emergency Readiness

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ABSTRACT

The use of mapping in emergency management can be very expensive. Through the use of web-based mapping systems such as Virtual Earth, we demonstrate that a low-cost emergency management application can be built that allows for display of custom data. The system also supports routing of emergency management vehicles and evacuation routes.

INTRODUCTION

Being prepared for an emergency is critical and mapping is becoming one of the main ways to help prepare local governments' emergency plans for emergencies whether they are natural or human caused. While GIS is now fairly integrated with many local governments for land information purposes (Assessors offices, parcel management), most local governments have not integrated mapping in to emergency management.

Many reasons exist for the lack of GIS/mapping integration, but the basic reason is lack of money. Smaller towns and counties lack the financial ability both for the necessary human resources, but also for purchase of necessary hardware, data maintenance, and application development for their specific purposes. Other factors that affect the integration of web-based mapping technologies into emergency management are the ease of use and reliability of the solution. While any web-based system has limitations to reliability, many these days have stated 99.9% availability and are planning and/or releasing versions that have built in offline cache systems. Virtual Earth is an example of such a system.

Over the last several years internet-based mapping has grown in popularity with the introduction of products such as ESRI's ArcIMS and now ArcGIS Server. While these products are designed for creating complex online mapping systems integrating diverse datasets and spatial information as shown at the recent ESRI Homeland Security GIS Summit in Denver, Colorado[1], they are very expensive. In addition, these products are in addition to the base GIS software needed by a local government for normal GIS use such as parcel maintenance. They require extensive training, application development skills and constant maintenance/upgrades.

Another technology has also become available in the last several years. Low cost mapping through the introduction of systems like MapQuest, Google Maps and Microsoft's Virtual Earth. These easy to use interfaces can be customized to add external data sources very easily and in

[1] Plunkett, C. 2007

many cases can be used for very low cost, or even free depending on deployment. For instance, during the fires in Southern California of fall 2007, Google and local governments worked to create a website that was constantly updated with the fire lines so that both the public and local governments would have nearly real-time access[2].

Using Virtual Earth we have created a demonstration application showing a possible basic emergency management application. The application contains the base Virtual Earth data, but also additional data added for emergency management. In addition we have added major potential evacuation routes. The application also supports routing, not only to and from emergency vehicles, but to emergency shelters from any location.

MAPPING TECHNOLOGIES

Until recently, there were very limited choices when it comes to internet mapping. Today this is anything but true. From full-blown GIS packages to basic maps there are many choices for nearly any need and budget. Below we review some of the most popular solutions for internet mapping applications that can be used for general emergency preparedness applications. This list is not all inclusive and in fact there are many more options. This is simply a list to show some of the options available for low cost mapping.

Microsoft Virtual Earth, MapPoint Web Services & MapDotNet Server

Microsoft's Virtual Earth is a web-based mapping solution that users may be most used to seeing when using Microsoft's Live Search Engine. Virtual Earth supports addition of point, polylines and polygon features. Virtual Earth provides geocoding, multi-point geocoding, multiple map styles and modes (including 3D). External data can be used via GeoRSS and LiveSearch results. Application development is accomplished through the use of the JavaScript API. The use of Virtual Earth is free for up to 100,000 requests per day. One request is equivalent to four map tiles, one geocode request or one direction request (routing). Users who require more than 100,000 requests per day pay based on the number of requests[3].

While the JavaScript API provides single request geocoding and routing capability, Microsoft also provides the MapPoint Web Services (MWS) for batch geocoding, complex routing and proximity searching. MWS requests and results can easily be incorporated in to Virtual Earth via .Net. MWS uses a request-based cost scheme virtually identical to Virtual Earth itself.

MapDotNet Server is a stand-alone web-based mapping server; however it integrates with Virtual Earth, allowing custom GIS data display using Virtual Earth. MapDotNet Server (MDNS) allows additional functionality not available via Virtual Earth or MWS such as spatial and attribute queries and buffering. Additionally, MDNS allows direct viewing of many spatial database formats including SDE, Oracle Spatial, Shapefiles and WMS. MapDotNet costs $3800 per server deployed, plus $1000 per year maintenance.

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[2] Chickowski, E, 2007
[3] Virtual Earth. 2007

Google Maps API

Most web users are familiar with Google Maps, as it is the default map result of searching using Google's search engine. Google Maps allows customization similar to Microsoft's Virtual Earth. Google provides a JavaScript API for creating custom Google Map applications. The API allows creation of markers, polylines and polygons. In addition, developers can geocode addresses. It supports multiple point routing. It allows overlay's of external data primarily via GeoRSS and KML. While use of Google Map's API is free, large amounts of map requests, batch geocoding, use tracking and the guarantee of no forced advertizing requires purchase of an Enterprise key, the cost of which is based on the number of map and geocode requests, with a base minimum cost of $10,000 per year. Keys are application based, thus multiple deployed applications are licensed separately[4].

AOL MapQuest

MapQuest is probably best known for providing an easy to use interface to generate directions from one location to another with integrated maps. Behind this technology is MapQuest's OpenAPI, a JavaScript API for creating custom MapQuest based web applications. Customization is limited to point icons and routing, there is no polygon or polyline display capability. While free to use for non-commercial low volume use, large amounts of map requests, geocoding and directions require purchase of a license which starts at $5000 per year. With a valid license, the Advantage API 5.1 offers the choice of development in JavaScript, Java, C++ or the .Net platforms. The AS3 API also supports polygons, polylines, buffering, and Adobe Flash, additional routing and proximity searches. In addition to the data inherent in MapQuest, additional custom data can be added via external databases or custom hosted databases[5].

ESRI ArcGIS Server

Environmental Systems Research Institute (ESRI) is best known for its desktop GIS applications including ArcGIS. It is the de-facto standard for true GIS software and is used by thousands of governments and commercial enterprises. ESRI's current solution for providing internet mapping is ArcGIS Server. ArcGIS Server can be purchased in three versions, however only Standard and Advanced provide web-based mapping capability. ArcGIS Server comes in either a Java or .NET version, with small differences between the two platforms. The capability of ArcGIS Server is extensive and can include true GIS functionality such as geo-processing, complex spatial analysis, etc. Geocoding, networking (routing), buffering, proximity searching is supported via the Application Development Framework (ADF) and ArcObjects. The development effort required can be extensive, and in-depth application development requires ArcObjects application development expertise. It should be noted that ArcSDE, ESRI's spatial

[4] Google Maps API 2007
[5] MapQuest Advantage API 2007

database engine is included as part of ArcGIS Server. Enterprise versions of SDE require Oracle, SQL Server, Informix or DB2 (all licensed separately). ArcGIS Server's cost varies depending on deployment, but usually would be between $20,000 and $40,000 per year. Users must provide their own data for use with ArcGIS Server/SDE[6].

Comparison Table:

Web Solution	Estimated Price	Pros	Cons
Microsoft's Virtual Earth	Free up to 100,000 hits per day.	99.9% promised up time, low cost, multiple layer types added, customizable	Currently only available online, base raster data is dated 3 or more years.
Google Maps	Free, but no guarantee of forced adds, otherwise a minimum of $10,000	Highly customizable, strong routing and geocoding features.	Looks to be more expensive than Virtual Earth, data is comparable to Virtual Earth in dating.
AOL Mapquest	Free for low volume, otherwise a minimum of $5,000 a year	Cheap, well established, excellent routing and customizable.	Free version is limited and is more expensive than Virtual Earth
ESRI ArcGIS Server	$10,000 a year plus hardware at a minimum	By far has the most geospatial and analysis functionality	This is the most complicated solution, it is also most likely the most expensive solution.

DEMONSTRATION SOLUTION

Emergency Management Application

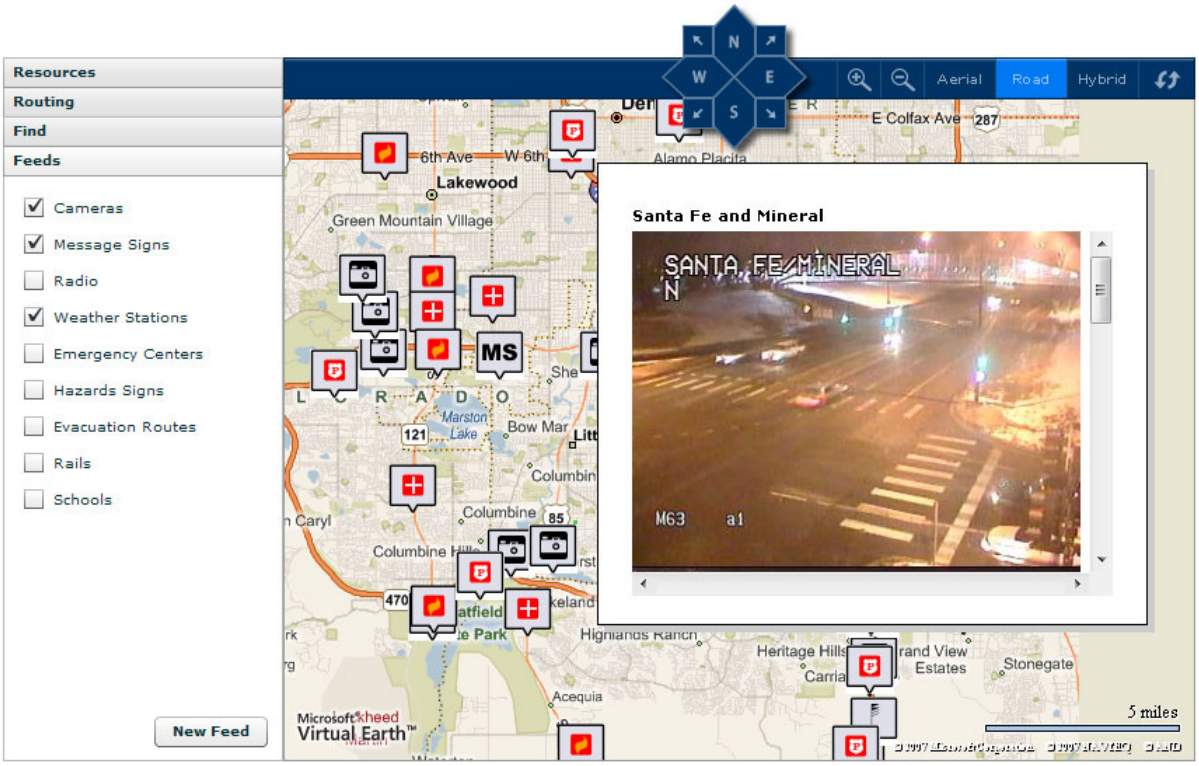
For our demonstration application we chose to use Virtual Earth, and a pure JavaScript based solution for simplicity. We hope to show that a simple emergency preparedness application can be accomplished with one of many web-based mapping systems. Our system requires only a web server and a web browser. Primary data consists of the road network, geocoding data and routing capability of Virtual Earth. Additional data is provided via the GeoRSS format. GeoRSS provides a free format for sharing geospatial data that can be consumed by various mapping applications including Virtual Earth and Google Maps. GeoRSS format data is added to Virtual Earth in the form of a 'layer' of information that users can then interact with via the mouse.

[6] ArcGIS Server. 2007.

Converting data to GeoRSS can easily be accomplished with various free tools or in-house code customization. We used a free GeoRSS tool for ArcGIS written by ArcGIS users posted to the ESRI ArcScripts website.

For each GeoRSS layer, we created a custom virtual earth shape layer, then imported the RSS feed in to the layer, created custom push-pin icons and info boxes. This only takes a few lines of code. For polyline and polygon layers, we can customize the polygon color, outline thickness and outline color. In addition, we can provide custom content for the infobox using standard html, which can include images, URLs and more.

Our sample data layers include emergency evacuation shelters (including schools), hazardous materials locations, dams, power plants, fire stations, police stations, Park-N-Rides and bus storage lots. We have also added the CDOT webcam network so that traffic conditions can be monitored directly from the map.

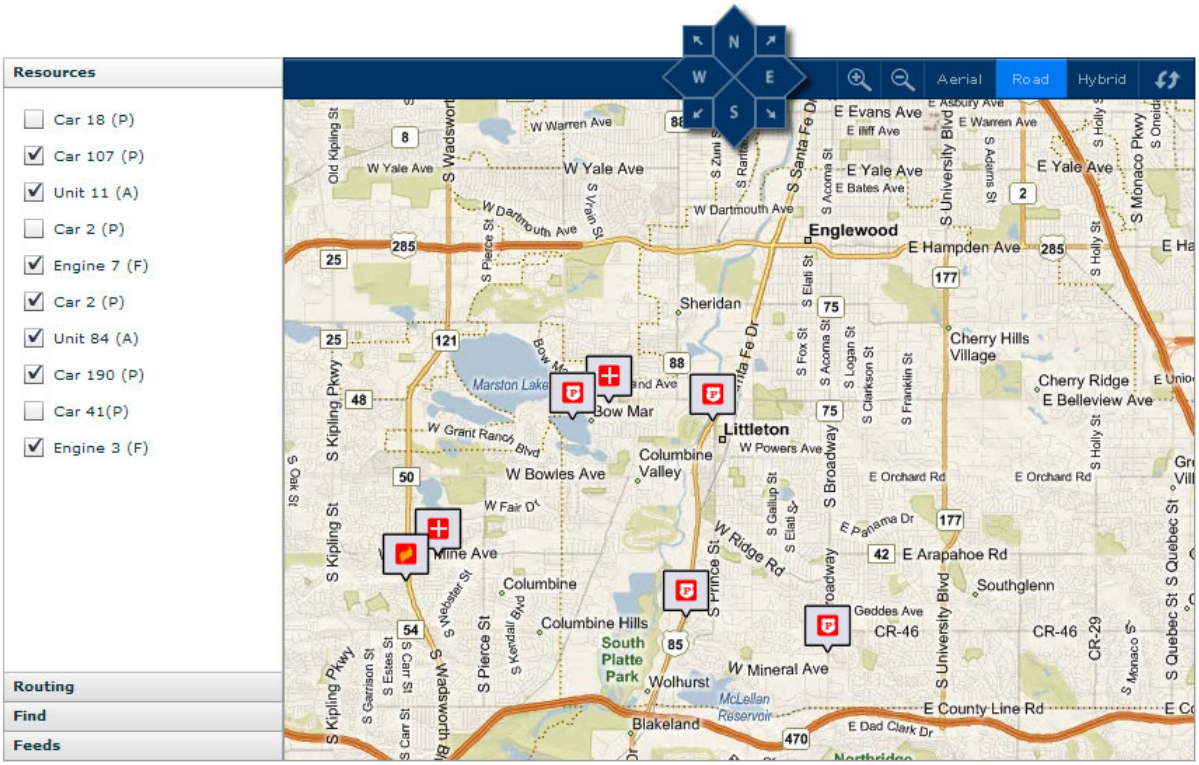


It is also possible to add WMS data sources using a custom .Net web handler to request the raster data in a format which will display seamlessly in Virtual Earth. This would allow display of additional data such as raster weather data such as satellite imagery and weather radar. In addition, this could be used to display other custom developed raster data from a WMS server.

One of the more important resources to add would be emergency vehicle locations, if available. Using GeoRSS this again is easy, provided the location can be queried from a database. Using simple JavaScript, the positions can be automatically updated from the database on specified time intervals.

Another important set of information added would be pre-determined major evacuation routes based on different emergency scenarios. This shows major evacuation routes out of Denver based on major incidents, depicting how the major road network can be used to evacuate as many individuals as possible.

While the different layers of information are important, using that information to determine vehicle routes between locations for emergencies is also important. While Virtual Earth and Google Maps are not perfect and do not allow complicated routing as a true GIS, they are easy to use. One can easily route an emergency vehicle to a specific location within seconds, or determine an evacuation route from a specific location. In addition, we can run several evacuation routes to determine the closest evacuation center or meeting point.



In addition, if paper-based maps exist and can be scanned, the maps can be added to virtual earth through the use of MapCruncher, which allows easy registration of the map to the Virtual Earth base map. MapCruncher is a free tool put out by Microsoft which started as a mashup utility from Microsoft Research. MapCruncher makes it easy to publish maps overlaid on Virtual Earth. Once you are familar with the tool, it will take you about ten minutes to crunch a new map. Just find 5 to 10 corresponding landmarks on your map and on Virtual Earth, and

MapCruncher will register your map to the global coordinate system, warp it to fit a Mercator projection, and generate a set of image tiles that can be seamlessly mashed up with VE's standard road or aerial imagery. It even makes a sample HTML page to show you how to use your mashed-up map.[7]

While being no expert of emergency planning and disaster recovery, with free or low cost data, this will show that a system such as our Virtual Earth demonstration can pull together, or mash up, data that could be of critical assistance in:

1. Emergency Planning
2. Emergency Routing
3. Citizen Awareness and Planning
4. Disaster Effect Planning
5. Mitigation Strategies

With a custom code system behind this, even complex analysis could be brought to help in creating a complex solution for emergency preparedness.

Web based drawbacks

There are of course draw-backs using web-based systems such as Virtual Earth or Google Maps. The first major drawback is that they require internet access at all times to function properly. This could be an issue during an emergency; however for use as a planning tool, this should not be a problem. Many of these solutions are open to allowing external caching and serving of the utility allowing non-Internet connected use. This ofcourse would increase the cost dramatically and for this test would break the concept.

In addition, relying on third-party data such that Virtual Earth or Google Maps use may be problematic in areas where development is occurring rapidly, as these sites only update their data periodically. For instance, the 'Birds eye' view data in Virtual Earth shows houses under construction in Douglas County CO that were in fact built in 2003. For most emergency response systems though, 3-5 year old data will have no impact on the needs of the system. And it is usually the aerial and bird's eye data that is 3-5 years old, the road layer is much more up to date.

Another issue is routing, routing in Virtual Earth or Google Maps doesn't allow one to create 'blocks', or roads that can no longer be used. However, routing capability in more complex systems requires very good data to work properly, by using an existing service such as Virtual Earth, no network data set is required. While blocks can't be set, routes can be formed with forced way points. It might not be the best routing but for the cost the value is good enough for the solution.

[7] Jeremy Elson, et al., "MSR MapCruncher for Virtual Earth,"Microsoft Research, 2007, 13 Dec. 2007, <http://research.microsoft.com/mapcruncher/>.

CONCLUSION

Integration of mapping and emergency management is a top priority for many smaller governments. However they do not have the financial or personnel resources to provide such a service. Web-based mapping solutions, such as shown in this demonstration can provide a low cost solution to for basic emergency management and routing needs while also lowering data costs, personnel requirements and infrastructure requirements. Mapping platforms such as Virtual Earth can be easily customized to display emergency management information from a variety of sources to allow planners and emergency personnel to better manage potential emergencies. These systems allow easy to use routing for vehicle deployment and evacuation purposes.

Is this a perfect system? No, the demonstration will only prove a concept that low-cost mapping can help municipalities that otherwise might not be able to afford a mapping based emergency planning system. While the system might not have all the features of more expensive entrants into this field, it can likely do what is needed for the client. With a post 9/11 and Katrina world, emergency planning and disaster recovery is an absolute must and finding creative ways to help incorporate this into becoming a standard for government agencies across America and the globe is critical to helping avoid future disasters, or at least be the best prepared possible.

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