BIGRAPHICAL INFORMATION

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Specific Responsibilities

A founding principal of PenBay Solutions, Mr Rich is responsible for all technology aspects of the GIS products and services for PenBay Solutions.

Past Experience

Mr. Rich has been involved in the design, implementation, and support of enterprise information systems for over fifteen years. Recently he has been involved as software architect and program manager for a wide range of clients and projects. Mr. Rich was heavily involved in the design and publication of the Penobscot Bay Media GIS Model for Interior Spaces published under the creative commons license in February, 2007.

Educational Information

B.S. – Forest Management, University of Maine

Building a Facilities Information Infrastructure to Support Public Safety

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EXECUTIVE SUMMARY

A number of recent events have served to highlight the lack of information about the insides of buildings typically available to emergency responders. From Mumbai, to the bombings in the London Underground, to Virginia Tech to the Deutsche Bank fire in which three fire fighters lost their lives, many instances from around the world have demonstrated how unprepared our public safety personnel are when faced with operating inside the buildings within their jurisdiction. Some emergency managers are starting to take action to fill in the holes in their digital maps of the environments they are expected to operate in. This paper will describe some of the new technologies for transforming existing data into more usable forms for public safety, capabilities for collecting new data and approaches for making this information available to emergency personnel in preparedness, analysis, response, and mitigation.

HOLES IN THE GIS FABRIC

GIS Uses for Emergency Services

Fire, police, and emergency medical services have been using GIS for years. The value of the technology has been proven time and again in rural areas and urban centers. Some of the areas where GIS has been most successfully employed include:

- Transportation logistics and routing
- Fire response planning
- Analysis of patterns of criminal activity
- Demographic analysis for the placement and type of emergency medical services

In most instances, GIS systems for public safety have been built in conjunction with other municipal systems and have leveraged investments made by other agencies in the development and acquisition of data layers such as transportation networks, parcels, imagery, and building footprints. As GIS use in state and local government has proliferated, a rich fabric of spatial data and information systems has grown up that can provide great value to the public safety community.

Unfortunately, most of the technologies used to develop GIS data have been based either upon aerial data collection or the field use of GPS. Neither of these approaches can effectively be used to collect data about the insides of buildings. The result of this history is that there are holes in our GIS data fabric. These holes correspond to the areas where we have the greatest concentration of financial capital, where we consume the greatest portion of our global energy resources, and where we spend the most of our time as human beings… the interiors of buildings.

GIS supports the four main areas of Public Safety

As stated previously, GIS has been deployed as a critical technology support for many different aspects of the public safety business cycle. The public safety community in the United States often organizes their approach to the problems of public safety into four main areas. GIS provides value to each of these areas in different ways.

- **Preparedness** - being prepared is one of the most important focal points of the public safety community. GIS supports preparedness most directly in the planning process. It is very common to see GIS used to create preplanned maps and a variety of scenario plans as the organization evaluates the various risks and threats that it faces and plans out how it will deploy its available resources to combat those threats.
- **Analysis** - the true strength of GIS is often most clearly demonstrated in the ability to analyze different facets of a public safety problem. GIS has been used to optimize the placement of fire stations. It has been used extensively to analyze and visualize the patterns of criminal activity. It has also been used to visualize the concentrations of at risk populations in order to better align public safety delivery capabilities with the demand for their services.
- **Response** - the use of GIS to support response units in the field has perhaps been overdramatized by TV shows such as 24 and the District. That said, GIS is becoming a critical component of most information fusion Center installations in our major urban environments. In this context, GIS is used to route emergency vehicles, established security cordons, and analyze the risk associated with flooding and airborne toxins.
- **Mitigation** - in the aftermath of an event and GIS is often used in damage assessment and in supporting the prioritization of mitigation efforts.

Lack of in-building data increases risk when operating inside buildings

All of the aspects of public safety preparedness, analysis, response, and mitigation apply equally to public safety activities that occur inside buildings. Unfortunately, until recently the public safety community has not had the tools available to them to support their planning, analysis, response, and mitigation activities within buildings. The risks associated with this lack of

information about the environment that they are working in is dramatized by events like the Deutsche Bank fire in New York City where three fire fighters lost their lives because they did not know that a critical standpipe had been deactivated during construction. In the Mumbai terrorist attacks, the emergency response community had no information about the interior of the buildings that were being occupied by the terrorists. A similar lack of information significantly hampered response efforts at Virginia Tech and Columbine high school. These events are but a few that highlight the risks associated with operating in an environment where there is inadequate geospatial information about building interiors available to the emergency response community.

PRACTICAL ALTERNATIVES FOR COLLECTING IN-BUILDING SPATIAL DATA

Recently, new technologies and methods for collecting and managing spatial information related to the insides of buildings have become more prevalent and more effective. Advances in 3-D city modeling technologies, building information modeling standards, and mobile deployment capabilities have opened up new possibilities for starting to fill in the holes in our geospatial data fabric. In some areas, new policy frameworks are evolving to compel building owners to contribute information about the insides of their buildings to a common public safety floor plan repository.

Types of data that are useful for Public Safety

We often think of floor plans as simple line work describing the core architectural elements within a building. While the basic geometries of the building architecture are certainly important to the public safety community, there is a lot of other information about the inside of a building, how it is used, and what is stored there, it is important for a holistic public safety approach to building internals. A few of the in-building data sources that would be of interest to public safety are listed below.

- **Floor plans** - floor plans are the obvious starting point for any in-building information system. These typically indicate the location of walls, windows, doors, stairwells, and elevators. Often there is no indication on a floor plan of how the space is being used other than perhaps the indication of where the bathrooms are located.
- **Emergency Action Plans** - emergency action plans add a layer of information on top of the floor plan to indicate where people congregate in the event of an emergency, where building exits are located, as well as the locations of any built-in emergency response equipment such as fire extinguishers, stand pipes, defibrillators, etc.
- **HAZMAT Inventories** - firefighters are particularly interested in knowing what kinds of hazardous materials they might run into during their response to an event. The locations of and contents of hazardous materials storage areas represent important data elements for firefighters that are often difficult for them to acquire.

- **Day/Night population estimates** - the response to a particular emergency event may be very different depending on how many people are actually in the building at the time. This information can sometimes be acquired through a relationship with the local building permitting authorities who have the responsibility for determining what uses are legal and appropriate for a given building.
- **Elevator plans** - particularly in large high-rise buildings where all of the elevators do not necessarily reach all the floors, it is important for firefighters to have an elevator riser diagram available that can explain to them the most efficient way for them to reach a particular floor.
- **Utility shutoff diagrams** - in many cases, providing or denying electric power, gas, and water, to particular portions of a building is an important aspect of a response plan. Understanding where the main utility flow control systems are and how to operate them is critical public safety information.
- **Locations of water supplies and other fire safety equipment** - one of the critical aspects of emergency response planning as a system of inspections that will validate the presence and proper operation of fire safety equipment inside the building.
- **Locations of unresolved inspection violations** - in many areas of the country, there is a system of public safety inspections conducted periodically for buildings within any given response jurisdiction. Making the locations of unresolved inspection violations available to responders can be critical information to be considered as they develop their tactical response plans. If this information had been available to commanders directing the response to the Deutsche Bank fire, those three firefighters might not have lost their lives.

Mandated submission of floor plans

Gaining access to floor plans can sometimes be a difficult challenge for the public safety community. There are several different approaches that are being taken in different areas across the country to address this problem. In some communities, the public safety community is working with those in the municipal government that have responsibility for various building permitting activities. As proposed and as built floor plans are often required documents for permitting processes, tying into the building permitting process can often be an effective way for the public safety community to harvest floor plans over time. In New York City, they have taken a more direct approach. In the aftermath of the Deutsche Bank fire, a city ordinance was put in place that requires the owners of buildings with 15 or more stories to submit updated emergency action plans per floor to the fire Department of New York every six months. This ordinance has enabled the fire Department of New York to collect hundreds of thousands of floor plans that were previously unavailable to their firefighters and make those floor plans available to those with responsibilities in planning, response, analysis, and mitigation.

Collection of existing plans for critical infrastructure buildings

In some areas, particular buildings have been identified as critical infrastructure. For these buildings, the public safety community has taken it upon themselves to fund data collection efforts that are specific to the risks associated with these particular buildings. Unfortunately, in many cases critical infrastructure buildings are older and the floor plans that exist for them may be out of date or inadequate for merchants who response purposes.

Collecting data from scratch

Fortunately for the public safety community, new technologies are evolving that enable very fast and cost effective data capture for a variety of in-building information requirements. A number of the major measurement technology providers such as Trimble are developing platforms designed to collect information about the interiors of buildings in ways that are readily usable for public safety requirements. As an example of this technology, Trimble has recently announced a mobile data collection platform capable of rapidly collecting 3-D lidar point clouds and spherical imagery in one pass through space. This kind of new technology capability should help public safety and other users to quickly and cost effectively develop data sets for their areas of responsibility.

Leveraging in-building data for other users

One important aspect to consider when thinking about designing a data collection approach for in-building data, is the fact that this data may be useful to a number of other communities as well. In the city of Boston and in the city of Philadelphia for example pilot projects are underway to collect information about the insides of buildings and underground infrastructure such as Subway stations that would be useful not only to the public safety community but also to those in city government responsible for capital planning, public property, transportation, and tax assessment. The possibility of investing in one data development effort that could serve multiple different municipal agencies is one that holds great appeal at the office of the CIO.

THE ROLE OF A COMMON GIS DATA MODEL FOR INTERIOR SPACES

In any data development effort, it is critically important for the data deliverables to be structured in such a way that they can provide value to a variety of downstream users. When it comes to modeling buildings there are a number of data standards that should be considered depending on the planned use of the data and the geographic scale that the solution is being designed for. At the city or regional scale, the CityGML standard put forth by the OGC shows great promise for being able to model buildings at the regional to neighborhood geographic scales. Unfortunately,

the portions of the CityGML standard that describes the internals of buildings are not well developed at this time.

At the individual building level, the national building information modeling (BIM) standard being put forth by the Building Smart Alliance is capable of modeling buildings and a very fine level of detail. The standard has been designed primarily for the design and construction of buildings rather than the operation and management of buildings that often valuable information can be extracted from a construction BIM that is useful for public safety purposes.

Another alternative that may be particularly attractive to public safety uses of in-building information is to model in-building data in the GIS. Over the past few years, ESRI, PenBay Solutions, and many other organizations have worked together to create a building interior spatial data model (BISDM) for GIS. This BSDM data model is intended to be a best practice pattern data model rather than a published standard. The data model can be downloaded from the ESRI website.

MAKING IN-BUILDING DATA AVAILABLE WHEN IT COUNTS

All the best in the world has no value if it cannot be put in the hands of decision makers in a form they can use when the time is right. The most appropriate form for this information and the tools with which to manipulate it is often very different depending on whether we are talking about the planning, analysis, response, or mitigation phases of the public safety effort. Some types of visualization and analysis require a full 3-D environment and desktop applications. Others require a very light weight mobile deployment on a handheld device. Still other requirements are best served through a web environment. Public safety users are leveraging all of these different technology models in different ways.

The fire Department of New York, for example, has a web enabled application for uploading and geo-referencing floor plans and a suite of mobile applications to support field inspection workflows. Other organizations are using a combination of CAD desktop tools and 3-D visualization environments to do it back to a show modeling from crowded spaces. The selection of a particular technology platform for a given public service agency is often driven by a combination of business requirements and the ability of that agencies IT department to support a specific technology stack.

FUTURE TRENDS FOR IN-BUILDING PUBLIC SAFETY GIS

The future of in-building public safety GIS is very interesting to contemplate. New innovations in the ability to rapidly collect information about the insides of buildings is greatly enhancing the availability of data while simultaneously driving down its cost of acquisition. New policy

frameworks and data sharing agreements between municipal agencies are helping to make data that already is being harvested by other agencies available to the public safety community. The addition of these new in-building data assets into an already rich GIS data framework represents a tremendous opportunity not only for the public safety community but for others that have interests in in-building information as well. Alongside the trends that are increasing the availability of information about the built environment, are the trends of rapidly increasingly available wireless bandwidth and a new generation of handheld devices that can take this information into the field. As these trends continue to make more data available to more people in more situations, it is not hard to imagine a world in which the likes of Jack Bauer of the show 24 truly have the decision support tools available to them to make the world a safer place for the rest of us.